Connecticut Embayments Study

Department of Environmental Protection
State of Connecticut

Phase I
Inventory & Problems Analysis

Anderson-Nichols
Hartford/Boston

CONNECTICUT EMBAYMENTS STUDY

PHASE I - INVENTORY AND PROBLEMS ANALYSIS

Prepared for
The State of Connecticut
Department of Environmental Protection
Coastal Area Management Program

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COASTAL EMBAYMENTS STUDY

PHASE I REPORT:

EMBAYMENT PROBLEM ANALYSES

Prepared for
Department of Environmental Protection

Prepared by
Anderson-Nichols Engineering

SUMMARY

Under a contract to the Department of Environmental Protection, Anderson-Nichols was selected to perform an environmental reconnaissance study of the coastal embayments of the state. A composite list of embayments was prepared by the Coastal Areas Management (CAM) Office. The list excluded embayments with known, well-documented problems, and focused on embayments with little or no existing documentation of problems.

Each community bordering one of the problem embayments received a set of questionnaires concerning the current state and history of the embayment. Municipal officials were invited to identify and describe any known environmental problems in the area. The responses were supplemented with a literature review, visits to key federal and state agencies, and a historic air photo analysis. The air photo analysis extended from 1934 to the present, and was supplemented by our own oblique air photos of the coast. The information collected in these analyses was used to identify a number of embayments that appeared to have serious environmental concerns. The state reviewed this list and added several sites, bringing the total number of embayments on the list to 35.

Each of the communities containing one or more of the study embayments was contacted by staff from Anderson-Nichols. Meetings and field visits to each embayment were scheduled and executed, and involved most of the local planning, engineering, and environmental officials. Information on the problems, land use, local environment, and developmental history was reviewed and discussed. Field visits included key town officials, and focused on typical or critical problem sites around the embayment.

All of the above information was compiled and presented by community and embayment in the appended report. Sections of the report for each embayment include such topics as basin environment, land use, problem identification, and problem analysis.

Based on the project analysis, seven basic problem categories were established: siltation, erosion, eutrophication, wetlands loss, fish and shellfish loss, flow constriction,and water pollution. The severity, trend and causes of each problem were provided to express the overall environmental quality of each embayment (see Tables S1 and S2).

Following this categorization of problems, various structural and non-structural solutions were discussed and evaluted in the Phase II Report.

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Table S.1

EMBAYMENT PROBLEM TYPE, SEVERITY, AND TREND

Name	Problem Type						
	Erosion	Siltation	Eutrophication	Wetland Loss	Fin/Shellfish Loss	Pollution	Flow Constriction
Wequetequock	-	2a	-	-	-	2b	1b
Quiambog	-	2a	3b	-	-	3b	-
West Cove	-	1b	-	-	-	-	2b
Palmer's Cove	-	3b	-	-	-	2b	1b
Mill Cove	-	2b	-	-	-	2a	2b
Poquetanuck	-	1b	1c	-	-	-	2b
Smith Cove	2b	1a	--	-	-	2c	1b
Keeney Cove	-	2b	-	-	-	2b	-
Smith's Cove	-	2a	3b	-	-	2c	2b
Niantic River	-	2a	-	-	-	2c	2b
Fourmile River	-	2a	3b	-	-	2a	3b
Middle Cove	2b	2b	-	-	-	2b	2b
Indiantown	3b	2b	-	-	-	3b	3a
Menunketesuck	2a	2a	-	-	-	2a	3b
West River	1a	1a	-	-	-	2b	1a
Little Harbor	-	1a	-	-	-	-	2b
E. Haven River	3b	2a	-	2b	-	2c	2c
Pattaconck	-	1b	-	-	-	3b	1b
Mill River	-	1b	1b	-	-	1b	2b
Gulf Pond	-	3a	-	-	-	2b	1b
Wepawaug	-	2b	-	-	-	2b	-
Marine Basin	-	3b	-	-	-	2a	-
Lewis Gut	-	-	-	1a	-	2a	2b
Frash Pond	-	3b	-	2a	2b	3b	1b
Ash Creek	-	-	-	-	-	2b	2b
Mill River	-	-	-	-	2b	1b	3b
Horse Tavern	-	-	-	2a	-	-	1a

Table S.1 (Continued)

EMBAYMENT PROBLEM TYPE, SEVERITY, AND TREND

Name	Problem Type						
	Erosion	Siltation	Eutrophication	Wetland Loss	Fin/Shellfish Loss	Pollution	Flow Constriction
Bermuda Lagoon	3a	-	-	-	2b	2b	-
Gray's Creek	-	2a	-	-	-	2b	-
Canfield Island	2a	2a	-	2a	-	-	-
Mill Pond	2a	1a	-	-	-	-	1b
Village Creek	-	2a	-	1a	-	-	-
Holly's Pond	-	-	-	-	-	2a	1b
Gorham's Pond	2a	-	-	-	-	-	2b
Byram Harbor	-	2b	-	3b	-	1c	-

Table Symbols

1 = Severe   2 = Moderate   3 = Minor

a = Conditions Worsening,   b = Conditions Stable,   c = Conditions Improving

Table S.2

EMBAYMENT PROBLEM CAUSES

Embayment	Problem					
	Erosion	Siltation	Eutrophication	Wetland Loss	Fin/Shellfish Loss	Pollution	Flow Constriction
Wequetequock	-	7,8	-	-	-	25,26,29	36
Quiambog	-	8,10	-	20	-	25,26,29	-
West Cove	-	11	-	-	-	-	38
Palmer's Cove	-	8	-	-	-	25,26,30	36,37
Mill Cove	-	7,8-	-	-	-	25	36,37
Poquetanuck	-	8	15	-	-	-	36
Smith Cove	2	9,8	-	-	-	25,28,32,33	36,37
Keeney Cove	-	8	-	-	-	25,26,32	-
Smith's Cove	-	8,12	15	-	-	25	44
Niantic River	-	8,9	-	-	-	25,26,32	36,37
Fourmile River	-	11	15	-	-	32	36,37
Middle Cove	4,5,6	10	-	-	-	26	44
Indiantown	6	7	-	-	-	25,26	45
Menunketesuck	2,4	11	-	-	-	25,26,31	37
West River	1	10,11	-	-	-	25,28	39
Little Harbor	-	11	-	-	-	-	38
E. Haven River	-	8,11	-	18	-	25,31,35	40
Pattaconk	-	8,14	-	-	-	25,26	36,37
Mill River	-	8,9	15	-	-	27,29,34	39,41
Gulf Pond	-	7	-	-	-	29	36,37
Wepawaug	-	8	-	-	-	26,29	-
Marine Basin	-	8,11	-	-	-	26,29,32	-
Lewis Gut	-	-	-	18	-	29,35	39

Table S.2 (continued)

EMBAYMENT PROBLEM CAUSES

Embayment	Problem: Erosion	Siltation	Eutrophication	Wetland Loss	Fin/Shellfish Loss	Pollution	Flow Constriction
Frash Pond	-	8	-	17	21,22	26	40
Ash Creek	-	-	-	-		27,29,30	39,40
Mill River	-	-	-	-	21	25,29,34	36,37,42
Horse Tavern	-	-	-	18	-	-	40
Bermuda Lagoon	-	-	-	16	23,24	25,26	-
Gray's Creek	-	8,9,10,11	-	-	-	27	-
Canfield Island	1	10,11	-	17,20	-	-	-
Mill Pond	1,2,3	7	-	-	-	-	43
Village Creek	-	8,11	-	17	-	-	-
Holly's Pond	-	-	-	-	-	26,29	42
Gorham's Pond	-	8,9	-	-	-	-	42
Byram Harbor	-	7,10	-	16,20	-	25,32	-

Table S.2 (continued)

Problem Cause Categories

Erosion

1. Wave Attack
2. Bank Undermining; Natural
3. Bank Undermining; Man-caused
4. Boat Wakes
5. Dredging Impacts
6. Wave Reflection

Siltation

7. Constriction
8. Upland Erosion
9. Bank Erosion
10. Current Transport
11. Wave Transport
12. Earlier Land Use
13. Development
14. Deteriorating Bulkheads

Eutrophication

15. Water Pollution

Wetland Loss

16. Riverine Erosion
17. Filling
18. Tide Gates/Flushing Restrictions
19. Wake Erosion
20. Wave Attack

Fin/Shellfish Losses

21. Pollution
22. Tide Gates
23. Septic Failure
24. Natural Conditions

Pollution

25. Septic Failure
26. Residential Runoff
27. Urban Runoff
28. Agricultural Runoff
29. Point Discharge
30. Marina Spills
31. Boat Discharges
32. Leachate from Landfills
33. Fly Ash Erosion
34. Contaminated Bottom Sediment
35. Transport from Other Areas

Flow Constriction

36. Rail Road Causeway
37. Bridge
38. Jetty/Groin
39. Natural Bar Formation
40. Tide Gates
41. Marsh Filling
42. Dam
43. Culvert
44. Natural Form
45. Filling

CHAPTER 1 PHASE I PROCEDURE AND SUMMARY

INTRODUCTION

The State of Connecticut possess extensive coastal resources in various states of development. These resources constitute a major environmental and economic asset for the state, and as such should be maintained and protected from future damage or destruction. The Department of Environmental Protection (DEP) under *Special Act 80-45 was charged to study the environmental problems present in the coastal waters of the state. The DEP selected Anderson-Nichols to perform the analysis. The following text outlines the study procedure and findings.

Study Procedure

The Study was divided into two phases. Phase I first identified embayments with environmental problems and then investigated the type, source and magnitude of each problem. The second phase identified a variety of solutions for the majority of problems encountered, and can be used as a guide to determine practical alternative solutions for each embayment studied. Since this report summarizes the first phase of the study, a detailed outline of the Phase I procedure follows.

Preliminary Embayment Identification

Following the selection of Anderson-Nichols as the consultant, our staff received a general listing of coastal embayments subdivided into the following six groups:

1. Sites containing a Federal Navigation Project: deleted from further study. Since the main problem would be future maintenance dredging, most have been studied in detail

2. Site does not meet the definition of an Embayment: deleted from further study, i.e. eroding headland fronting Long Island Sound

3. Site contains no known or identified problems: deleted from further study

4. Embayments where multiple and complex problems exists: beyond the scope of study, deleted from further study

* An Act to Study Pollution and Siltation in Coastal Waters.

Preliminary Embayment Identification (con't)

5. Sites studied by the Federal Railway Administration Study: deleted from further study

6. Embayments which contain or are suspected to contain problems - these form the nucleus of sites for further study

A summary of this list is presented in Table 1.1. Federal Navigation Projects, and Federal Railway Administration studies were excluded, since the embayments have already been studied and have received some form of federal funding. Those sites not meeting the criteria of an embayment were missing one or more of the following attributes:

1. tidal influence

2. presence of salt water

3. semi-enclosed shape

4. of a size similar to those in Table 1.1.

A second list of embayments identified 41 sites that had potentially serious problems, and would require further study (See Table 1.2).

In order to make the study more comprehensive and representative of the entire coastal environment, our staff reveiwed topographic maps of the state, and included 29 additional embayments that conformed to the four criteria listed above, but were not included on the state list (see Table 1.2 for the composite list). This group of embayments was subjected to a screening analysis based on the presence or absence of significant environmental problems.

Detailed Screening

The detailed screening of sites listed in Table 1.2 involved three major steps: a literature review, a questionnaire sent to various members of the local government, and a review of past and present air photos. Based on the results of this screening, a number of embayments were selected for on-site field studies and in-depth analysis.

TABLE 1.1

PRELIMINARY EMBAYMENTS LISTING: CAM

Branford
- Branford Harbor - 1

Clinton
- Clinton Harbor - 2
- Hammock River - 2

Deep River
- Post & Pratt Coves - 3

Essex
- Middle Cove - 6
- North Cove - 6
- South Cove - 6
- Great Meadows - 2
- Thatchbed - 2

Greenwich
- Byram Harbor - 6
- Greenwich Cove - 6
- Tomac Cover - 6
- Cos Cob Harbor - 1
- Greenwich Harbor - 1

Guilford
- East River - 1,2
- Little Harbor - 6
- West River - 6

Lyme
- Hamburg Cove - 3
- Selden Cove - 3

Montville
- Horton Cove - 3

Bridgeport
- Black Rock Harbor/Cedar Creek - 1
- Bridgeport Harbor - 1,4

Darien
- Gorham's Pond/Darien River - 6
- Holly Pond - 6
- Scott Cove - 6

East Lyme
- Fourmile River - 6
- Niantic River - 6
- Smith Cove - 6
- Pataguansett River - 6

Fairfield
- Ash Creek - 6
- Mill River (above Harbor Rd.) - 6
- Pine Creek (to the dike) - 6

Groton
- Birch Plain Creek - 2
- Poquonnock Cove - 3
- Beebe Cove - 6
- Poquonnock Cove - 6
- Bakers Cove - 6
- Pine Island Bay - 6

Ledyard
- Clark Cove - 6
- Long Cove - 6
- Poquetanuck Cove - 6
- Mill Cove - 3

Milford
- Milford Harbor - 3
- Gulf Pond - 6

New Haven
- New Haven - 1
- Duck Pond - 2
- Hemingway Creek Salt Marsh - 2
- Mill River - 6

TABLE 1.1

PRELIMINARY EMBAYMENTS LISTING: CAM (continued)

New London
- Shaw Cove - 5

Old Lyme
- Lord Cove - 6

Stamford
- Cove Harbor - 2
- Cummings Park Cove - 2
- Stamford Harbor - 1,4

Stratford
- Lewis Gut - 6
- Marine Basin - 6
- Selbys Pond - 2

Westbrook
- Patchogue River - 1

Norwalk
- Canfield Island - 6
- Harbor View Wetland - 6
- Mill Pond - 6
- Village Creek - 6
- Wilson Cove - 6

Old Saybrook
- North Cove - 1, 3

Stonington
- Lords Point Cove - 6
- Quiambog Cove - 6
- Wequetequock - 6
- Mystic River - 2
- Quanaduck Cove - 3
- Stonington harbor - 1
- Whitford Pond - 2

Waterford
- Goshen Cove - 6
- Keeny Cove - 6
- Smiths Cove - 6
- Mamacoke Cove - 3

Westport
- Gray's Creek - 6
- Saugatuck Harbor - 1
- Bermuda Lagoon - 6

1- Federal Navigation Project
2- Does not fulfill definition requirements
3- No known or identified problems
4- Multiple & complex problems, beyond the scope of this study
5- Federal Railway Admin. Study
6- May require study

Note: For the purposes of this study, the following rivers are not embayments: Connecticut River, Thames River and Housatonic River.

Detailed Screening (con't)

The first step in the analysis involved a literature review of the selected embayments. Various federal and state agencies were approached for any studies on the coast, including the Corps of Engineers, FEMA, EPA, NOAA, Sea Grant, NERBC, the State Department of Environmental Protection, etc. (See Table 1.3) All collected studies were reviewed and classified by community and problems addressed.

The second step in the analysis involved a mailing of questionnaires to officials responsible for town environmental issues. The questionnaire (See Figure 1.1) listed eight general categories of problems evident from the above literature review. These categories included erosion, siltation, pollution, circulation and flow, eutrophication, shell and finfish losses, saltmarsh encroachment, and other (special problems). The respondents were requested to identify the cause, severity, history and trends of the problem(s), as well as potential proposed solutions to each problem. A general environmental inventory was also requested for each site. These questionnaires were sent to four or five environmental officials at each town (listed in Table 1.2) requesting their reply. The relatively large number of officials contacted at the community level insured a response from each community, and in the case of overlapping responses, allowed a more thorough coverage of embayment problems. A list of officials receiving the questionnaire has been provided in Appendix I. Out of the 98 questionnaires mailed out, 55 were returned to Anderson-Nichols. Many of the communities offered only one response. Copies of of these responses have been provided to the DEP.

Following receipt of the questionnaires, our staff examined the 1934, 1951, 1965, 1970 and 1980 vertical black and white photos of each embayment, as well as the 1974 infra-red vertical air photos. These photos were reviewed, along with the questionnaire responses, and both were used to specify the type and general change rates of problems in each embayment. Items considered included evidence of excessive shoreline development, rapid rates of erosion or accretion, changes in water, tone or color, encroachment into wetlands, and other items of concern. The data from the photos were used to verify problems already identified, and to isolate new problems where visible. Special attention was paid to visible trends over the most recent 10-15 year period, especially in areas that exhibited specific environmental concerns. In cases of distorted photographs and/or lack of visible data supporting any official identification of a significant problem, phone calls were made to the officials of the town in question. Questions were raised and discussed, allowing clarification of any uncertainties.

TABLE 1.2

EMBAYMENTS REQUIRING FURTHER EXAMINATION

A. STONINGTON
1. Wequetequock Cove
2. Lord's Point Cove
3. Quiambog Cove

B. GROTON (Town)
1. Bebe Cove
2. West Cove
3. Palmer's Cove
4. Bennett's Cove
5. Pine Island Bay
6. Poquonnock Cove
7. Baker's Cove

C. LEDYARD
1. Long Cove
2. Clark Cove
3. Poquetanuck Cove

D. WATERFORD
1. Smith's Cove
2. Goshen Cove
3. Keeny Cove

E. NORWICH
1. Yantic River

F. EAST LYME
1. Smith Cove
2. Niantic River
3. Fourmile River
4. Pataguansett River

G. OLD LYME
1. Black Hall River Wetlands
2. Lord Cove

H. ESSEX
1. Middle Cove
2. North Cove
3. South Cove

I. OLD SAYBROOK
1. Indiantown Harbor

J. WESTBROOK
1. Patchogue River
2. Menunketesuck River

K. GUILFORD
1. East River
2. Grass Island
3. West River
4. Little Harbor

L. BRANFORD
1. Stony Creek
2. East Haven River
3. Page's Cove
4. Lamphier Cove
5. Linsey Cove

M. CHESTER
1. Pattaconk Creek

N. NEW HAVEN
1. Mill River

O. HAMDEN
1. Mill River

R. MILFORD
1. Gulf Pond
2. Wepawaug River
3. Beard's Creek

TABLE 1.2

EMBAYMENTS REQUIRING FURTHER EXAMINATION (continued)

S. STRATFORD
1. Marine Basin
2. Lewis Gut
3. Mac's Harbor

T. SHELTON
1. Farmill River

U. FAIRFIELD
1. Ash Creek
2. Mill River
3. Pine Creek
4. Mill Pond
5. Horse Tavern Creek

V. WESTPORT
1. Bermuda Lagoon (man-made)
2. Gray's Creek

W. NORWALK
1. Canfield Island
2. Charles Creek
3. Harbor View Wetland
4. Mill Pond
5. Village Creek
6. Wilson Cove
7. Fivemile River
8. Farm Creek

X. DARIEN
1. Scott cove
2. Holly Pond
3. Gorham's Pond

Y. GREENWICH
1. Byram Harbor
2. Greenwich Cove
3. Tomac Cove

TABLE 1.3

FEDERAL, STATE, AND PRIVATE SECTOR DATA SOURCES

Federal Agencies

- EPA
- NERBC
- U.S. Army Corps of Engineers
- Fish & Wildlife
- National Marine Fisheries
- USGS
- SCA
- FAA
- FEMA
- USCG
- New England Rivers Center
- NOAA
- Sea Grant Program

Private Sector

- Yale University
- Connecticut College
- URI
- U Conn
- Northeast Utilities
- Oceanic Society

State Agencies

- DEP Natural Resources Center
- DEP Water Compliance Unit
- Department of Health
- DEP Planning and Coordination/Coastal Area Management
- DEP Fisheries Unit
- DEP Wildlife Unit
- 208 Program
- DEP Water Resources Unit
- CEIP-Office of Policy & Management

Detailed Screening (con't)

Following this screening, the results were summarized in a letter forwarded to the state. In that letter, the embayments listed in Table 1.2 were stratified into two groups:

1. those embayments having significant ongoing environmental problems with little possibility of immediate resolution

2. those embayments exhibiting problems of an insignificant nature, or problems that are clearly reversing themselves.

The results of this analysis are summarized in Table 1.4. Several special additions were made to the existing list (see Table 1.4) at the request of the state. In most cases, sites had been eliminated because the town did not respond to the questionnaire in a timely manner. The specific reasons for selection or elimination of each embayment are presented in Appendix II.

Detailed Analysis of Embayments

Each of the embayments in Table 1.4 was subjected to a detailed analysis. This analysis included a review of historic air photos (1934, 1951) to determine visible trends in settlement, land use, sedimentation, etc. Following a review of the air photo base, interviews were scheduled for each community. One or more of our field staff members and arranged meetings with key planning, environmental, engineering, and administrative staff. The history, type, and trends of each embayment's problems and uses were discussed. In addition, our staff toured each embayment with one or more community staff members, inspecting, and photographing embayment and shoreline condition of concern. Available reports, supporting data, and any other information of interest were gathered for further analysis. In concert with the field interviews, our staff flew the length of the coast, taking high altitude oblique color and black and white photos of each study site. These photos provided a timely resource for locating points of concern and identifying current conditions around each study site. Finally, our staff contacted regional, state and federal environmental agencies (as well as the private sector) to obtain various environmental data (see Table 1.3). These data included water quality information, hydrologic data, biospheric data, earlier studies, etc.

TABLE 1.4

FINAL LIST OF STUDIED EMBAYMENTS

A. STONINGTON
- A.1 Wequetequock Cove
- *A.2 Quiambog Cove

B. GROTON
- B.2 West Cove
- B.3 Palmer's Cove

C. LEDYARD
- *C.1 Mill Cove
- *C.3 Poquetanuck Cove

D. WATERFORD
- D.1 Smith Cove
- *D.3 Keeny Cove

F. EAST LYME
- *F.1 Smith's Cove
- *F.2 Niantic River
- *F.3 Fourmile River

H. ESSEX
- H.1 Middle Cove

I. OLD SAYBROOK
- I.1 Indiantown Harbor

J. WESTBROOK
- J.2 Menunketesuck River

K. GUILFORD
- K.3 West River
- *K.4 Little Harbor

L. BRANFORD (East Haven)
- L.2 East Haven River

M. CHESTER
- M.1 Pattaconk Creek

N. NEW HAVEN
- N.1 Mill River

R. MILFORD
- R.1 Gulf Pond
- R.2 Wepawaug River

S. STRATFORD
- S.1 Marine Basin
- S.2 Lewis Gut
- S.3 Frash Pond

U. FAIRFIELD
- U.1 Ash Creek
- U.2 Mill River/Pond
- U.5 Horse Tavern Creek

V. WESTPORT
- V.1 Bermuda Lagoon
- V.2 Gray's Creek

W. NORWALK
- W.1 Canfield Island
- W.4 Mill Pond
- W.5 Village Creek

X. DARIEN
- X.2 Holly Pond
- X.3 Gorham's Pond

Y. GREENWICH
- Y.1 Byram Harbor

* Special Additions Requested by State CAM Office

Detailed Analysis of Embayments

All of the above data were collected and organized by embayment and community, and were used to review and identify the major enviromental problems present, their causes, and a general analysis of the expected problem trends in the fuure. A composite enviromental/land use profile was also assembled. The results of these labors comprise the next 20 Chapters of this report. Each community is reviewed in a separate chapter, and each embayment within a given community is analyzed in its own section. The last section of each chapter arranges the problems into groups based on the type and severity of problems experienced within each given embayment, and provides a general ranking of the problem embayments.

Chapter 21 provides an overall discusson of the general environment for all the embayments studies, and summarizes problem types, trends, severity and causes.

CHAPTER 2 STONINGTON EMBAYMENTS

INTRODUCTION

The Town of Stonington is located in New London County and is the easternmost community on the Connecticut shoreline. The town has an area of 42.7 square miles, of which approximately 80% lies within the Mystic coastal basin. The remaining 20% drains into the Pawcatuck River. During the period 1970 to 1978 Stonington's population increased 7.2% (1970-15,940, 1978-17,100), while the average state increase was only 4.7%. The population density of the town is 451.1 persons per square mile, significantly lower than the state average of 651.8 (1978 census data).

The Stonington shoreline is highly irregular, with several streamfed bays extending one to two miles inland. The entire area was altered by the most recent glaciation and now features areas of exposed bedrock and large volumes of glacial outwash (gravel, silt, and clay). The receding ice mass also left behind debris that allowed the offshore formation of Fisher's Island. In addition to glacial impact, coastal erosional processes have allowed the formation of both Sandy Beach and Napatree Beach, as well as the erosion of a portion of Watch Hill (See Figure 2.1).

The lee of Fisher's Island provides a well-sheltered boating area and also helps protect coastal development from major southerly storms. In addition, the estuarine processes within Fisher's Sound have formed extensive shallow areas. The best example of these shallows is the Little Narragansett Bay Region.

There are five major embayments in Stonington: the Pawcatuck River, Wequetequock Cove, Stonington Harbor, Quiambog Cove, and Mystic Harbor. Historically, the Mystic Harbor and Pawcatuck River have been most intensively used. Currently, the Pawcatuck River drains a large industrial area, and the river exhibits major water pollution problems. Stonington Harbor is used as a regional boating center and exhibits water pollution problems characteristic of heavy recreational/marine traffic.

Since there are areas of moderately dense settlement within Stonington, sewer systems have been provided in many areas. Sewered areas include the Pawcatuck River, Mystic Harbor, and Stonington Harbor. The predominantly residential areas around Quiambog and Wequetequock Coves are not sewered. Septic systems provide the only water treatment available in these areas. Poor embayment circulation, poor land drainage, tidal flooding, and occasional septic tank failures aggravate local pollution problems. Large areas of open land suggest a potential for major development around these embayments.

WEQUETEQUOCK COVE

A: Physical Description

Location

The cove is approximately 2.5 miles from the Rhode Island border and is the major northern tributary to Little Narragansett Bay (See Figure 2.1). The mouth of the cove is approximately 1.5 miles north of the mouth of the Pawcatuck River. The Boston Post Road (U.S. 1) parallels the shoreline near the head of the cove. Approximately 0.75 miles south of the highway, the Conrail line causeway and bridge divide the embayment into an inner and outer harbor. The southern limit of the embayment is defined by a line between Randall Neck and Ledwood Island (also known as Elihu Island), and the causeway to the island (See Figure 2.1).

Site Orientation and Configuration

The embayment is roughly linear with its axis oriented SSW to NNE (See Figure 2.1). The width of the mouth of the cove (SE point of Ledwoods Island to Randall Neck point) is approximately 0.5 mile and narrows progressively as it penetrates inland. The embayment length (Green Haven Road bridge to Ledwood Island) is approximately 1.9 miles.

Tidal Data

Mean tidal range -	2.7 ft.
Spring tidal range -	3.2 ft.
Mean tide level -	1.3 ft.

Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth: 1-7 ft. (MLW)
Channel Depth: 3-7 ft. (MLW)

Additional Comments: A privately-maintained channel runs form the outer cove off the northeast shore of Ledwoods Island, through the Conrail Bridge, to a marina just north of the confluence of Oxecosset Brook and the cove.

Basin Hydrology

Regional Drainage Basin: Mystic River
Embayment Basin Area: 10 square miles

Tributaries to Embayment: Anguilla Brook
Oxecosset Brook
Two Unnamed Brooks

Other Sources of Freshwater Inflow: Storm runoff

Scale: 1" = 2000'

FIG 2.1 WEQUETEQUOCK COVE ENVIRONMENTAL LAND USE

Legend:

wetlands	**B** beach
A agriculture	**M** marina
R residential	**S** shellfish beds
C commercial/ industrial	→ public access

Constrictions to Natural Flow and Circulation:

Structure	% Constriction	Distance from Mouth
Conrail Bridge	75-100	3800 feet

Sources: U.S. Geological Survey Connecticut Drainage Basin Gazeteer, 1981 Conn. Dept. of Environmental Protection

Water Quality Conditions

Upstream Water Quality Classification: B
Embayment Water Quality Classification: SB

Direct Discharges:

Source	NPDES Permit #	Waste Characteristics
American Velvet	CT0003727	BOD loading, suspended solids, phosphates, salt

Sewer Service Area and Discharge Point: None

Significant Non-point Pollution Source: Residential and road runoff.

Shoreline and Bottom Conditions

Extent of Shoreline Modification: Most of the outer cove shoreline remains in an undisturbed state. Ledwoods and Grass Islands are large rock outcroppings and have bedrock shorelines with little wetland vegetation. The rest of the outer cove consists of fringe wetlands ranging from 100 to 500 feet wide.

The inner cove shoreline (upstream of the Conrail bridge) is more densely settled and has been stabilized and altered in a number of areas. These areas include the town landing field, the confluence of Oxecosset Brook and the Cove, and the Cove shoreline in general. The landing strip extends to within 50 feet of the shoreline, and the inland side is bordered by roughly 500 feet of wetlands, suggesting that the entire area was once a wetland. In the area near the mouth of Oxecosset Brook, most of the shoreline has been structurally stabilized. Former wetlands on the west shore have been filled for residential development, and the roadbed of U.S. 1 covers the natural shoreline. The shore near U.S. 1 is littered with drift and debris (oil drums, old wood, scrap iron, etc.).

Shoreline and Bottom Conditions (con't)

The shoreline at the confluence of Anguilla Brook (head of Wequetequock Cove) is well-stabilized with seawalls and a weir extending across the narrow water body. Houses are situated close to the brook on fill and little remains of the former natural landscape.

On the east side of the inner cove, some of the wetlands have been filled to create buildable upland areas. A few seawalls and pile supported docks can be found along the shoreline. The presence of a continuous fringe marsh, even in front of old seawalls, seems to indicate that the marshes have been colonizing silted intertidal areas.

Shoaling and Sedimentation Problems: Sedimenation is a problem throughout the embayment. The constriction caused by the Conrail causeway accelerates sedimentation in the upper embayment, so most of the sediment delivered by upland erosion remains in the upper embayment. Wave transport carries substantial volumes of sediment on-shore in the lower embayment, and the entire area is characterized by shallow water and shifting bars.

Bottom Sediment Conditions: Bottom sediments vary the length of the cove and are mostly a mixture of mud/silt, with larger components of sand near the mouth of the embayment.

Surrounding Lands

Maximum Basin Elevation:

Location	Height
Randall Neck	80 feet

Topography: The area terrain is relatively level, and few areas exhibit steep slopes. In the upper reaches, the topography is gently rolling, and local relief does not exceed 70 feet. The steepest slopes in the area border the western edge of wetlands that border the western shore of the embayment (See Figure 2.1).

General Vegetation Characteristics: Most of the embayment drainage basin remains in a natural state. Upland vegetation near the embayment consists primarily of forest and overgrown fields. Some land remains in agriculture, usually for hay and pastures, or in a few cases, truck vegetables. The Stonington airport is predominantly a grass field.

Surrounding Lands (con't)

The wetlands in the lower embayment are in excellent condition, while the upper cove wetlands have been filled and destroyed for development. Some small intertidal areas are being recolonized at this time. See Section 10 for more detail).

Soils:

Name	Characteristics	Slope %	Septic Tank Suitability
Charlton-Hollis	fine sandy loam	3-15	poor
Ridgebury, Whitman and Leicester	extremely stony fine sand	-	very poor
Rumney	fine sandy loam	-	very poor
Woodbridge	extremely stony fine sandy loam	3-15	poor
Haven	silt loam	0-3	very poor
Raypol	silt loam	-	very poor
Tisbury	silt loam	0-3	very poor
Typic Udorthents	cut and fill	-	variable
Pawcatuck	mucky peat	-	very poor
Rock Outcrop - Hollis	complex	-	very poor
Narragansett - Hollis	complex	3-15	poor
Paxton & Broadbrook	extremely stony soils	3-15	poor

Shellfish and Finfish Resources

According to a University of Rhode Island marine technical report (Ehringer et al, 1978), the shellfish found in Little Narragansett Bay include a variety of species including: quahogs, soft-shelled clams, surf clams, bay scallops, blue crabs, rock crabs, green crabs, oysters, mole crabs, mud crabs, lobsters, spider crabs, horseshoe crabs, periwinkles, mussels, lady crabs, moon snails, and oyster drills.

Shellfish and Finfish Resources (con't)

According to Ehringer et al, bay scallops had been absent for sometime in Little Narragansett Bay until the area was seeded in 1974; now they are abundant. The greatest concentration of blue mussels is located at Sandy Point. Louis Bayer, a member of the Stonington Conservation Committee, indicated that razor clams can also be found in the embayment.

Though no biological surveys on shellfish are available for the inner cove, it is likely that shellfish, tolerant of lower salinities, can be found in this area. Specifically, the inner reaches are likely to support oysters and bay scallops.

Past biological surveys of Little Narraganset Bay and its tributaries (Gordon, 958; Sisson, 1972; White, 1972) indicate that a number of fish species are found in the embayment, including: alewife, shad, american eel, anchovy, weakfish, smelt, bluefish, winter flounder, striped bass, brook trout, sand dab, scup, pipefish, and tautog.

Wetlands

Most of the shoreline along the lower portions of the embayment exhibits a continuous fringe marsh ranging from 100 to 500 feet wide. The marsh essentially separates that basin uplands from the water and provides both a valuable habitat and a highly-effective biological filer for detritus and eorded soil. A few stretches of embayment shoreline have more expansive tidal wetlands such as the inland side of the Stonington landing field.

Most of the tidal wetlands along the upper reaches of Wequetequock Cove (north of confluence of Oxecosset Brook) have been filled and destroyed to support commercial and residential development. A narrow fringe marsh appears to have recolonized some stretches of these shallow intertidal areas. Some segments of shoreline, such as the filled shoreline along the U.S. 1 embankment, are too steep and their substrate too coarse to support fringe marshes.

Other embayment wetlands have been altered by the following two activities: 1) mosquito ditching, and 2) construction of bridges and causeways which have altered coastal drainage and tidal circulation patterns. The Conrail causeway and bridge have likely reduced the average salinity of the inner cove, thus leading to possible changes in marsh vigor and species type. Tributaries to the cove also have been constricted. Templeton (1972) indicates that the U.S. 1 bridge over Oxecosset Brook (a.k.a. Donahue Brook) has significantly reduced tidal exchange with wetlands on the inland side of the highway. Consequently, they have become essentially freshwater marshes. The weir across the head of Wequetequock Cove (See Figure 2.2) is another case of reduced tidal influence, as the mouth of Anguilla Brook has been reduced to only an 8-foot opening. Freshwater marshes are found along the shoreline above the weir.

Wetlands
(con't)

Overall, the embayment marshes have been disturbed very little over the past ten years. The shoreline alterations mentioned above, in most cases, date back at least twenty years and, in the case of the railroad bridge, over 100 years.

Environmentally
Sensitive Areas

The Barn Island State Wildlife Management Area lies directly southeast of the embayment. It is separated from Wequetequock Cove by a north/south ridge on Randall Neck. Though the Management Area is outside the embayment study area, much of the wildlife there relies on the embayment to some extent for food and additional habitat. Field observations during Spring 1981 noted that an Osprey (Pandion haliaetus) was nesting on one of te platforms in the Management Area. The ecological value of the Barn Island marshes is well-documented by Hebard (1980).

B: Land Use Analysis

Current Shoreline
and Water Use

Historically, Wequetequock Cove has not served as a major boating harbor but rather as a quiet coastal area for passive recreation. The embayment has no federally-maintained channels. The shallow characteristics of the cove and the low clearance of the railroad bridge (6 feet) present a major impediment to expanded boating use.(See Figure 2.1).

Presently, the cove has one marina which is located north of the mouth of Oxecosset Brook. Most of the boats at the marina are small, shallow draft vessels that can fit under the bridge. Several of the houses along the inner cove shoreline have docks for private boating use. These docks typically are supported on pilings and extend fromths horeline through a narrow fringe marsh to deeper water.

Fringe marshes line most of the embayment shore, leaving little developed shoreline with direct water access. The inner cove shoreline, north of Oxecosset Brook is one of the few areas that has ben stabilized. (See Figure 2.1).

Current Upland Use

The uplands exhibit moderate to light levels of development, and land uses range from residential lots to low-impact farming. There are increasing developmental pressures on the area that are being regulated by the town.

Historical and Significant Land Use Changes

Historically, the Wequetequock Cove drainage basin has been an agricultural area. 1934 aerial photographs show large tracts of land under cultivation with some large fields set aside for grazing and hay. Since the 1930's the agricultural-based economy has dwindled. Aerial photos froms 1951, 1970, and 1980, show a successive decrease in actively-farmed acreage. Most of the inactive land is now either overgrown fields or forest, depending on the time that has lapsed since active use.

Concurrent with the decline in agriculture, the basin land has become more residential and commercial. Little new road building has occurred since 1951 on either the east or west side of Wequetequock Cove, though there has been some residential infilling. The most significant change in land use is evident along the west side of the inner cove. The Stonington landing field was build during the 1970's on coastal frontage formerly used for agriculture. Commercial development within the immediate basin has expanded principally along U.S. 1, eastbound from the Oxecosset Brook bridge. The development is typically of low height, spread over a large area, and includes large parking lots. These developments increase the area's impervious surface and generate increased urban runoff and the potential for non-point pollution of the embayment.

In an effort to offset increasing development pressures along the coast, the town revised the zoning to include a special zone for coastal lands. Site planning standards under this zoning classification provide for a 100-foot minimum setback from tidal marshes and significant inland wetlands, as well as a 25-foot setback from the 100-year flood hazard level. The coastal land zone surrounds almost all of the immediate upland around Wequetequock Cove and in several places (such as Randall's Neck) extends inland up to 1-2 miles. The narrowest segment of the special zone is along U.S. 1 where there is a general commercial zone and a low-density residential zone. The landing strip property is classified as industrial.

Public Access and Recreational Opportunities

There are no known public boat launching areas within the embayment; however, there is a public access point outside the cove on the eastern side of the point at Randall's Neck (See Figure 2.1). The Wequetequock Cove Boat Company and Coveside Motel and Marina both maintain private boat ramps which are available for a minor user charge. Transient slips are also available to overnight boaters.

C: Problem Identification

Local Departments and Offices Consulted

Stonington Planning and Zoning Commission
Stonington Shellfish Commission
Stonington Conservation Commission

Response from Questionnaires and Local Meetings

Responses and interviews indicated that the Old Conrail bridge and causeway have had a major impact on the tidal circulation and flushing of the cove. The narrow horizontal clearance of the bridge (64 feet) is only 8 percent of the natural embayment width. This restricts flushing and probably has changed the salinity characteristics of the inner cove. Limited flushing increases the potential impact of pollutants (such as the suspected septic tank leachate and highway runoff) entering the cove.

One of the other major impacts of limited flushing is accelerated sedimentation. Potential sources include shoreline erosion, natural drainage and surface runoff. Town officials believe that siltation of the cove is a moderate problem that has increased since the 1940's. Other cited problems include eutrophication and fish loss.

Pawcatuck River pollution was also mentioned by town officials as historically having a significant impact on coastal water quality of the cove. Napatree Beach and Sandy Point enclose Little Narraganset Bay, which localizes and moves the polluted river discharge into Wequetequock Cove. Tide and wind play a major role due to the shallowness of Narragansett Bay. Officials, however, also claim that recent construction of the new Pawcatuck wastewater treatment plant improved the river and embayment water quality significantly.

Results of Field Survey and Research

A field survey of the embayment confirmed existence of the cove's circulation and siltation problems. The small inlet, confined to the 64 foot wide bridge span of the railroad crossing, affords only a fraction of the tidal circulation and mixing that formerly flushed the embayment of pollutants and silt. At present less than 25 percent of the embayment shoreline inside the railroad crossing is developed, explaining why only limited problems have developed from this large-scale constriction. Much of this privately-owned open space has yet to be developed so there is also considerable potential for future direct and indirect pollution of the embayment.

Results of Field Survey and Research (con't)

Several neighborhoods at the head of the cove already impact the water quality of the embayment. Homes in the area where Anguilla Brook flows into Wequetequock Cove are built very close to the water's edge permitting little room for the proper placement of septic systems. The houses are also in the floodplain with high water table conditions. These combined factors have lead in the past, according to town officials, to widespread failure of septic tanks. The town believes that these failures are responsible for degraded water quality of the embayment including bacterial contamination forcing closure of the local shellfish beds.

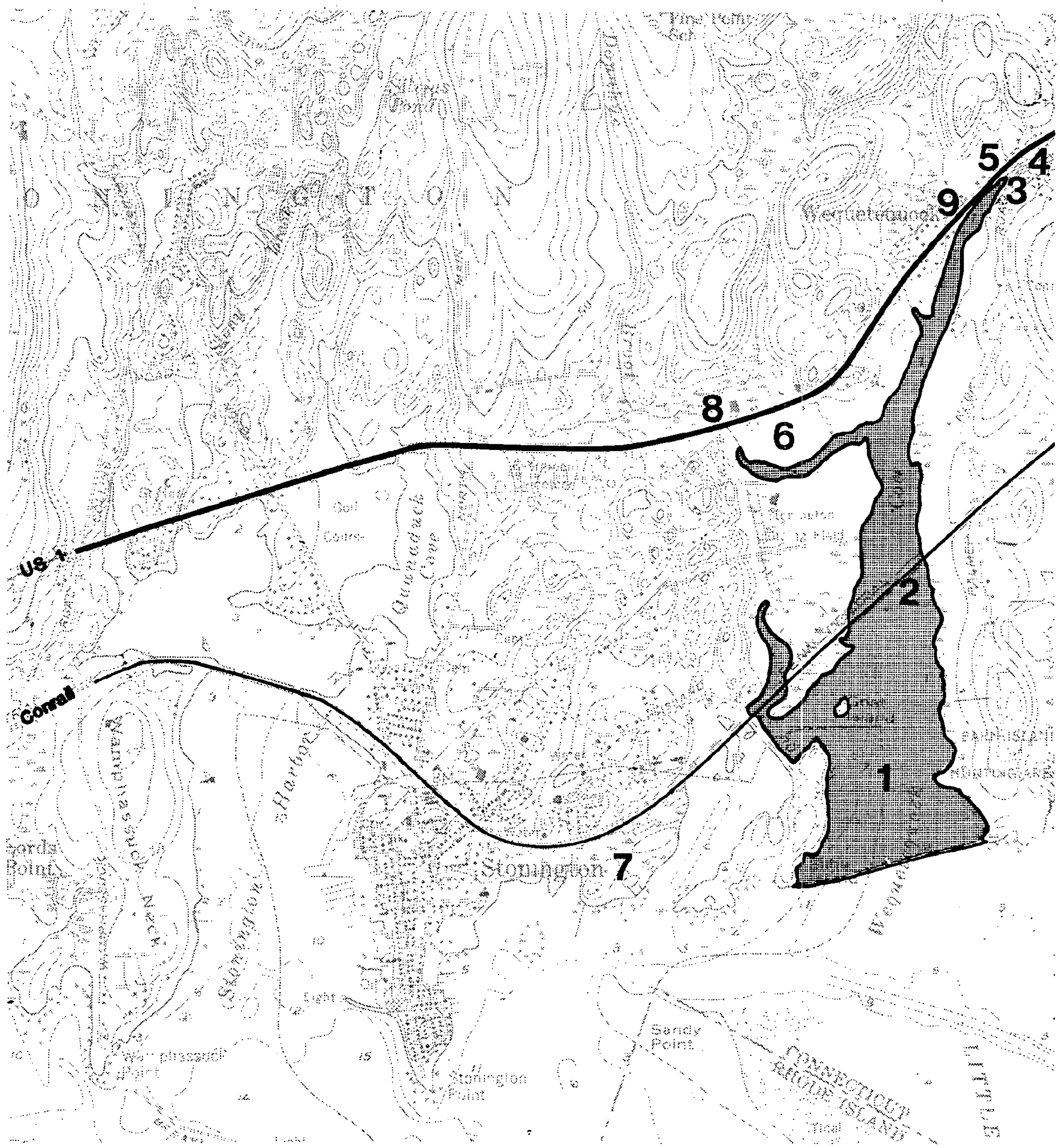
D: Problem Analysis

Sedimentation

The railroad reduces circulation substantially through a reduction in the embayment cross-section by a factor of ten. This reduction effectively eliminates any flow exchanges between the upper and lower embayment. In addition, the length of the embayment was cut in half, virtually eliminating any wave generation within the embayment. The reduced flushing and wave action make it virtually impossible to move bottom sediments. Annual average inflows for the entire basin draining into the cove do not exceed and estimated 25 cfs, and, with a cross-sectional area of 450 ft^2 at the bridge, it is doubtful that the resultant velocities (.06 ft/sec) would be able to move any sediment at all. The only period of significant flushing would be during high streamflow events and an outgoing tide.

Using an average rate of 0.1 acre feet per mi^2 per year as a sediment output average, more than 80 Aft of sediment would have been deposited in the upper cove over the past 80 years. Since the upper cove is less than 65 acres in size, more than 1 foot of stream sediment would have been introduced into the system since 1900. Additional sediments would have been provided by shoreline erosion and delivery of sediment from Long Island Sound. Because of the lower velocities characterisitc of the streams in this area, most of the sediments would be fine in nature. Three feet of sediment in an already shallow embayment would act to reduce bottom life and restrict navigation, thereby limiting the future utility of the embayment for recreational activities.

The flushing will also limit return transport of coarser sediments deposited in the lower embayment by wave action from Long Island Sound. Coarser sands brought in during storms will be depostied and left in the cove and will not be transported back out to sea. This would further act to restrict navigation and circulation throughout the embayment (See Figure 2.2).



Scale: 1"=2000'

FIG 2.2 WEQUETEQUOCK COVE ENVIRONMENTAL PROBLEMS

Problem Areas

1. Closed shellfish beds
2. Restricted flow from Conrail bridge and causeway
3. Restricted flow from weir across Anguilla Brook
4. Area of known septic failures
5. Area of suspected septic failures
6. New 80,000 commercial building and large parking lot
7. American Velvet Co. industrial discharge
8. U.S. 1 bridge restricts flow of Oxecosset Brook
9. Some debris along shoreline

Sedimentation (con't)

The circulation has been further restricted by Route 1 and by weir construction at the head of the embayment. Route 1 construction severed a section of salt marsh from the influence of the tides, and the marsh is now being succeeded by a freshwater marsh (See Figure 2.2). Weir construction at the head of the embayment has also acted to regulate inflow and to restrict flushing.

Water Pollution and Circulation Constriction

Several problems appear to be significant in this embayment. These problems include poor circulation, water quality problems, and siltation. All of the problems can be tied, in part, to the constriction of the embayment circulation by the railroad causeway.

The restricted flow conditions in this embayment do not allow rapid flushing of any contaminants introduced into the system. Residential runoff and known/suspected septic tank failures at the head of the embayment have contributed significant pollution loadings to the upper cove, and the water quality ratings of the area reflect high bacterial levels. Pollutant levels are also being elevated by non-point residential runoff, runoff from Route 1, and effluent from the American Velvet Company. The American Velvet plant is currently discharging up to .2 MGD, exhibiting high BOD's, suspended solids, phosphates, and organic carbon. In the past, additional pollutants were introduced into the cove from industry along the Pawcatuck River (washed back in from Little Narragansett Bay). Recent improvements in water quality treatment have virtually eliminated this problem.

QUIAMBOG COVE

A: Physical Description

Location

The embayment is located on the western side of Stonington and is intersected by both U.S. 1 and the Conrail line (See Figure 2.3). Mystic is the closest town and is approximately 1.5 miles west of the cove along U.S.1. The embayment empties into Fisher's Island Sound.

Site Orientation and Configuration

The cove is long, narrow, and approximately linear, with its axis oriented north to south (See Figure 2.3). The U.S. 1 bridge intersects the cove approximately 0.3 mile from the mouth, and divides the embayment into two water bodies. These will be referred to as the inner and outer coves. The shoreline of Quiambog Cove is somewhat irregular, particularly the eastern side of the outer cove (See Figure 2.3).

Tidal Data

Mean tidal range -	2.7 ft.
Spring tidal range -	3.2 ft.
Mean tide level -	1.3 ft.

Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth:	2-4 ft. (MLW)
Channel Depth:	See Comment

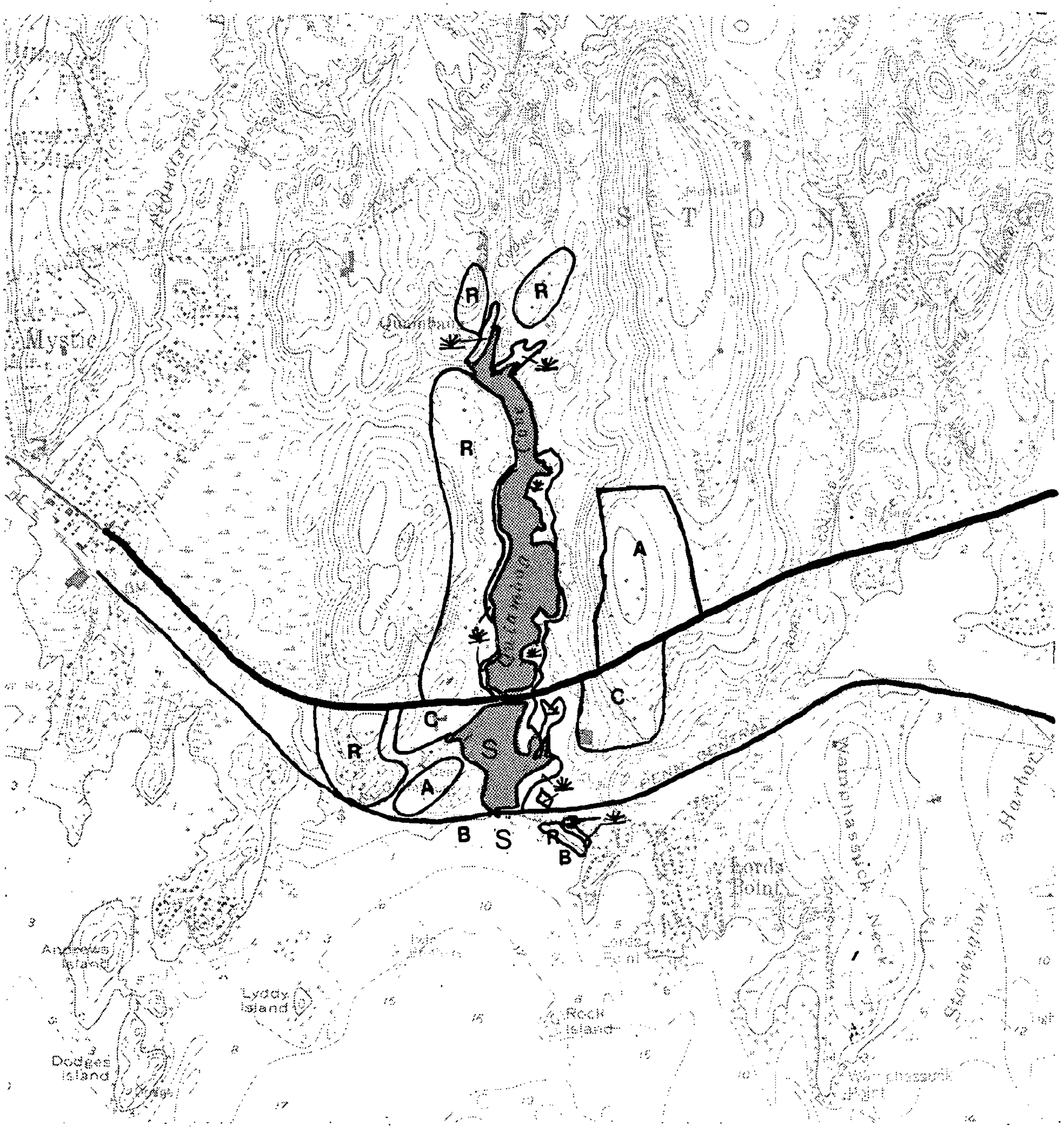
Additional Comment: No channel is maintained but natural currents maintain a 10 fot depth under the U.S.1 Bridge.

Basin Hydrology

Regional Drainage Basin: Mystic River Basin
Embayment Basin Area: 7.75 square miles

Tributaries to Embayment: Copps Brook
Two Unnamed Brooks

Other Sources of Freshwater Inflow: Storm drainage from residential areas and local steep slopes.



Scale: 1" = 2000'

FIG. 2.3 QUIAMBOG COVE ENVIRONMENTAL LAND USE

Legend:

- wetlands
- **A** agriculture
- **R** residential
- **C** commercial/industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Constrictions to Natural Flow and Circulation:

Structure	% Constriction	Distance from Mouth
Conrail Bridge	75-100	
U.S. Route 1 Bridge	75-100	1500 feet

Sources: U.S. Geological Survey, Connecticut Drainage Basin Gazeteer, 1981; Conn. Dept. of Environmental Protection

Water Quality Conditions

Upstream Water Quality (Copps Brook): B
Embayment Water Quality: SB

Direct Discharges:

Source	NPDES Permit #	Waste Characteristics
Mystic Valley Water Co.	CT003271	Suspended solids, aluminum

Sewer Service Areas and Discharge Points: None

Shoreline and Bottom Conditions

Extent of Shoreline Modification: The inner cove of the embayment has an irregular shoreline with tidal marshes penetrating out into the nearshore area. A small segment of the west shore has been developed and exhibits a number of shoreline protective structures. The outer cove has tidal marshes on the east side and shoreline stabilized with a seawall and riprap on the west shore.

Most land use surrounding the inner cove is residential. Several houses on the west side sit on former wetlands, and their yards have been filled to the water's edge. A narrow fringe marsh has recolonized intertidal areas in front of these filled lots. The shoreline on the east side of the cove is more irregular with less filling of wetlands for residential development. Most waterfront homes have some form of water access (docks, beach, etc.). The outer cove has a wide expanse of wetlands on the east side and a developed shoreline stabilized with riprap on the western side. The outer cove shoreline is stabilized primarily to protect the embankment of a coastal road and the U.S. 1 causeway and bridge abutments.

Shoreline and Bottom Conditions (con't)

Shoaling and Sedimentation: Most visible signs of erosion and sediment transport are at the mouth of the embayment and along the shoreline of the outer cove. The mouth of Quiambog Cove experiences shoaling and considerable sand shift as part of a natural westward sand transport system. Tides and wind-generated currents also resuspend outer cove bottom sediment and erode the shoreline as evidenced by eroding wetlands on the east bank and a somewhat scoured but well stabilized shore on the west bank.

Bottom Sediment Conditions: Field observations that the inner cove bottom is composed primarily of silt/mud, while the outer cove bottom is primarily sand.

Surrounding Lands

Maximum Basin Elevation:

Location	Height
Montauk Avenue	170 feet

Areas of Steep Slopes: The local topography is composed of long narrow ridges paralleling the cove. Slopes are locally steep, and exceed 15% in a number of areas. The western ridges do not penetrate far inland, and do not exceed elevations of 110 feet. Both ridges decrease as they approach the coast.

General Vegetation Characteristics: The vegetation of the uplands surrounding the embayment is predominantly forests interspersed with some large grassy fields. A wide expanse (700 feet) of tidal wetlands is located along the eastern shore of the outer harbor. The wetlands narrow to essentially a fringe marsh throughout the rest of the embayment (See Figure 2.3).

Soils:

Name	Characteristics	Slope %	Septic Tank Suitability
Rumney	fine sandy loam	-	very poor
Hollis-Rock Outcrop	complex	15-35	very poor
Pawcatuck	mucky peat	-	very poor
Enfield	silt loam	0-3	very poor
Enfield	silt loam	3-8	very poor
Raypol	silt loam	-	very poor

Soils: (continued)

Name	Characteristics	Slope %	Septic Tank Suitability
Canton	very stony fine sandy loam	8-15	good
Narragansett	extremely stony silt loam	3-15	good
Tisbury	silt loam	0-3	very poor
Typic Udorthents	cut and fill		variable
Narragansett-Hollis	complex	3-15	poor
Narragansett	extremely stony silt loam	15-25	poor
Hinckley	gravelly sandy loam	0-3	very poor

Shellfish and Finfish Resources

The shellfish beds, located in the outer cove of the embayment, are legally open for harvesting. Though no shellfish and finfish data are available specifically for Quiambog Cove, it is likely that the biological survey data cited for Wequetequock Cove are representative (See Section 1).

Wetlands

The wetlands of the embayment consist mostly of fringe tidal marshes. Wetlands along the east side of the inner cove have remained relatively intact with houses either set back from the water's edge behind the marshes or situated in the midst of the wetlands. Most of the wetlands on the west shore of the inner cove have been filled during housing development. Some wetland vegetation on the west bank as reestablished itself in the shallow intertidal areas seaward of the old fill line.

In the outer cove there is a 500-foot wide tidal marsh interspersed with uplands and associated upland vegetation. The western shore of the outer cove is lined with boulders and riprap and has no wetlands.

Environmentally Sensitive Areas

The saltmarsh in the area represents a significant resource for biological productivity and habitat. The marshes provide nesting for an abundance of migratory waterfowl as well as fish spawning grounds and shellfish habitat.

B: Land Use Analysis

Current Shoreline and Water Use

The embayment has only a minor recreational use, which is limited to private waterfront use and some boating. The outer cove and shoals off the mouth of the embayment are actively used for shellfishing.

Current Upland Use

Residential development is common on the western shore of the inner cove but sparse on the eastern shore (See Figure 2.4). Most houses on the western shore are of an earlier period, and many of the lots are built on land that was formerly wetlands. The fill is now well-vegetated and extends to the water's edge. Houses on the east bank are of a more recent period and are set back behind the coastal marshes or in the midst of the marshes (keeping most of the vegetation in its original state).

Under existing zoning, the density of housing development around the inner cove is unlikely to increase signficantly. The west bank is zoned for one-acre residential lots along the road that serves that area. The eastern shore of the inner cove is zoned as coastal land with special development restrictions. Around the outer cove, the industrial zone is limited solely to the Kellems Cable Company site, while the rest of the land is a mixture of two-acre rural zoning and the special coastal land zone.

Historically Significant Land Use Changes

The 1934 aerial photos show that the higher elevations of the east and west ridges flanking the embayment were forested, the lower elevations were farmland, and the lowland coastal plain was developed for housing. Since that time, most of the inner cove farmland has become forest or abandoned overgrown fields. The outer cove farmland (except for a parcel on the west shore) has changed to industrial use.

Public Access and Recreational Opportunities

Recreational use of the embayment is virtually non-existant. There are no major public access points within the cove, and there are no known public boat launching areas.

C: Problem Identification

Local Departments and Offices Contacted

Stonington Planning and Zoning Commission Staff
Stonington Shellfish Commission
Stonington Conservation Commission

Response from Questionnaires and Local Meetings

The two major problems cited by town officials are siltation and pollution. Both problems are exacerbated to a great extent by the Conrail Railroad and U.S. 1 bridges which constrict tidal flushing.

Town officials also cite road salt from U.S. 1 and agricultural runoff as other potential sources of pollution. In addition, the Mystic Valley Water Company continues to discharge untreated filter backwash to Copps Brook, causing potential downstream pollution impacts to the embayment.

Results of Field Survey and Research

The field survey confirmed the contrast in sedimentation and development impacts between the inner and outer sections of the cove. The inner cove is separated from Long Island Sound by the narrow bridges which constrict tidal flow and accelerated siltation. Some saltmarsh cordgrass is now colonizing the shallow tidal flats of the inner cove that have developed as a result of the siltation. The outer cove has better tidal flushing and the bottom sediment is more sandy and less silty than the inner cove. The formations of wetland vegetation appear to be shifting due to erosion and this shift makes it difficult to determine whether there has been a net gain or loss in vegetaton acreage over the past years.

The inner cove shoreline is mostly developed with housing. The older period houses line the west bank and the style of development during that period typically involved filling wetlands out to the water's edge. Houses on the east bank are relatively newer and are set back behind a vegetated buffer of tidal marsh. Development on both banks relies on septic tanks but low elevation of the land combined with high water table conditions makes this a likely area for septic tank failure.

Results of Field Survey and Research (con't)

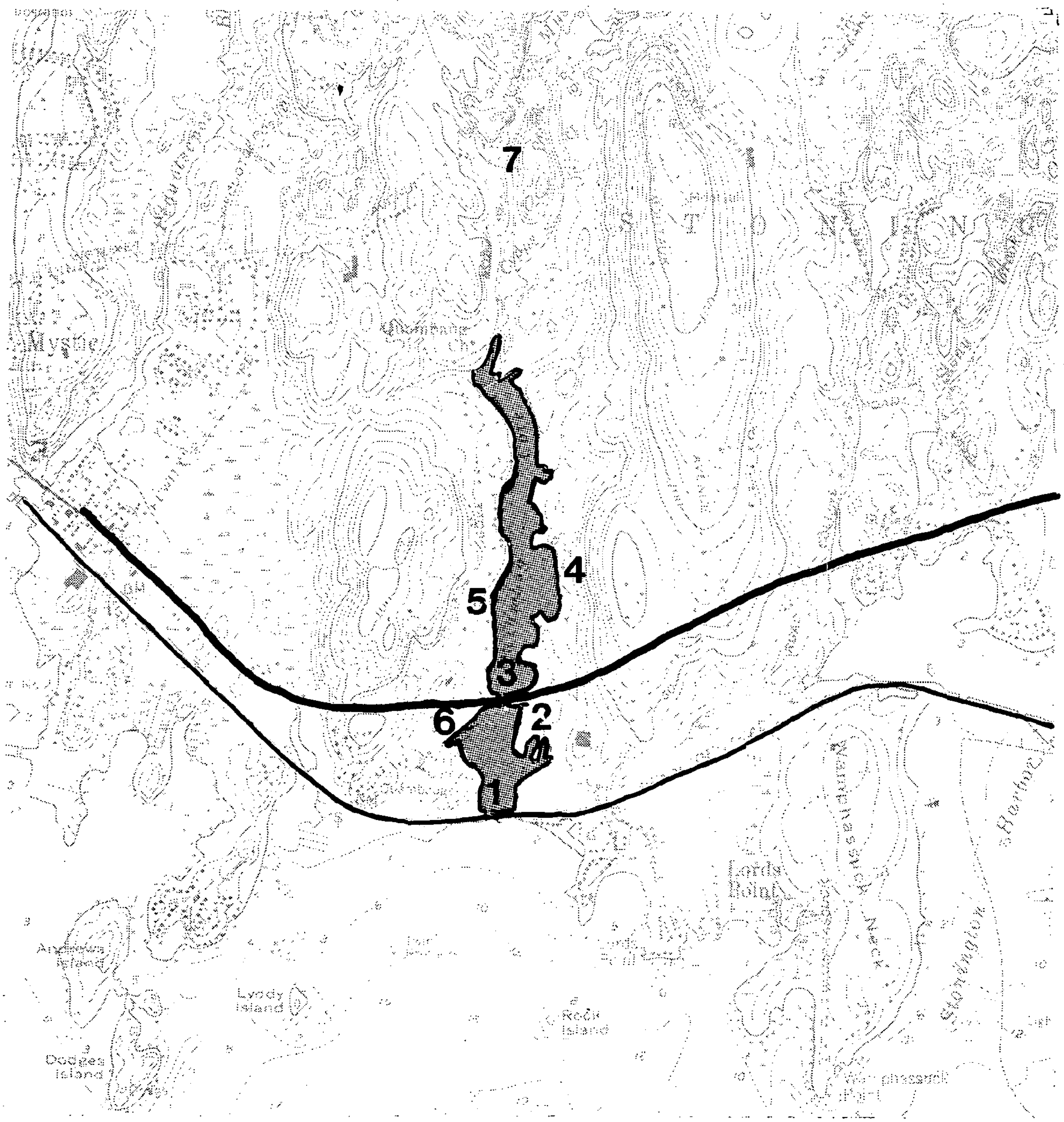
The outer cove is more densely settled and includes a mix of residential and industrial land use. The Kellems Cable Company was in the middle of a large building expansion project at the time of the field survey. In addition large acreages of marsh were recently burned over. The cause of the fire was not visibly apparent. In general the eastern bank of the outer cove is less developed or altered along the shoreline, leaving a natural wetland and intertidal buffer between the embayment and upland development. The west bank, however, has a road running along half of its shore and the waters edge has been filled and riprapped to prevent erosion of the road bed.

D: Problem Analysis

Sedimentation

Sedimentation appears to be fairly significant in the cove, especially in the lower portions. Some sediment is enterng from the Copps Brook Basin, but the bulk of the sediment in Copps brook will be deposited in the Mystic Reservoir (still-water settling). Probably the greatest sources of sediment would be those streams draining agricultural areas or areas with steep exposed soil faces. Additional sources would include erosion of wetlands, wave transport of sediments across the embayment mouth, and surface runoff from newly developed areas. Because of the sharply-reduced exposure and fetch of the upper cove, due to the cove restrictions, wave development will not be significant and circulation will be minimal, creating an ideal area for net deposition of sediment (See Figure 2.4). Since most of the drainage area is blocked by the Mystic Reservoir, siltation should only be of moderate concern in the upper portions of the cove. The mouth of the cove, however, is another matter. Relatively linear sedimentary shorelines will foster the development of longshore transport mechanisms that will tend to fill and block the embayment mouth over relatively short period of time.

The outer cove experiences a greater degree of wave and tidal flushing. Bottom sediments are coarser than those of the inner cove, with some of the outer cove bottom comprised of sand. Aerial photographs reveal that the wetlands on the east shore overlay sand and have changed configuration significantly over the past 30 years due to erosion from wave and current action.



Scale: 1" = 2000'

FIG. 2.4 QUIAMBOG COVE ENVIRONMENTAL PROBLEMS

Problem Areas

1. Restricted flow from Conrail bridge
2. Surface runoff from Kellems Cable Co. construction site
3. Restricted flow from U.S. 1 bridge
4. Suspected residential septic tank failures
5. Suspected residential septic tank failures
6. Filled and stabilized shoreline; surface runoff from parking lots
7. Mystic Valley Water Co. discharges untreated filter backwash

Water Pollution

There are two areas of concern when considering water quality: point and non-point pollutant sources. Non-point sources include suspected septic tank leakages, minor amounts of road runoff, and runoff from new construction sites (See Figure 2.4). The septic tank leakage may be responsible for the moderate bacteria levels reflected in past water quality sampling. Surface runoff from roadways will introduce minor amounts of metal and salt into the embayment, while runoff from new development sites (including Kellems Cable Co.) will add additional sediment to the system. The only significant point source of pollution would involve filter backwash from the Mystic Valley Water Company. The effluent contains significant levels of aluminum and suspended solids but is not of major concern as a significant polluter.

PROBLEM SUMMARY

Wequetequock River

1.	Sedimentation at the Head of the Embayment	Moderate	(b)
2.	Circulation Constriction	Serious	(b)
3.	Pollution	Serious	(a)

Quiambog Cove

1.	Sedimentation, Head of the Embayment	Minor	(a)
2.	Sedimentation, Mouth of the Embayment	Moderate	(a)
3.	Erosion	Minor	(b)
4.	Water Pollution	Minor	(b)

KEY: (a) Conditions becoming worse (b) No change (c) Conditions improving

CHAPTER 3 GROTON EMBAYMENTS

INTRODUCTION

The community of Groton is located in New London County and forms the western bank on the Thames River. The municipality is divided into two distinct political units: 1) the City of Groton and, 2) the Town of Groton. (In this report the two political units will be treated as one community, and will be called the Town of Groton). The town has an area of 33.0 squre miles of which 92 percent is within the Thames River Basin. The remaining 8 percent is located within the Mystic Coastal Basin. THe population of Groton has decreased 1.2 percent from 1970 to 1978 (1970-38,244; 1980-37,800). Groton is one of five coastal communities to register a population loss over this period. New London, located on the other side of the Thames, lost 3.3 percent of its population over the same period. Population loss in these two communities is an exception in th region as the county population grew 7.0 percent ov r those 8 years.

It is important to note that despite the decrease in Groton's population, housing units in the town increased by 12.8 percent over the same 8 year period. Viewed together, these two trends indicate either a significant reduction in average household size.

The town's shoreline is divided into three segments. The eastern waterfront along the Mystic River is highly irregular. Mason Island, at the mouth of the river, provides shelter from storms for most of the shoreline from Noank to West Mystic. The Conrail line is located very close to the coast along this segment of shoreline, and intersects Sixpenny Island and spans the mouths of several bays, including Baker Cove.

The south shore borders on Long Island Sound. The southern segment is similar to the Mystic River waterfront in that the coast is highly irregular. The major difference is that littoral transport and sand barrier formation's are clearly present as a part of the coastal geologic prcesses. Large sand spits are located near or at the mouth of Venetian Harbor, Mumford Cove, Poquonock River, and Baker Cove.

As in the case of Stonington, the south shore embayments of Groton ar small drowned river valleys that were formed in the wake of the ice age by rising sea level. These embayments are typically flanked to the east and west by necks providing topographic divides between the embayments. The ridge elevations of these necks range from 20 feet to 120 feet. Headlands are located at the tips of the necks and are comprised of large boulder fields, and in some cases, rock outcroppings. The boulder fields also form nearshore reefs and are located off Groton Long Point, Mumford Point and Morgan Point.

The western shore of Groton, along the Thames River, is very regular. The City of Groton is located on this shoreline, and its associated high density development makes this segment of the Groton coast the most intensely developed shoreline of the community. Large industrial manufacturers such as the Electric Boat Division of General Dynamics take advantage of the Thames' deep water port. No significant embayments are located along this waterfront segment.

In addition to the City of Groton there are seven other centers of settlement in the community: West Mystic, Noank, Groton Long Point, Poquonock Bridge, Groton Heights, Groton Center and Burnetts Corner. The first four listed above are along the waterfront and historically have been linked by the coastal railroad. Today Route 215 and U.S. 1 (Post Road) provide the major coastal overland link. The Conrail line and Interstate 95 to the north provide regional access.

The estuaries of the Long Island Sound are fed by four drainage systems: Birch Plain Creek, Poquonock River, Fort Hill Brook and Eccleston Brook. The largest of the four drainage systems is Poquonock River which includes the Groton Reservoir in its upper reaches. The natural flow of these four systems has been disrupted significantly by railroad crossings and highways.

This is particularly true of Palmer Cove which is divided into three bodies of water by the solid-fill Conrail causeways. Tidal waters constricted by these linear structures are particularly subject to pollution problems. Such problems are discussed in greater detail in this chapter.

This study initially considered seven embayments for detailed analysis in this report. Beebe Cove, Bennets Cove, Pine Island Bay, Poquonock Cove and Bakers Cove were dropped from the study for various different reasons. For example, the Beebe Cove circulation problem was relatively well defined and mitigation would have required modifying the railroad crossing. Bennets Cove also was impacted by long-term historical problems. The problems of Pine Island Bay, Poquonock Cove and Bakers Cove were already being investigated by the state or the town. West Cove and Palmers Cove were selected for further study in this report because they were subject to severe environmental problems, particularly sedimentation and tidal flushing. The definition and analysis of these problems constitutes the scope of this chapter.

WEST COVE

A: Physical Description

Location

The community of Noank forms the eastern shore of the Cove. Fishers Island Sound is to the south and Groton Long Point is to the west. Both the Conrail line and Marsh road pass directly north of the head of the embayment (See Figure 3.1).

Site Orientation and Configuration

The embayment is small, measuring only 0.2 miles wide and 0.3 miles long. It is tapered toward the head with the long axis oriented from N.E. to S.W. The cove's shoreline on both east and west sides is regular except for coastal structures such as the breakwater and rock filled piles supporting docks (See Figure 3.1).

Tidal Data

Mean tidal range -	2.3 ft.
Spring tidal range -	3.2 ft.
Mean tide level -	1.3 ft.

Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth:	1-7 (MLW)
Channel Depth:	3-7 (MLW)

Additional Comments: A privately owned channel provides access betwen the sound and the head of the cove. In light of reported rapid siltation rates, the cited bottom depths of 3-7 ft. (MLW) are probably greater than currently exist.

Basin Hydrology

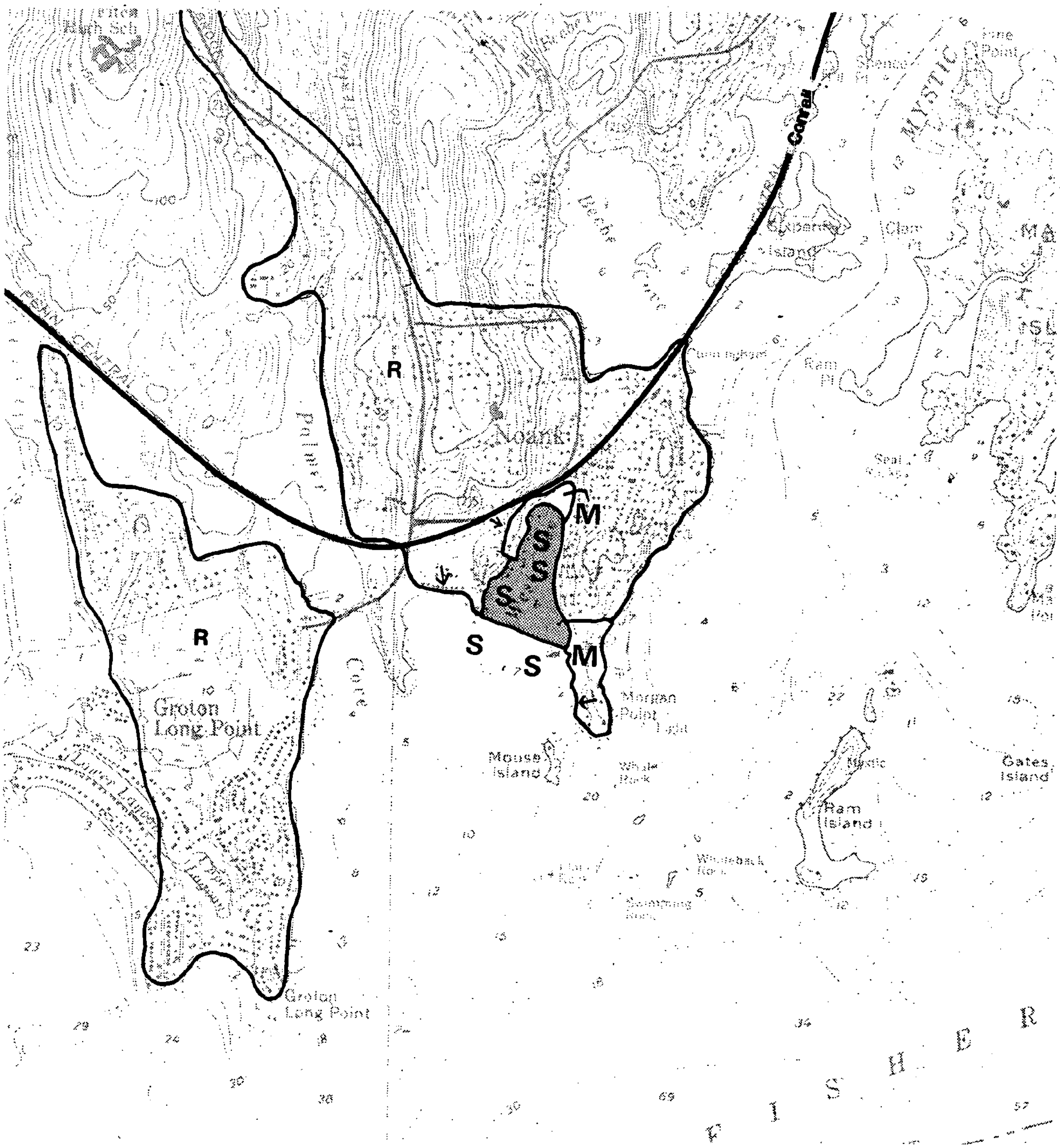
Regional Drainage Basin: Mystic Coastal Basin
Tributaries to Embayment: None

Other Sources of Fresh Water Inflow: Minor amounts of stormwater runoff flows from the western side of the Noank peninsula and from a local boatyard.

Constrictions to Tidal Flow and Circulation:

Structure	% Constriction	Distance from Mouth
Spicer Marina Breakwater	25-50	1250 feet

Sources: U.S. Geological Survey, Connecticut Drainage Basin Gazeteer, 1981; Conn. Dept. of Environmental Protection



Scale: 1" = 2000'

FIG 3.1 WEST COVE ENVIRONMENTAL LAND USE

Legend:

- wetlands
- **A** agriculture
- **R** residential
- **C** commercial/industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Water Quality Conditions

Upstream Water Quality Classification: Not Applicable
Embayment Water Quality Classification: SB/SA

Direct Discharges: None

Sewer Service Area and Discharge Point: An interceptor runs along Marsh Road and includes Noank. Potential users are required to tie in only if they have a failing septic system.

Storm Sewer Outfalls: None Known to exist

Significant Non-Point Pollution Sources: Runoff from the slopes of Noank, particularly the streets and driveways at the street ends, will provide small amounts of residential area-type pollutants, including fertilizer, salt, and auto effluent (some inorganic wastes). Boat traffic will also provide oily waste and septage from uncontrolled dumping.

Shoreline and Bottom Conditions

Extent of Shoreline Modification: Almost all of the shoreline along West Cove has been modified. The east shore is residential and has a mix or rip-rap and concrete seawalls. Seven docks and one solid-filled pier extend out into the embayment. The west shore is the site of a medium-sized marina and several houses. Sections of the marina shoreline have been filled and there are two rock jetties (one approximately 100 ft. long, the other 40 feet long) and 4 piers. A concrete seawall and areas of exposed bedrock are visible in aerial photos at this site. A rip-rapped section separates the seawall from the marina.

A small creek used to drain land near the head of the cove but has been filled in and is now used as a boat storage area for the marina.

Bottom Sediment Characteristics: The bottom material cosists of a fine silt. Field inspection of the material indicated that the sediment is highly anoxic.

Surrounding Lands

Maximum Basin Elevation:

East Bank (Noank)	50 feet
West Bank	110 feet

Topography: The area exhibits a gently rolling topography, grading into a steeply rolling topography to the north and west. In general, the hills are oriented in a N-S direction.

General Vegetation Characteristics: The eastern side of the cove is well developed and landscaped for residential living. The western shore has some natural vegetation (trees, shrubs) interspersed with some exposed rock surfaces.

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Hollis-Rock Outcrop	Complex	15-35	very poor
Narragasett	extremely stony silt	3-15	poor
Pawcatuck	mucky peat	-	very poor
Adrian and Palms	muck	-	very poor
Canton	very stony, fine sandy loam	-	very good
Charlton-Hollis	fine sandy loam	8-15	poor
Enfield	silt loam	3-8	very poor
Hollis-Rock Outcrop	complex	3-15	very poor
Paxton	fine sandy loam	3-8	poor
Woodbridge	fine sandy loam	0-3	poor
Hollis-Charlton	complex	15-35	very poor

Shellfish and Finfish Resources

Clams are in moderate abundance on the west side of the cove. Oysters are also found in moderate numbers at the head of the cove, attached to submerged rocks in the cove, and along the western shore. The shellfish beds are currently closed, probably due to pollution from boat traffic and local runoff.

Shellfish and Finfish Resources (con't)

Despite the fact that West Cove is closed to shellfishing, the Groton Shellfish Committee Report (1977) indicates that the cove supports a "healthy shellfish population." In addition, the John Buck study, referenced above states:

> "In general the benthic invertebrates found (in Palmer Cove) are indicative of typical coastal estuaries and do not suggest the existence of gross pollution conditions. Undoubtedly, the organic input entering (the) water is stimulating to the invertebrates population, but has not acted as a selected force in grossly affecting the macro-biota"

The benthic sampling conducted by Buck is most representative of outer West Cove, but may not represent the conditions common to the inner cove area. Frequent dredging of the marina and the cove access channel may disturb the benthic populations and impact the ecosystem, but further research would be required to determine if this is significant.

Though no fish surveys other than the limited Groton Shellfish Committee report mentioned above are available on West Cove, two other surveys conducted on Groton's coastal waters are representative. According to these surveys finfish found specifically in the area include: winter flounder, striped bass, eels, atlantic silversides, killifish, menhaden, bluefish, bay anchovies, rainbow smelt, alewives, black sea bass, and summer flounders, blue crab, horseshoe crab, mud crab, calico crab, green crab, sand shrimp, marsh snail, mud snail and periwinkle,

Sources: John D. Buck, 1971, Biological and Chemical Observations in Mumford and Palmer Coves; CT Department of Transportation, 1980, Groton - New London Airport Master Plan Technical Report; Kenneth Holloway, Groton Scallop Warden; Connecticut Department of Heatlh Services; Groton Natural Shellfish Bed Committee, 1977.

Wetlands

There are no wetlands present in the cove. All of the wetlands along the shoreline have been filled in support of residential and commercial development. Seawall and rip-rap have now replaced the former sloping shoreline.

Environmentally Sensitive Areas

The eelgrass beds covering the embayments bottom at the mouth of the cove provide valuable habitat for marina life.

B: Land Use Analysis

Current Shoreline and Water Uses

Water use in West Cove is principally for recreation. Use of the Noank waterfront is limited to 5 docks. The Spicer Marina has 125 slips with a dockside sewage pumping station. The marina also rents rowboats and motor boats. Blue Meadows Mooring one of several smaller marinas on the north and west shores, currently maintains 45 moorings with space for 5 transient boats. Golden Era Boats, a second marina, uses its waterfront for mooring and boat repairs.

Current Upland Use

The east shore (Noank) is comprised of residential development on half acre lots or smaller. Many of the houses were built at the turn of the century, so additional dvelopment in Noank has been limited to residential infilling. Areas of the north and west shores of the cove currently provide storage for 210 boats as part of Spicer's Marina (See Figure 3.1), while another marina and a boat builder occupy the shorefont on the remainder of the coves north and west side.

Historic and Significant Land Use Changes

There has been a reduction in the number of residential docks along the shorefront over the 1934-1970 period, particularly on the Noank side. The Spicer Marina, built at the head of the cove, added commercial land use to the predominantly residential waterfront. The head of the cove also had become increasingly silted and finally filled. The area is now used to a add boat storage area within Spicer's Marina (See Figure 3.2). There has been some residential infilling at scattered sites with Noank. A breakwater for the marina was constructed and extended during the 1960's.

There has been very little recent change in land use, because virtually all of the coast was developed as of 1970.

Public Access and Recreational Opportunities

Spicer's marina (a private operation) offers customers both use of a boatramp and rental boats.

Source: Boating Almanac, Vol. 2 (Long Island, Connecticut, Rhode Island, Southern Mass, 1981.

C: Problem Identification

Local Departments and Offices Consulted

Town of Groton Planning Department
Groton Shellfish Commission
Spicer's Marina

Response from Questionnaires and Local Meetings

The town identified siltation and flow stagnation as the two major problems impacting West Cove. The shoreline marinas were also identified as potential sources of water pollution. The siltation problem is believed to be caused by re-suspension of offshore bottom sediments during southeaster storms. The circulation problem is in part caused by the natural configuration of the cove, but also is believed to have been aggravated by the extension of the jetty during the 1960's.

Results of Field Survey and Research

A visit to the site confirmed that the cove is experiencing siltation. The owner of Spicer's Marina currently dredges the embayment once every year and would prefer to dredge more frequently, but costs would be prohibitive.

The siltation problem appears to be most severe along the Noank shoreline, as the residential docks are cut off from the water by tidal flats at low tide. Water access is restricted along in some segments of the shoreline even at high tide (See Figure 3.2).

It appears that the extended jetty may be shifting some of the sedimentation to the Noank shorefront, thus accelerating the deposition rate in the area (See Figure 3.2). It appears that the jetty extension has helped to focus wave energy on the bottom sediments, eroding them and carrying them towards the Noank shoreline, where they are redeposited and block boat access.

D: Problem Analysis

Flushing and Circulation Constriction

Though the embayment is not constricted by any causeways or bridges, free tidal circulation is impeded somewhat by the Spicer Marina jetty (See Figure 3.2). The jetty was designed to shelter marina boats from storm generated waves approaching from the southwest. An unintended side effect, however, has been the

Scale: 1" = 2000'

FIG 3.2 WEST COVE ENVIRONMENTAL PROBLEMS

Problem Areas

1. Southwest winds resuspend bottom sediments causing siltation
2. Cove closed to shellfishing
3. Privately dredged channel
4. Breakwater extended in early 1960's
5. Noank docks completely silted in
6. Upland filling

Flushing and Circulation Constriction (con't)

creation of a low-velocity zone in the lee of the jetty, providing an ideal settling basin for sediment. This local reduction in flow circulation also serves to concentrate local water pollution introduced by the marina (i.e. oil and gas discharge, constant prop wash, engine exhaust, etc.). Spicer's Marina has attempted to reduce the potential for cove pollution by installing a boat waste pump out facility.

Sedimentation

Though the Spicer Marina jetty may contribute to the sedimentation problems within the cove, it is not the primary cause. Sedimentation patterns and rates inferred from past dredging operations indicate that the problem is almost as severe outside the jetty as inside. Since no streams feed into the cove, the most likely source of the material is re-suspended sediment from Long Island Sound. The silty character of the sediment suggests that the cove is quiet enough to allow a relatively fairly complete settling of suspended solids. Since there are few conditions to promote flushing of sediment, the deposition increases the chance of eutrophication and bar formation.

One of the major factors affecting sedimentation is the configuration of the cove. The Noank Peninsula shelters the cove from prevailing summer winds and the hill at the head of the cove shelters it from the northwest winter winds (See Figure 3.2). The regular shoreline, small size, and gradually narrowing configuration of the embayment limit the opportunity for tidal and wave scouring of bottom sediment.

Currently, the Noank shoreline is excessively silted, but it is difficult to tell whether the situation is the result of a lack of dredging over the last 20 years or an indirect impact of the Spicer jetty on sedimentation patterns. Aerial photos show a significant reduction in private docks over the period from 1934 to 1970, which may have led to a decline in interest in dredging. The Spicer Marina dredges once annually, but this benefits the control channel of the cove and does little to increase water depths near the Noank shoreline. Consequently, the waterfront is now silted in, with tidal flats eliminating water access at low tide.

PALMER'S COVE

A: Physical Description

Location

The embayment is bordered by Morgan Point (Noank) to the east, Fishers Island Sound to the south, and Groton Long Point to the west. Marsh Road access Palmer Cove at the mouth and provides highway access between Groton Long Point and Noank which are approximately 0.6 miles apart. The Conrail line also intersects the embayment north of the Marsh Road bridge (See Figure 3.3).

Site Orientation and Configuration

The cove is irregular in shape, roughly 0.8 miles long (from confluence of Eccleston Brook to Marsh Road bridge) and roughly 0.25 miles wide. The Conrail line intersects the cove in two places dividing the embayment into three water bodies. For the purpose of this report the three bodies will be referred to as the outer cove (between Marsh Road and Conrail bridges), the middle cove (fed by Eccleston Brook), and the inner cove (connected to outer cove by small dredged channel).

Tidal Data

Mean tidal range -	2.3 ft.
Spring tidal range -	2.7 ft.
Mean tide level -	1.1 ft.

Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth:	1-5 ft. (MLW)
Channel Depth:	2 ft. (MLW)

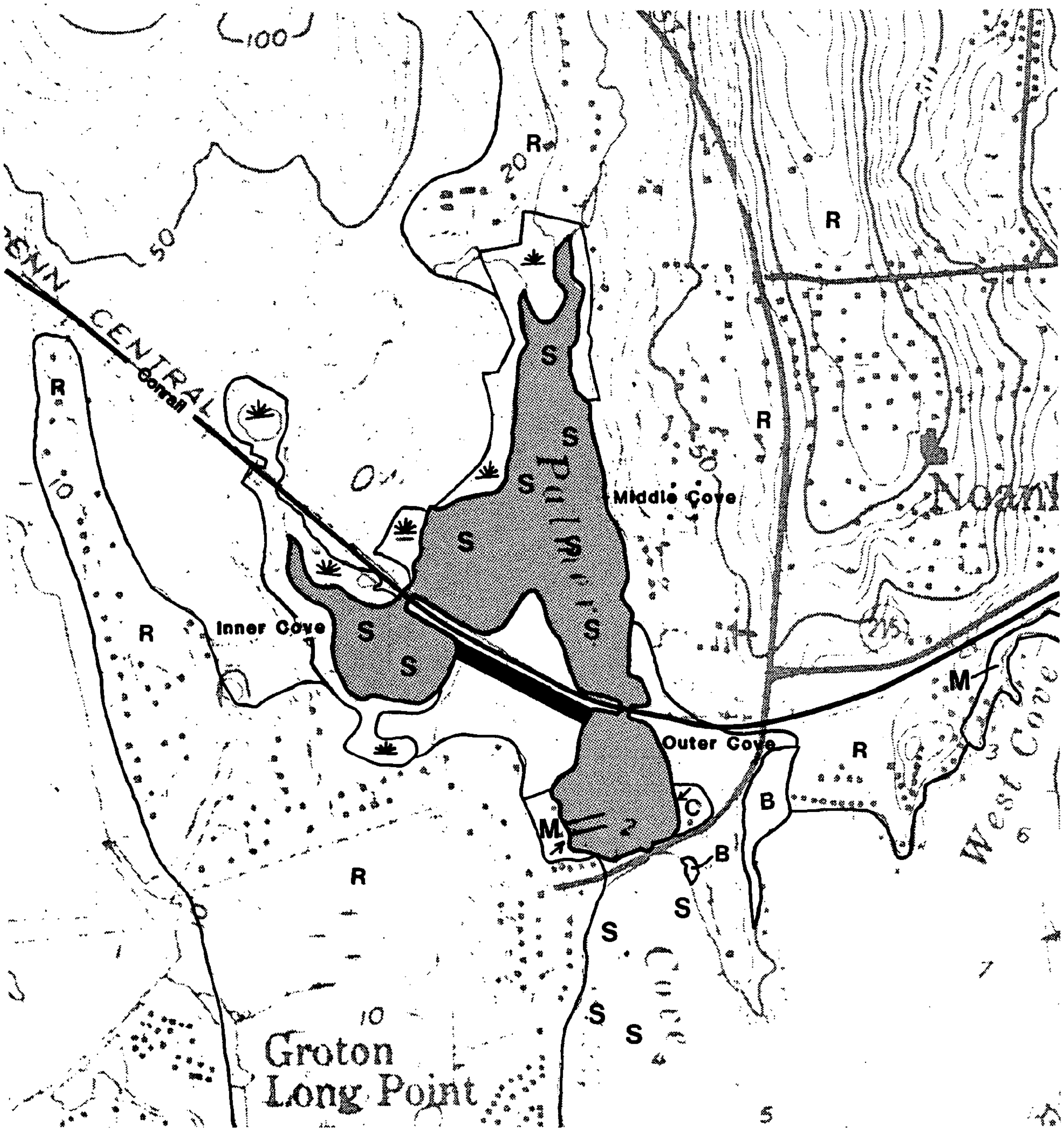
Additional Comments: A privately maintained channel provides access from Fishers Sound to a small marina in the outer cove. Depths of the middle and inner coves are presumed to be not more than 5 feet at mean low water (MLW) (See Figure 3.3).

Source: NOAA National Ocean Survey Maps

Basin Hydrology

Regional Drainage Basin: Mystic Coastal Basin
Tributaries to Embayment: Eccleston Brook

Other Sources of Fresh Water Inflow: Stormwater runoff, particularly from the steep slopes of development on the eastern shore.



Scale: 1" = 1000'

FIG 3.3 PALMER COVE ENVIRONMENTAL LAND USE

Legend:

wetlands	**B** beach
A agriculture	**M** marina
R residential	**S** shellfish beds
C commercial/ industrial	→ public access

Constrictions to Natural Flow and Circulation:

Structure	% Constriction	Distance from Mouth
Marsh Rd. Bridge	75-100	At Mouth
Conrail Bridge	75-100	1000 ft.

Sources: U.S. Geological Survey, Connecticut Drainage Basin Gazeteer, 1981; Conn. Dept. of Environmental Protection

Water Quality Conditions

Upstream Water Quality Classification: A

Embayment Water Quality Classification: A

Direct Discharges: None

Sewer Service Area and Discharge Point: None

Storm Sewer Outfalls: None

Significant Non-Point Pollution Sources: Runoff from the outer cove restaurant parking lot discharges to the east side of the basin. The housing tract development on the east side of the middle cove is constructed on steep slopes and runoff drains into the cove at the street ends.

Shoreline and Bottom Conditions

Extent of Shoreline Modification: The east shoreline of the outer and middle cove has been filled and developed for a restaurant and housing, respectively.

Consequently there is now landscaped grass and shrubs to the waters edge and a rocky shoreline (similar to rip-rap). The west side of the outer and middle cove remains in a natural state, except for some outer cove filling and shore stabilization to support a marina. The inner cove remains in a near natural state except for the causeway built for Conrail (See Figure 3.3).

Significant Areas of Erosion: Groins have been built on the west shore (just outside of Palmer Cove) to stem erosion of the sand beach. Rip-rap has been placed outside the cove along the east shore and the west shore (Groton Long Point) to prevent erosion of uplands during winter storms. Some additional erosion is caused by development and yard maintenance on the steep eastern slopes of the middle cove shoreline.

Shoreline and Bottom Conditions (con't)

Shoaling and Sedimentation: Sediment from Eccleston Brook, the eroding slopes mentioned above, and resuspended offshore bottom sediments contribute to the silted conditions of the embayment. This condition is exacerbated by the circulation constriction of the Marsh Road and Conrail bridges.

Bottom Sediment Characteristics: No data available.

Surrounding Lands

Maximum Basin Elevation:

Haley Farm State Park	50 feet
Groton Point	20 feet
East Shore	150 feet

Topography: Terrain to the west and south is relatively flat, while to the east and north, is fairly steep and rolling, with hills oriented to the N-S.

Areas of Steep Slopes: The east bank has slopes up to 15% along Brook Road. The area is the site of a large suburban housing tract development (See Figure 3.3).

General Vegetation Characteristics: Groton Long Point vegetation is limited to landscaped trees and bushes. The east shore of middle cove is cleared of most vegetation. Haley Farm State Park consists of large fields and stands of trees. The Eccleston Brook basin is fairly rural with large trees and a vegetated floodplain.

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Narragansett	extremely stony silt	3-15	poor
Pawcatuck	mucky peat	-	very poor
Typic Udorthent	cut and fill	-	variable
Adrian and Palms	muck	-	very poor
Canton	very stony, fine sandy loam	15-25	poor

Soils:
(con't)

Name	Characteristics	Slope %	Developmental Drainage Suitability
Enfield	silt loam	3-8	very poor
Hollis-Rock Outcrop	complex	15-35	very poor
Narragansett-Hollis	complex	3-15	poor
Paxton and Broad-brook	extremely stone soils	3-15	poor
Ridgebury, Whitman Leicester	extremely stony fine sandy loam	-	very poor
Woodbridge	fine sandy loam	-	poor

Shellfish and Finfish Data

The entire cove is considered to be a natural shellfish area. Clams are in moderate numbers in the middle cove. Oysters are found in moderate numbers along the west shore (Haley Farm,) and in large numbers along the rocky area adjacent to the railroad bridge. Soft-shelled clams (*Mya arenaria*) are moderately abundant along the shoreline throughout the cove. The entire cove area is open to shellfishing.

Finfish which have been caught along the shores and within embayments in Groton include: bluefish, bay anchovies, rainbow smelt, alewives, black sea bass, summer flounders, winter flounders, striped bass, eels, atlantic silversides, killifish, and menhaden.

Sources: Connecticut Department of Health Services; Groton Natural Shellfish Bed Committee, 1977; John D. Buck, 1971, Biological and Chemical Observations in Mumford and Palmer Coves; CT Department of Transportation, 1980, Groton - New London Airport Master Plan Technical Report; Kenneth Holloway, Groton Scallop Warden; University of Connecticut, 1971 Wetlands Survey of the State of Connecticut: Ecological Unit No. 62 Pequonock River. Groton Conservation Commission, 1974, Natural Resources and Open Space

Wetlands

Fringe marshes are located predominantly on the west sides of the outer, middle and inner coves (see Figure 3.4). The largest consolidated area of saltmarsh is located at the head of the cove in front of the Haley Farm State Park property. Vegetation consists mostly of saltmeadow cord-grass (Spartina-patens) and saltmarsh cord-grass (Spartina alterniflora).

Most of the marshes form a fringe along the shoreline, thus providing a natural filter for detritus, anchoring soil to reduce erosion, and providing an important aquatic habitat.

There were once wetlands along the east shores of all three coves, but these have since been filled to support housing development and to provide an easement for the railroad. Some wetland areas along the western side of the outer cove were filled to provide commerical space for the marina.

Although there are pressures for additional waterfront development, little filling of wetlands has occurred since enactment of the State Wetlands Act. Wetlands along the shoreline of Haley Farm Park and the inner cove are virtually assured of protection.

Environmentally Sensitive Areas

The saltmarshes and adjacent natural uplands of Haley Farm State park provide valuable habitat for wildlife of the surrounding area. According to the Groton Conservation Commission publucation, "Natural Resources and Open Spaces, the 198 acre Haley Farm is "an exceedingly important wildlife area." The report makes particular note of the great diversity of plants and animals that inhabit the property.

The farm consists of freshwater wetlands, upland forest, open fields and tidal wetlands. According to the Groton Conservaton Commission, the State Park provides habitat for nearly 100 species of birds and several unusual mammals, including the red fox, white-tailed deer, and star-nosed mole. The several acres of wetlands at the park help preserve the environmental and water quality of the middle cove. This is particularly important for the future of the local shellfish beds.

Sources: Groton Conservation Commission, 1974 Natural Resources and Open Spaces; Field observations, Anderson-Nichols, 1981.

B: Land Use Analysis

Current Shoreline and Water Use

The cove is primarily used by small powerboats operating out of Palmer's Cove Marina. The major limitation on boat size is the 5 foot vertical bridge clearance at high tide. The middle and inner coves are primarily used for passive recreation and some shellfishing. The shellfishing is most active in the nearshore tidal flats at low tide.

Current Upland Use

The land is generally used for commercial purposes along the outer cove (See Figure 3.3). The east bank of the middle cove is a residential area, while the west bank is open space. The inner cove upland is completely undeveloped and currently has no road access. It appears that any additional changes in land use will be limited to expansion of the existing housing tract development within the middle cove.

Historic and Significant Land Use Changes

A pile-supported trolley bridge has been replaced by a solid fill abutment supported bridge at the embayment mouth (See Figure 3.3). The horizontal clearance of the new bridge is only 50 feet and provides less circulation than the old trolley bridge. The Palmer's Cove Marina has been constructed on the west bank of the outer cove, and a large scale housing development has been built on former forest land along the east shore of the middle cove.

The housing development on the east bank of the middle cove has continued to fill in with additional houses, and is now completely developed.

Public Access and Recreational Opportunities

There is a town waterfront recreation area at the foot of the housing development on the east side of the middle cove. The Haley Farm State Park offers visitor access to the middle cove shoreline.

C: Problem Identification

Local Departments and Offices Consulted

Town of Groton Planning Department
Groton Shellfish Commission

Response from Questionnaires and Local Meetings

The major problem identified throughout consultation with the town was siltation, primarily in the outer cove. Reduced circulation (caused by the railroad and highway bridge) and eutrophication were also indicated as additional problems (See Figure 3.4).

The siltation problem is believed to be caused by the construction of a sewer line that crosses the mouth of Palmers Cove along Marsh Road.

Results of Field Survey and Research

The field survey did not contribute much additional information about the extent of the sediment problem in Palmers Cove. Investigation of the housing development on the middle cove did confirm the potential for stormwater runoff to be generated by the relatively steep slopes of the bank and hillside. Soil erosion at the corners of street ends was noted.

It was also noted that unsewered housing is located in the floodplain of Eccleston Brook and may allow bacteria release during high water table periods. The prevalence of inland wetland vegetation near the houses indicates that this area likely has a frequently high water table and is probably poorly suited for septic systems.

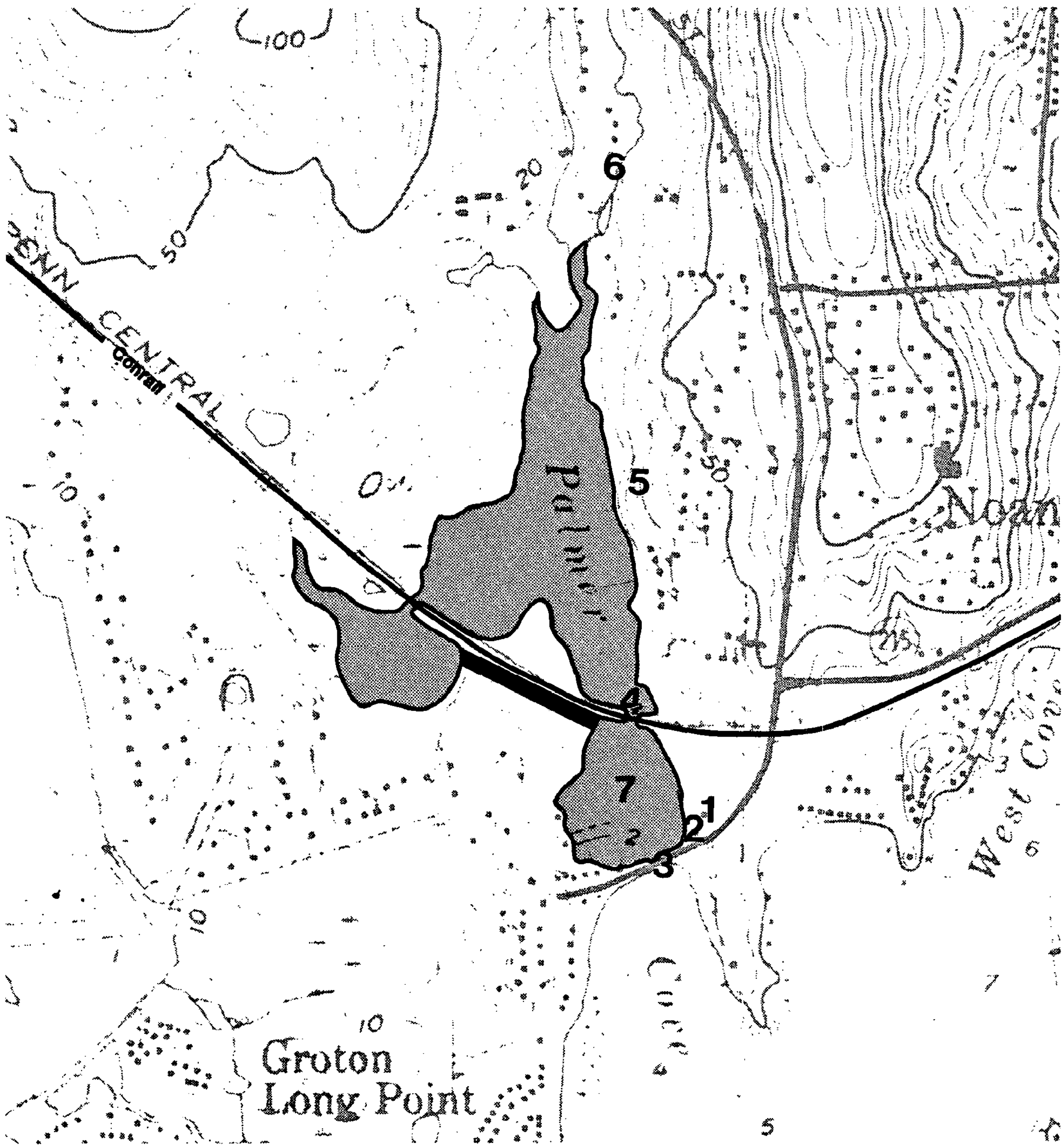
D: Problem Analysis

Constricted Circulation and Sedimentation

The constricted water circulation caused by the railraod and highway bridges is the single largest cause of the reported sedimentation and eutrophication within the cove. The highway bridge at the mouth of the cove has reduced the width of the embayment inlet by a factor of 10 (500 feet to 50 feet). This reduction has severely limited flow exchanges between Long Island Sound and the cove (See Figure 3.4).

The railroad bridge and causeway has reduced the embayment cross-section by nearly a factor of nine (420 feet to 49 feet) at the intersection of middle and outer coves. This severely limits flow exchange between the outer and middle coves (See Figure 3.4).

Tidal exchange to the inner cove would have been eliminated altogether were it not for the excavation of a hard-pan bottom channel connecting it to the outer cove.



Scale: 1" = 1000'

FIG 3.4 PALMER COVE ENVIRONMENTAL PROBLEMS

Problem Areas

1. Marsh Road sewer line construction silted outter cove
2. Surface runoff from restuarant parking lot
3. High way bridge constricts flow
4. Railroad bridge and causeway constricts flow
5. Residential development on steep slopes; potential source of urban runoff
6. Suspected area of septic tank failures
7. Siltation of cove sub-basins

Reduced flushing and the absence of wave action make it difficult for natural forces to erode and transport bottom sediment out of the cove. The net effect is to accelerate settling within the embayment. This magnifies the impact of any sediment discharge into Palmers Cove during nearshore construction activities. The recent sewer construction (See Figure 3.4) probably provided significant sediment for the Cove. Any construction activity with a potential for soil erosion should be carefully controlled to limit or preferably eliminate the introduction of sediment into the cove.

Water Quality Degradation

The three significant sources of water pollution in the cove are septic tank leachate contamination originating from Eccleston Brook, stormwater runoff from the middle cove housing development and any spills of gas and oil at Palmer's Cove Marina. The cove is currently open to shellfishing, yet previous water quality research has found total coliform counts to be over 200,000 MPN per 100 ml at the confluence of Eccleston Brook and the middle cove. Fecal coliforms at this same sampling site were 5,100 MP per 100 ml. Temporal comparisons of sampling data show a clear inverse relationship between fecal coliform counts and salinity levels. Even water samples from the outer cove showed significantly high levels of bacteria when the salinity decreased to approximately 20 parts per thousand (ppt). High counts in the outer cove, however, are unusual and are not representative of typical water quality conditions.

The constrictions that reduced tidal flushing have allowed greater coliform impacts in the inner coves; these impacts will not be reversed unless the coliform sources are eliminated or the flow constricitons eliminated.

With limited tidal circulation, even nominal sources of pollution have a magnified impact on water quality. Sources of degradation such as stormwater runoff are very difficult to control because the polluton enters the cove in many different locations.

It is also very difficult to reduce septic tank leachate contamination without relocating tanks to higher ground. This is not usually feasible where entire housing lots are within the floodplain. The only other solution is to seek off-site treatment, which might be prohibitively expensive.

Controlling careless spills of oil and gas at marinas would require the concerted education and enforcement effort by local officials. Currently it is very difficult to quantify or even estimate the cumulative impact of these spills on the cove.

PROBLEM SUMMARY

West Cove

1.	Flushing and Circulation Constriction	Moderate	(b)
2.	Sedimentation at the Head of the Embayment	Severe	(b)

Palmer's Cove

1.	Circulation constriction	Severe	(b)
2.	Sedimentation of Inner Coves	Minor	(b)
3.	Sedimentation of Outer Cove	Moderate	(b)
4.	Water Quality Degradation	Moderate	(a)

KEY: (a) Conditions becoming worse (b) No change (c) Conditions improving

CHAPTER 4 LEDYARD EMBAYMENTS

INTRODUCTION

The Town of Ledyard is located in New London County on the east shore of the Thames River, just upstream from Groton (See Figure 4.1). The area of the town is 39.3 square miles, of which approximately half is located in the Thames River Basin; the remainder is in the Mystic Coastal Basin. During the period 1970 to 1978, Ledyard's population increased 11.2 percent (1970-14,837; 1978-16,500), which is almost three times the average state increase for that same period. The population density is 419.8 persons per square mile, which is slightly less than Stonington's current density. This figure is roughly two-thirds of the average state density.

According to the most recent Plans of Development, Ledyard is characterized primarily as a residential community. More than 85 percent of the total developed land consists of housing. Only 30 percent of the total land area, however, is developed or allocated for some specific use. The remainder is privately-owned woodland. Residences account for slightly more than 3,000 acres, or 12.5 percent of the total town area. Commercial and industrial uses account for only 146 acres, or less than 1 percent of total land area. Agricultural uses account for approximately 11,000 acres or about 4.5 percent of the town area. Land serving recreational and public open space purposes totals 3042 acres, of which 1641 acres surround and protect Groton's reservoir.

The contour of the shoreline along the Thames River is regular. Three major embayments (Poquetanuck Cove, Clark Cove, and Mill Cove) are located along the Thames shoreline and mark the confluence of major streams or brooks and the river. Two unnamed embayments are also located along the river. All five of these embayments are spanned at their mouths by the Conrail line.

Historically, the railroad has functionally precluded access to the waterfront and, therefore, most residents do not regard Ledyard as a coastal community. Similarly, residents living along Ledyard's embayments derive little benefit from owning waterfront property. In fact, degraded water quality, combined with the dumping of debris and obnoxious odors from low tide mud flats, has made the waterfront seem more of a liability than an asset to property owners. Some of this trend has been reversed by water quality improvements over the past 10 years, but there are still many signs that the old values remain. Examples of these values include residential landscaping purposely blocking waterfront views and the virtual absence of private docks.

Ledyard has no large population centers, as most homes are widely dispersed along town roads. Two villages of some size are Ledyard Center and Gales Ferry. Most development has occurred along Route 12, which parallels the Thames River on the western side of town (See Figure 4.1). Though the town recognizes that much of its land area is poorly suited for septic system-supported housing, only the Highlands development and the Dow Chemical plant at Allyns Point are presently sewered. The treatment needs of other moderately settled areas of town are currently being studied as part of an on-going facility planning process. Recent housing tract developments such as Aljen Heights may be likely candidates for additional future sewer service.

MILL COVE

A: Physical Description

Location

The cove is off the Thames River, approximately 7 miles upstream from the mouth. Located in the southwestern part of Ledyard, the embayment is intersected by a local road called Military Highway. Groton is approximately 4 miles south of Mill Cove, and Gales Ferry is approximately 1 mile north of the Cove (See Figure 4.1).

Site Orientation and Configuration

The cove is irregular in shape and oriented roughly in a northeast to southwest direction. The embayment is divided into two water bodies by Military Highway. They remain connected via a large box culvert and, for purposes of this report, will be referred to as the inner and outer coves. The outer cove is roughly 1000 feet long and 600 feet wide, while the inner cove is 800 feet long and 500 feet wide (See Figure 4.1).

Tidal Data

Mean tidal range -	2.5 ft.
Spring tidal range -	3.0 ft.
Mean tide level -	1.2 ft.

Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth:	2-4 ft. (MLW)
Channel Depth:	4 ft. (MLW)

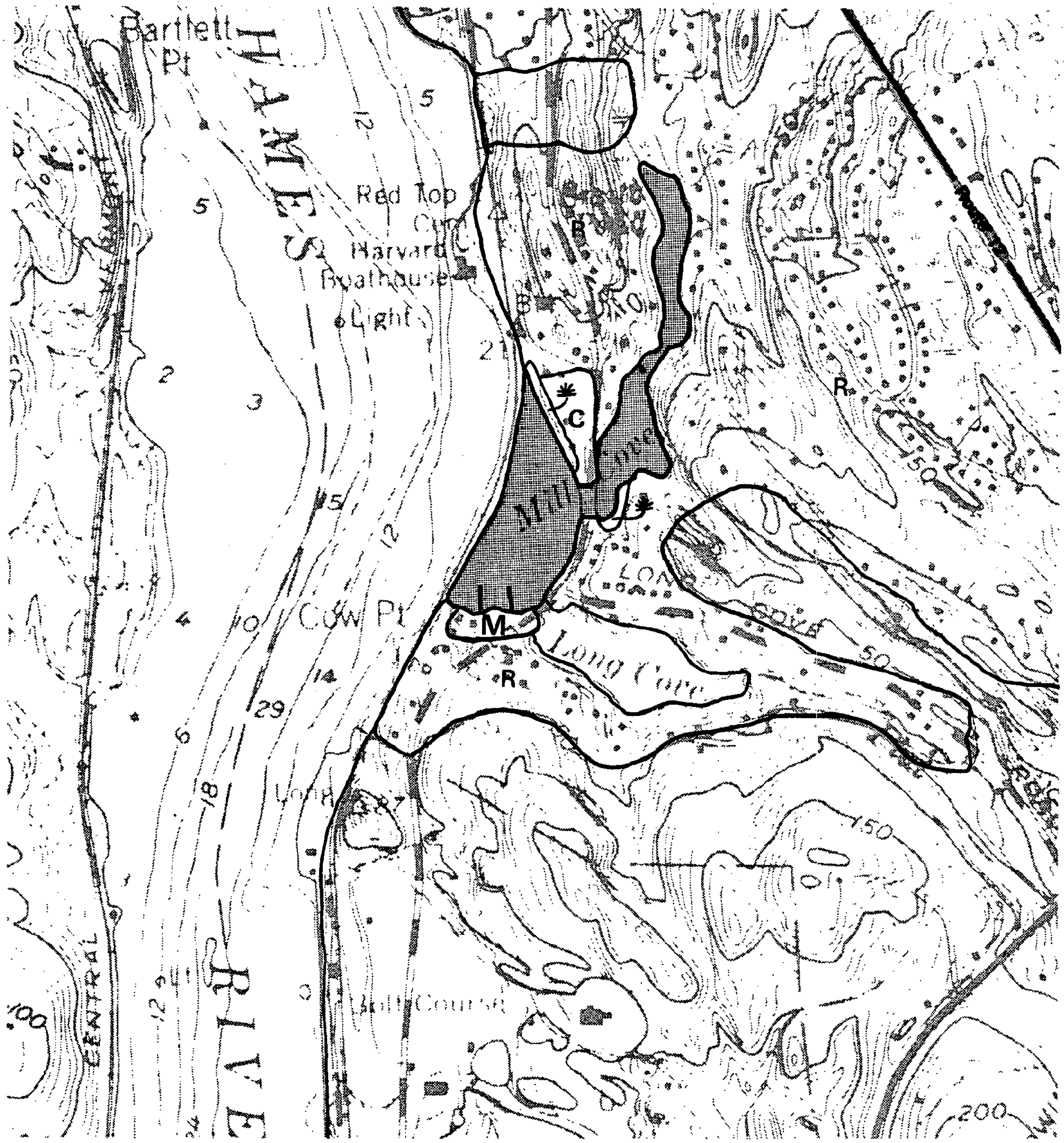
Additional Comments: The channel serves the Long Cove Landing (marina) in outer Mill Cove.

Source: NOAA National Ocean Survey Maps

Basin Hydrology

Regional Drainage Basin: Thames River drainage basin
Tributaries to Embayment: Pine Swamp
Long Cove

Additional Significant Sources of Fresh Water Inflow: The surface runoff from Military Highway drains into the embayment.



Scale: 1" = 1000'

FIG 4.1 MILL COVE ENVIRONMENTAL LAND USE

Legend:

- wetlands
- **A** agriculture
- **R** residential
- **C** commercial/ industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Basin Hydrology (con't)

Constrictions to Tidal Flow and Circulation:

Structure	% Constriction	Distance from Mouth
Conrail Bridge	75-100	At Mouth
Military Highway Bridge	75-100	1000 ft.

Sources: U.S. Geological Survey, Connecticut Drainage Basin Gazeteer, 1981; Conn. Dept. of Environmental Protection

Water Quality Conditions

Embayment Water Quality Classification: SC/SB (Thames River).
Upstream Water Quality Classification: Not classified.

Direct Discharges: None.

Future Status of Discharges: Not applicable

Sewer Service Area and Discharge Point: None yet. Community is reviewing treatment needs currently.

Storm Sewer Outfalls: None, except for roadside drainage ditches discharging through culverts.

Significant Non-Point Pollution Sources: According to the 1981 Draft 201 Facilities Plan, both Mill Cove and Long Cove are impacted by leachate from failing septic tanks.

Water Quality Sampling Data

Location	Parameters						
	Temp	NO3	NH3	O.D.	BOD	FC2	FS3
Mill Cove at Route 12 6/3/80	61°F	0.34	0.96	8.2	2.4	68	100

1. All results in mg/l except bacteriological, which are number of organisms per 100 ml.
2. FC = Fecal Coliform bacteria
3. FS = Fecal Streptococcus

Source: Hayden, Harding and Buchanen, Inc., 1981, Town of Ledyard Draft Facility Plan, Volume 2, Appendix.

Shoreline and Bottom Conditions

Extent of Shoreline Modification: Almost all of the outer cove has been modified, as well as part of the inner cove. Sections of the outer cove have been filled to support a marina, provide boat storage area, stabilize a road embankment, and provide buildable lots along the road (See Figure 4.1). The west shore of the outer cove is formed by the railroad causeway and is supported on rip-rap and fill. The southern end of the inner cove has been filled to provide for grass lawns and a driveway. The western side of the inner cove is a rock lined embankment of the highway. The north end of the inner cove remains in a fairly natural state.

Significant Areas of Erosion: There were no observed areas of active erosion, though the rip-rapped east side of the outer cove between the Long Cove inlet and the inner Mill Cove inlet are directly exposed to wave action. This situation is in contrast to other segments of the cove shoreline, where sediment has been deposited in front of the rip-rap.

Shoaling and Sedimentation Problems: The only area regularly used for boating is the southwestern corner of the outer cove by the railroad bridge. No cove dredging or sediment data are on file at the Connecticut DEP Water Compliance Unit, but town officials indicate that cove siltation is posing a problem for marina boaters. The inner cove, because of its quiet environment, limited tidal flushing, and high soil erosion potential associated with steep slopes, probably also experiences siltation. The inner cove, however, is virtually unused for boating.

Bottom Sediment Characteristics: Based on field observations, the sediment along the shore of the outer cove ranges from coarse sand to fine silt. The inner cove bottom is composed of fine silt.

Surrounding Lands

Maximum Basin Elevation:

Location	Height
Eastern shore of the inner cove (See Figure 4.1)	150 ft.

Topography: The area is characterized by moderate relief and steep sloped hills.

The eastern shore of the inner cove has very steep slopes consisting of both ledges and unconsolidated material. Some of the stone-ledged areas approach side slope angles of 90^0.

General Vegetation Characteristics: The former forests of the outer cove area have been clearcut and revegetated with grass. The inner cove shoreline is covered with dense stands of trees and shrubs, and has homes scattered throughout the area.

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Hinckley	gravelly sand loam	0- 3	very poor
Hinckley	gravelly sandy loam	3-15	very poor
Typic Udorthents	cut and fill	-	variable
Adrian and Palms	muck	-	very poor
Carlisle	muck	-	very poor
Charlton-Hollis	fine sandy loam	3-15	poor
Haven	silt loam	0 - 3	very poor
Hollis-Rock Outcrop	complex	3-15	very poor
Narrangansett	silt loam	3- 8	very good
Rock Outcrop-Hollis	complex	-	very poor

Shellfish and Finfish Resources

Little is known about the current status of shellfish resources in Mill Cove. All shellfish beds in Ledyard are closed.

Wetlands

The tidal wetlands of the cove are limited to a narrow fringe marsh along the northeastern shore of the outer cove and small pockets of marsh along the shoreline of the inner cove. The vegetation is predominantly Salt-marsh cord-grass (*Spartina alterniflora*).

The outer cove fringe marshes provide some function as biological, filters but the more likely function is intertidal habitat. The same is true of small pockets of marsh along the inner cove shoreline.

The outer cove shoreline has been extensively filled and altered to provide a rail bed for Conrail and to provide a road bed for Military Highway. Several sections of the outer cove shoreline are now stabilized with either rip-rap or a seawall.

Wetlands (con't)

The inner cove has been filled in sections, primarily to provide yards for homes. Scattered sections of shoreline have remained in a near natural state, as no homes have been built nearby

Past filling around the outer cove provides little suitable substrate in which wetland vegetation can prosper. Wind and wave energy also makes these areas difficult to revegetate. The inner cove wetlands may expand into shallow offshore areas, particularly if the cove is not dredged. Continued sedimentation from filling and onshore development may even accelerate a revegetation trend.

Environmentally Sensitive Areas

Pine Swamp, located at the head of inner Mill Cove, is a highly productive freshwater wetland. The vegetation and limited surface water of this system provide a valuable food source and habitat for surrounding wildlife.

B: Land Use Analysis

Current Shoreline and Water Use

The 30 slip Long Cove Landing (marina) is the only active commercial land use found within the embayment. It is located on the southern shore of the outer cove (See Figure 4.1). The rest of the shoreline supports little water related use and is limited to a few private docks. The boats within the embayment are generally small because the height restrictions imposed by the Military Highway and Conrail fixed-span bridges.

Current Upland Use

All of the upland land use, except for the marina property and one closed commercial structure, is residential. Almost all of the residential dwellings are single family detached structures. A significant portion of the land surrounding the inner cove has limited development potential due to steep soil slopes and exposed rock ledges.

Currently, the land north of Mill Cove is zoned for high density residential use with a minimum lot size of 20,000 square feet. The land to the east and south is zoned for moderate density residential use with a minimum lot size of 40,000 square feet. There are no special use restrictions for waterfront property.

Historical and Significant Land Use Changes

Historical photographs dating back to 1934 show that the land use of the area has changed from primarily agriculture to residential use. There used to be a large orchard at the intersection of Long Cove Road and Military Highway, but the area is now residential. Agricultural land was also located along many other segments of Military Highway, but has also been gradually developed for housing.

Since the 1930's and 1940's, the western side of the Town of Ledyard, including the land around Mill Cove, has become the most densely settled residential area in the community. The Mill Cove marina, originally constructed in the 1950's, represents the most commercailly intensive water use within the cove.

Public Access and Recreational Opportunities

The Long Cove Landing provides use of a cement boat ramp to the public for a minor fee. The marina also has upland storage for 30 boats.

Aside from boating, the use of the cove is limited to passive recreation. Military Highway provides scenic views of the embayment, and areas have been provided for motorists to pull off the road. The cove also enhances the property value and aesthetics of surrounding homes.

C: Problem Identification

Local Departments and Offices Consulted

Ledyard Planning Department.

Response From Questionnaire and Local Meetings

Ledyard officials indicated that there is a severe tidal circulation problem and moderate pollution and siltation problems. The circulation and pollution problems are believed to be more severe now than in the past, but are not expected to become any more severe than the current situation. In an effort to reduce the contamination of embayment water quality by septic tank leachate, the town is engaged in a program to plan sewer placement throughout the community.

Response From Questionnaire and Local Meetings (con't)

Town officials also indicated that it would be highly desirable to construct railroad drawbridges at the mouths of both Mill and Poquetanuck Coves, allowing greater boating access. The officials are aware, however, that the bridges would be very expensive, and that there are no apparent sources of funding.

Results of Field Survey and Research

A site visit confirmed that the embayment is shallow and that pollution problems appear to be significant in the inner cove (See Figure 4.2). Dense mats of brown algae are visible in the shallow areas of the inner cove (1-2 feet of water) and cover the bottom sediment. The suspected cause of the algae bloom is leaching septic tanks of houses sited close to the water's edge. This factor, combined with the warm water temperature during summer months, shallow depth and minimal tidal flushing of the embayment, contributes to its eutrophic condition. The field survey in Spring, 1981 confirmed the onset of eutrophic conditions in the inner cove.

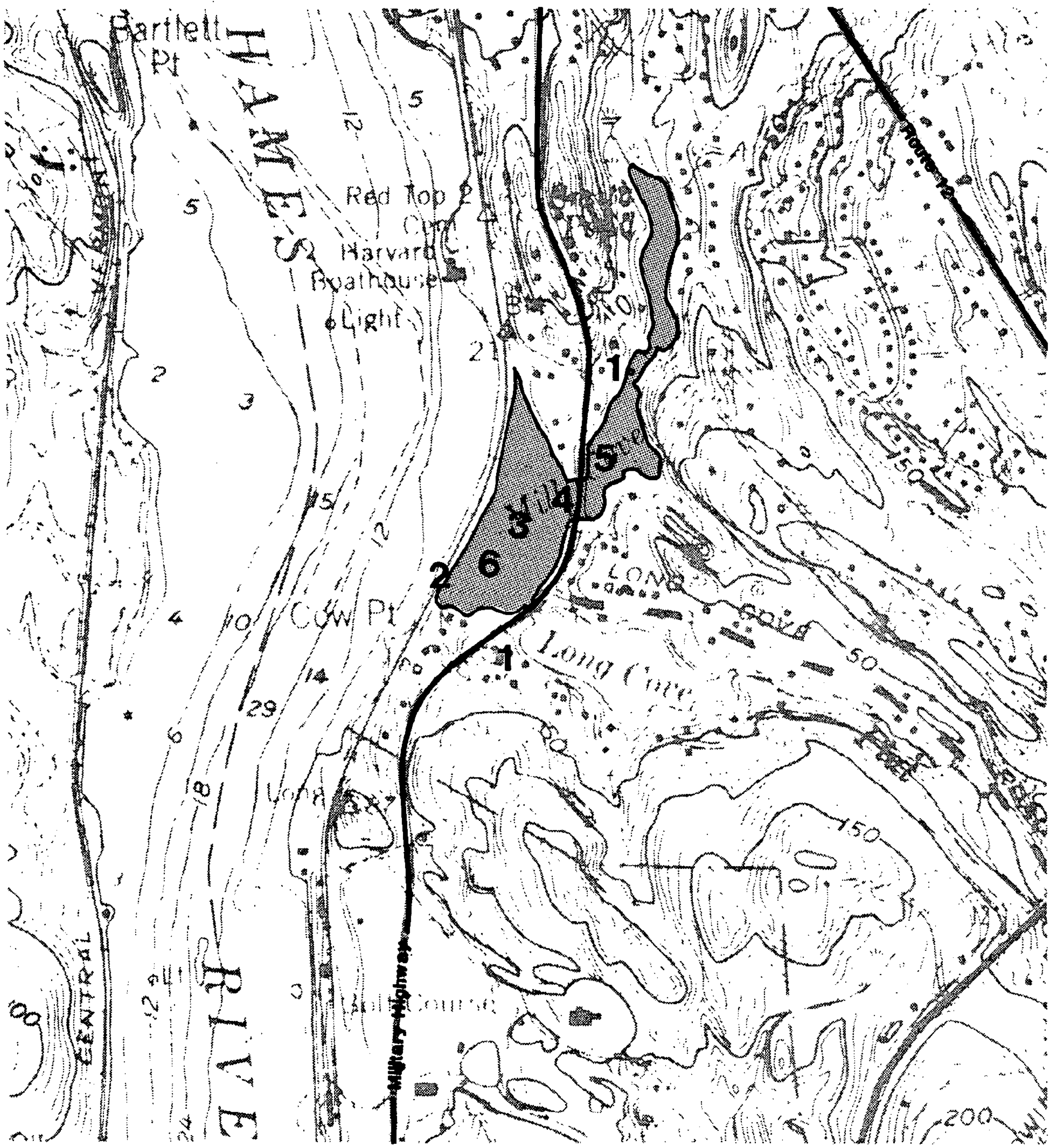
A survey of the outer cove revealed that the bottom sediment is much coarser than the inner cove and that the shoreline appears to be impacted by small wind-generated waves. Overall, the outer cove water quality appears to be superior to that of the inner cove. The outer cove exhibits more effective tidal flushing, has no houses along its shoreline, and has virtually no major sources of external organic material (e.g. tree leaves, grass clippings, overhanging bushes) that consume dissolved oxygen during decomposition in the water.

Long Cove drains to the Thames River through outer Mill Cove, and has pollution problems similar to those of inner Mill Cove. The degraded water quality of both Long Cove and inner Mill Cove impact the water quality of outer Mill Cove during ebb tide, and probably significantly increases the nutrient loading and decreases the dissolved oxygen levels of the receiving water body.

D: Problem Analysis

Flushing and Circulation Constriction

Poor flushing and circulation seems to be the single largest problem of the embayment. It accounts for both accelerated sedimentation rates and localization of leachate contaminants and marina wastes. Prior to the construction of the railroad causeway and bridge, the eastern shore of the outer embayment was probably open to the river and in all likelihood was the original shoreline.



Scale: 1" = 1000'

FIG 4.2 MILL COVE ENVIRONMENTAL PROBLEMS

Problem Areas

1. Area of suspected septic tank failures
2. Railroad bridge constricts water circulation
3. Cove closed to shellfishing
4. Highway bridge constricts water circulation
5. Algae bloom in shallow areas of inner cove
6. Siltation inhibits boat access

Flushing and Circulation Constriction (con't)

Tidal exchange with the inner cove was severely reduced by the construction of the Military Highway road bed spanning the former mouth of the cove. The existing inlet is only about 20 feet wide and represents at least a five-fold reduction in the original natural inlet width.

Sedimentation

Though little information is available on sedimentation rates within the cove, it appears that constricted tidal flushing has essentially created conditions conducive to settling of suspended sediment. The river flood waters that enter the cove are likely to deposit some sediment in the low velocity cove waters. Any sediment introduced into the cove from onshore sources will also accelerate cove sedimentation rates.

Of the inner and outer coves, the inner cove appears to be the more impacted from any sediment contributions. The surrounding steep slopes shelter the embayment from wind and nearly eliminate any potential for wind-generated agitation of silty bottom sediments. This partially accounts for the silty bottom of the inner cove and subsequent successful salt marsh revegetation within the inner cove.

The outer cove uplands are relatively flat, exposing the embayments to wind-generated waves. The wide expanse of river to the northwest also makes the outer cove bottom susceptible to agitation from waves generated by strong winter winds. These conclusions are supported by field observations which found the outer cove shoreline and bottom sediments to be much coarser than those of the inner cove. In fact, the eastern shore of the outer cove showed signs of scouring, and the owners of the marina (located on the south shore) placed rip-rap at the water's edge to stem erosion.

Despite the higher natural energy of the outer cove, the water body still functions as a sediment basin because of the causeway. Consequently, the Long Cove Landing, which requires a navigational channel for its boats, dredges the outer cove regularly.

Water Quality Degradation

The inner Mill Cove area experiences the most significant water quality degradation in the embayment. Dense mats of brown algae, a form of algae bloom, are apparently caused by nutrient-loaded septic tank leachate. In addition, decaying organic material, Water Quality Degradation (con't)

such as leaves, grass clippings, etc. may also contribute to eutrophic conditions. The three major factors that cause leachate impacts on the cove include: 1) the close proximity of the septic tanks and leach fields to the water's edge (in some cases less than 30 feet), 2) the poor soils, which do litle to renovate the effluent, and 3) the minimal depth to bedrock, particularly on the east side of the inner cove. This last item prevents percolation and forces the effluent to move laterally into the cove.

During ebb tide, the nutrient rich waters flow into outer Mill Cove, causing a degradation of water quality. The impact of this effluent on the outer cove is lessened by dilution as it mixes in the larger body of water. Long Cove also flows into the outer cove and also degrades the outer cove water quality. Greater tidal flushing and stronger wind-generated circulation and mixing dampen the impact of this additional degradation on the outer cove.

Loss of Wetlands

Although the wetlands of the outer cove were extensively filled during the construction of the railroad and highway causeways, little wetland filling continues today. There is some potential for additional filling of wetlands to support new housing developments along the inner cove, but such filling could be minimized through regulation and enforcement.

Current Plans for Mitigation

The town is currently in the middle of a wastewater facility planning process. At present, even if construction of a sewer plant is recommended by the consultant, there is no assurance that this proposed action will be adopted by the town.

Also, town officials voiced an interest in replacing the existing fixed bridge across the mouth of the embayment with a drawbridge. A drawbridge is expensive however, and neither Conrail nor the town is willing to pay for one. The impacts of a drawbridge would be to increase embayment boat traffic, probably leading to further environmental damage. The Long Cove Landing is expected to continue its program of periodic maintenance dredging to ensure navigational access to the river.

POQUETANUCK COVE

A: Physical Description

Location

Poquetanuck Cove is off the Thames River, approximately 10 miles upstream of the mouth, and forms the northwest border of Ledyard (borders on Preston, CT). The cove is bordered to the west by Route 12, intersected on the eastern end by Route 117 and paralleled to the north by Route 2A (See Figure 4.3). The cove is approximately 4 miles south of Norwich and 4 miles north of Ledyard Center.

Site Orientation and Configuration

The cove is narrow and oriented in roughly a northeast to southwest direction. The embayment is discretely separated from the Thames River for most of its length by the Conrail solid fill causeway and bridge. The cove is intersected by Route 12 approximately 0.5 miles from the railroad bridge. The highway is constructed on piles almost the entire natural width of the cove, and presents a minor impediment to drainage and any tidal currents. Poquetanuck Cove is approximately 2.15 miles long and 0.27 miles wide at its widest point.

Tidal Data

Mean tidal range -	2.5 ft.
Spring tidal range -	3.0 ft.
Mean tide level -	1.2 ft.

Source: U.S. Department of Commerce, <u>1980 Tide Tables: East Coast of North and South America</u>

Bathymetry

Range of Depth:	1-8 ft. (MLW)
Channel Depth:	3-8 ft. (MLW)

Source: NOAA National Ocean Survey Maps

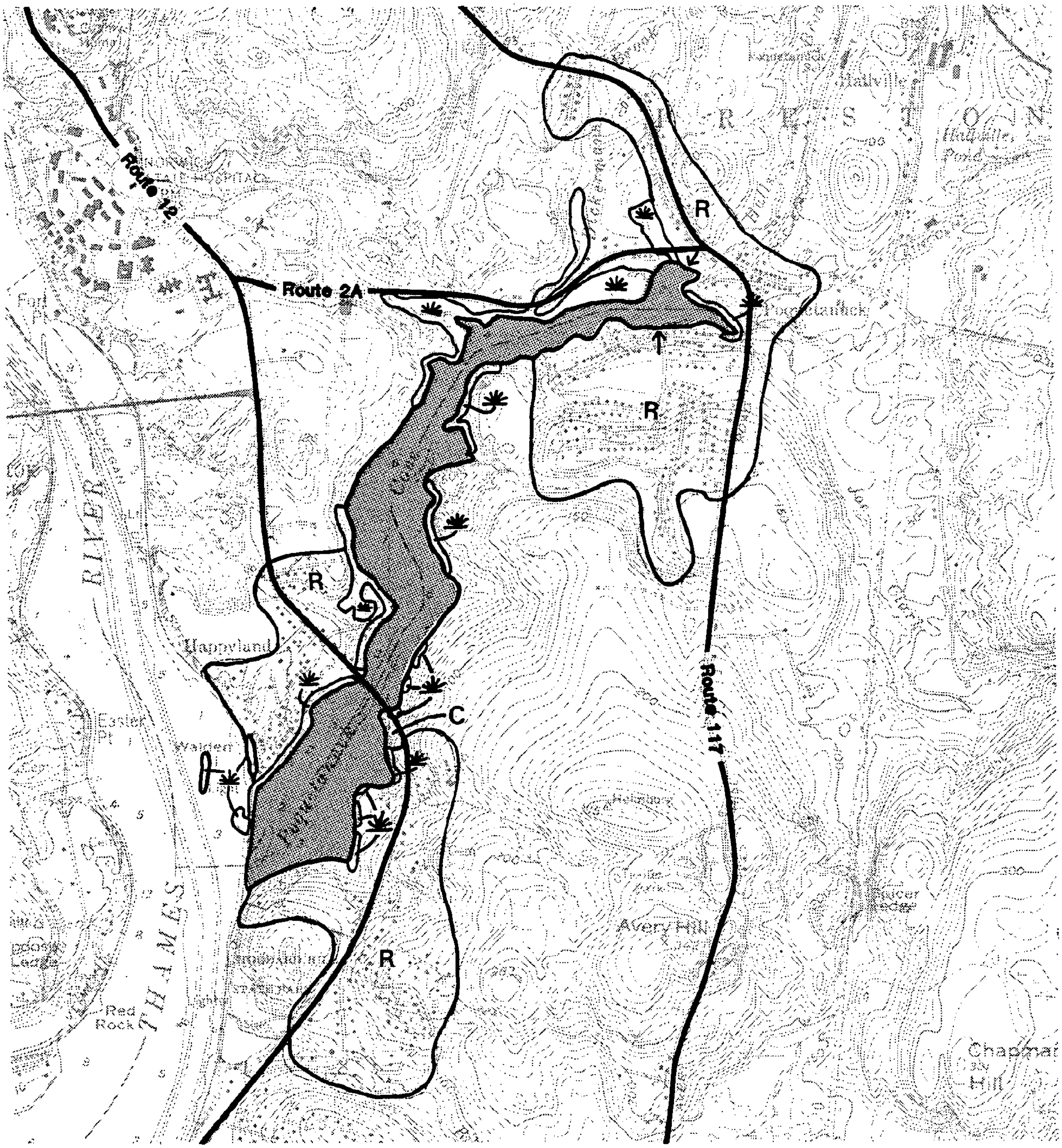
Basin Hydrology

Regional Drainage Basin: Thames River drainage basin

Tributaries to Embayment: Dickermans Brook
Halls Brook
Joe Clark Brook

Additional Significant Sources of Fresh Water Inflow:

Several unnamed brooks also flow into Poquetanuck Cove. Storm sewers from the Aljen Heights housing development also discharge into the embayment.



Scale: 1" = 2000'

FIG 4.3 POQUETANUCK COVE ENVIRONMENTAL LAND USE

Legend:

- wetlands
- **A** agriculture
- **R** residential
- **C** commercial/industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Basin Hydrology (con't)

Constrictions to Tidal Flow and Circulation:

Structure	% Constriction	Distance from Mouth
Conrail Bridge	75-100	At Mouth
Route 12 Bridge	0-25	2800 ft.

Sources: U.S. Geological Survey, Connecticut Drainage Basin Gazeteer, 1981; Conn. Dept. of Environmental Protection

Water Quality Conditions

Upstream Water Quality Classification: B/A*

Embayment Water Quality Classification: B/A

* Second letter following first indicates the CTDEP goal for future water quality.

Direct Discharges: None present.

Future Status of Discharges: Not Applicable.

Sewer Service Area and Discharge Point: Community is currently engaged in sewer planning process. A plant and outfall are being considered for a Poquetanuck shorefront site just west of the Aljen Heights development.

Storm Sewer Outfalls: Storm sewers at Aljen Heights discharge directly to Poquetanuck Cove

Significant Non-Point Pollution Sources: Some stormwater runoff from Aljen Heights is generated by streets and driveways and runs into the cove at the street ends.

Water Quality Sampling Data

Location	Parameters						
	Temp	NO3	NA3	O.D.	BOD	FC2	FS3
Unnamed stream, Intersection of Route 12 and Orchard Drive 5/2/80	56°F	0.16	0.48	10.2	3.1	2	9

Water Quality Conditions (con't)

Location				Parameters			
	Temp	NO3	NA3	O.D.	BOD	FC2	FS3
Aljen Heights Stream 5/21/80	-	2.70	2.04	7.6	2.6	0	20
Aljen Heights Stream 6/3/80	59°F	5.00	0.48	6.8	0.6	3	53

1. All results in mg/l except bacteriological, which are number of organisms per 100 ml.

2. FC = Fecal Coliform bacteria

3. FS = Fecal Streptococcus

Source: Hayden, Harding and Buchanen, Inc., 1981, Town of Ledyard Draft Facility Plan, Volume 2, Appendix.

Shoreline and Bottom Sediment Conditions

Shoreline Modification: the mouth of the cove has been altered by the presence of the railroad causeway, which virtually separates the embayment from the Thames River. Between the railroad bridge and the Route 12 highway, the north shore has been filled for waterfront housing. On the south side, the shoreline has been stabilized for a truck storage lot and housing. The middle portion of the cove is heavily forested on both sides, with an undisturbed shoreline at the water's edge. The shoreline along the upper reaches of the cove has been filled as part of the housing development at Aljen Heights. The shoreline across the cove from Aljen Heights is filled in sections for residential waterfront lots.

Significant Areas of Erosion: Significant erosion occurred around the asphalt boat ramp next to the Aljen Heights housing development. As a result, the shoreline was eroded to the high tide mark. Also, the river side of the railroad causeway appears to be a potential site for future floodwater scouring, since the flow is constricted and the shoreline is composed of unconsolidated sediments. Aside from these two indications of erosion, other portions of the cove shoreline appear to be accreting sediment.

Shoaling and Sedimentation Problems: The cove is used minimally for boating. Most boats are docked outside or within 500 yards of the Route 12 bridge, where the embayment depth is at least four feet below mean low water.

Large areas of tidal flats and scattered submerged and exposed boulder fields make navigation of the upper reaches of the cove difficult at low tide.

Bottom Sediments Conditions: No dredging data on the embayment are available from the Connecticut DEP. Field observations indicate that much of the bottom in the upper reaches is fine silt. Little information was available concerning bottom sediment composition in the lower embayment, because greater low tide water depths obscurred the bottom.

Surrounding Lands

Maximum Basin Elevation:

Location	Height
North shore	290 ft.
East shore (north of Lincoln Park Road)	150 ft.
South shore	342 ft.

Topography: The area is characterized by moderate to significant local relief. The entire area exhibits a similar irregular topography.

Nearly all shores of the cove have moderately steep slopes, except for a 0.8 mile stretch along Route 2A (north shore). Aljen Heights the largest development on the cove, has slopes of up to 25%.

General Vegetation Characteristics: The southern shoreline (from Aljen Heights to Avery Hill to Stoddard Hill) is covered by a dense forest. The north shore is comprised of a mix of wetlands and forest interposed with occasional housing sites (See Figure 4.3).

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Agawam	fine sandy loam	3- 8	very poor
Birdsall	silt loam	-	very poor

Surrounding Lands
(con't)

Soils:
(con't)

Name	Characteristics	Slope %	Developmental Drainage Suitability
Canton & Charlton	extremely stony fine sandy loam	3-15	poor
Haven	silt loam	3- 8	very poor
Hinckley	gravelly sandy loam	3-15	very poor
Hinckley	gravelly sandy loam	15-35	very poor
Merrimac	sandy loam	0- 3	very poor
Narragansett	extremely stony silt loam	3-15	very good
Rumney	fine sandy loam	-	very poor
Typic Udorthents	cut and fill	-	variable
Westbrook	mucky peat	-	very poor
Adrian and Palms	muck	-	very poor
Broadbrook	silt loam	8-15	poor
Broadbrook	very stony silt loam	3- 8	poor
Enfield	silt loam	3- 8	very poor
Hinckley	gravelly sandy loam	0- 3	very poor
Hollis-Charlton	complex	15-35	very poor
Narragansett	silt loam	3- 8	very good
Narragansett	extremely stony silt loam	15-25	poor

Surrounding Lands (con't)

Soils: (con't)

Name	Characteristics	Slope %	Developmental Drainage Suitability
Rainbow	silt loam	0- 3	poor
Rainbow	silt loam	3- 8	poor
Ridgebury, Whitman, and Leicester	extremely stony fine sandy loams		very poor
Tisbury	silt loam	0- 3	very poor
Windsor	loamy sand	3- 8	very poor

Shellfish and Finfish Resources

Little is known about the status of shellfish beds in Poquetanuck Cove. All shellfish beds in Ledyard, however, are closed.

Wetlands

Tidal marshes are located throughout Poquetanuck Cove, from the mouth near the Conrail bridge to the head of the cove at the confluence of Joe Clark Brook (See Figure 4.3). Most of the marshes fringe the cove with widths of less than 30 feet. At the confluence of the major brooks, the tidal marshes are fairly extensive and occupy much of the floodplain at the mouth. Most of the marshes act as natural biological filters, retaining eroding soil and organic detritus. In addition, they provide valuable habitat and extensive surface area for the decomposition of organics by bacteria.

Most filling has occurred in the following areas: at the base of Aljen Heights; the Route 2A road embankment where it runs close to the cove and near the intersections of Route 12; and the Conrail bridge and causeway. Little additional wetland filling has occurred over the past 10 years. Some new wetlands have revegetated shallow tidal flats over the past 20 years, even in areas where the wetlands were filled to the water's edge. Increased siltation of the cove has probably improved the opportunity for revegetation of nearshore waters.

Environmentally Sensitive Areas

Stoddard Hill State Park is a valuable forested habitat for wildlife. Very little of the park acreage is accessible by car, reducing the potential for use impacts.

Other sensitive areas include the freshwater wetlands in the floodplains of Dickermans Brook, Halls Brook, Joe Clark Brook and an unnamed brook which drains the property of Norwich State Hospital.

B: Land Use Analysis

Current Shoreline and Water Use

Very few residents of homes along the embayment shoreline use the water for boating. For example, there are only a small number of private docks, and few homeowners store boats at the water's edge. Most use is limited to passive recreation. Some residents fish from the shoreline and occasionally from small boats.

Current Upland Use

Less than half of the Poquetanuck Cove upland has been developed, and the majority of the land remains in forest and preserved open space. Almost all of the developed land is used for housing. One exception is a tractor storage area near the southern end of the Route 12 bridge.

The residential neighborhoods consist primarily of single family detached dwelling units on lots of one acre or more. Most of the yards are landscaped with grass lawns and some trees and shrubs. Landscaping of the houses near the cove usually obscures any view of the water and indicates that little aesthetic value is placed on the waterfront locations.

Historical and Significant Land Use Changes

The area surrounding Poquetanuck Cove has historically been used for agriculture. Aerial photographs from 1934 show large acreage of both orchards and vegetable crops. Since that period, agriculture has been on the decline, and former sites have been developed for housing or abandoned. Most of the abandoned fields are now reforested.

The oldest housing development (dating back to the nineteenth century) is at the head of the cove on the north shore. These old sites tend to have lot sizes exceending the standard one-acre lots characteristic of Aljen Heights on the opposite shoreline. Aljen Heights is one of the largest housing tract developments in Ledyard, and has more than tripled in size since 1960.

Some newer homes have been built near the shoreline in a section of Ledyard called Happyland, where Route 12 crosses Poquetanuck Cove. Additional homes have also been built on the opposite shore since 1960 (See Figure 4.3).

Public Access and Recreational Opportunities

A public boatramp, located at the western end of the Aljen Heights development, provides free water access for the public. There are no marinas on the cove, and docks are limited to those associated with private homes. Surrounding roads provide good visual access to the embayment. Several bridges with roadside stops provide access for fishing.

C: Problem Identification

Local Departments and Offices Consulted

Ledyard Planning Department.

Response from Questionnaire and Local Meetings

Town officials cited pollution, siltation and eutrophication as the three major problems within the embayment. The problems are believed to be moderate, have existed for at least 20 years, and are anticipated to become more severe in the future. Septic tank failures at Aljen Heights and landfill leachate via Joe Clark Brook were two noted sources of water quality degradation. The Conrail bridge and causeway were identified as an obvious constriction to tidal flow.

During the local meeting, town officials mentioned that the community was currently planning sewers to replace faulty local septic systems, but there was uncertainty whether town residents would support the sewer plan.

Results of Field Survey and Research:

Field observations confirmed the severity of the Conrail bridge tidal constriction and noted the presence of large tidal flats and shallow water in the upper half of the cove. Though the flats may limit navigation of the upper reaches, they also serve as an important feeding area for a large number of shore birds.

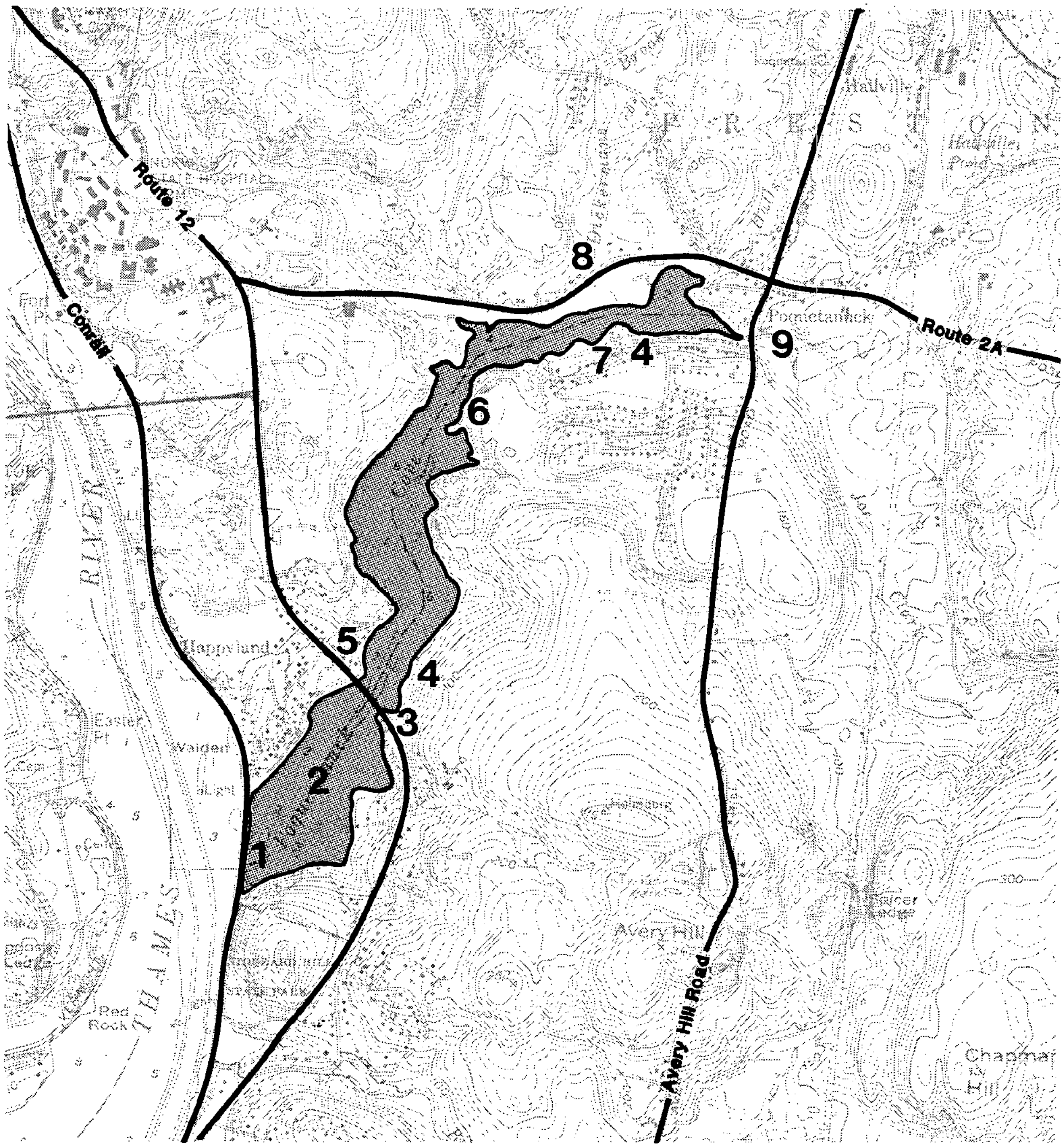
In studying the shoreline, it appears that the segments which were once filled to the water's edge now have salt marsh grass (Spartina alterniflora) recolonizing nearshore tidal flats. This may improve embayment water quality as the vegetation anchors eroded soil and provides a natural biological filter along the developed shoreline.

Ledyard's zoning along the embayment waterfront is primarily for one acre minimum lot size. Current water quality analysis shows extensive degradation of a brook draining from Aljen Heights (See Figure 4.4). This indicates that even at a one acre density, the septic tanks of the housing development will fail due to poor soils and steep slopes. Continued expansion of the tract development without sewers will probably lead to increased water pollution of the cove.

D: Problem Analysis

Flushing and Circulation Constriction

The Conrail bridge and causeway severely constricts tidal flushing of the embayment. The pile-supported span of the bridge is only 140 feet wide and represents a reduction of over 80 percent of the original embayment width at the mouth. The large area size of the embayment, however, increases the dilution factor of degraded streams that drain into the cove. This tends to offset the direct impact of contamination from a small landfill next to Joe Clark Brook and leachate contamination from the Aljen Heights housing development. The high nitrate (NO_3) levels observed in a brook flowing from the Aljen development most likely come from failing septic systems. The nitrogen contamination should be regarded with caution, as it may in fact be a limiting nutrient within the cove ecosystem, and the high input rates may lead to serious eutrophication problems.



Scale: 1" = 2000'

FIG 4.4 POQUETANUCK COVE ENVIRONMENTAL PROBLEMS

Problem Areas

1. Railroad bridge restricts tidal circulation
2. All of Cove closed to shellfishing
3. Surface runoff from commercial trucking
4. Steep slopes
5. Urban runoff from highway
6. Proposed sewer outfall and wastewater treatment facility
7. Area of known septic tank failure
8. Heavy siltation
9. Potential landfill leachate via Joe Clark Brook

Sedimentation

The lower reaches of the cove have a natural depth of up to 8 feet in tidal channels near the center of the embayment. The depth is maintained by tidal currents that resuspend bottom sediment during flood and ebb tides.

The long and relatively narrow dimensions of the cove tend to focus sediment resuspension in the lower reaches of the cove. Little or no sediment movement off the bottom occurs in the upper reaches of the cove.

Large boulder fields in the middle of the upper reaches of the cove impede tidal flushing and increase depositional dynamics. This explains the large tidal flats characteristic of the cove's upper reaches. Also, the cove shoreline has become quite shallow due to the combined impact of soil erosion from adjacent steep slopes and deposition of sediment-laden waters from the Thames River during flood flows. The flats and boulders tend to limit the navigability of the upper reaches. The 2 foot clearance of the railroad bridge (measured at high tide), however, is the most significant impediment to navigation.

Eutrophication

Though town officials cited a growing eutrophication problem in the cove, research showed few manifestations of any such problems. Despite documented high nitrate levels in brook drainage, no algae blooms were visible in the cove and local questionnaires mentioned no specific characteristics of a eutrophic condition.

The draft Wastewater Facility Plan for Ledyard (1981) concluded that the water quality of the stream feeding into Poquetanuck Cove is generally excellent. The conclusions are based on nutrient and bacteriological analysis, and do not address potential degradation from volatile organics and exotic chemicals. Thus, there still is little information about the impacts of the Joe Clark Brook landfill on the cove's water quality.

Overall, Poquetanuck Cove appears to exhibit little, if any, indication of eutrophication. Consequently, this potential impact is not regarded as a significant problem.

PROBLEM SUMMARY

Mill Cove

1.	Flushing and Circulation Constriction	Moderate	(b)
2.	Sedimentation	Moderate	(b)
3.	Water Quality Degradation	Moderate	(a)

Poquetanuck Cove

1.	Flushing and Circulation Constriction	Moderate	(b)
2.	Sedimentation	Minor	(b)
3.	Eutrophication	Minor	(c)

KEY: (a) Conditions becoming worse (b) No change (c) Conditions improving

CHAPTER 5 WATERFORD EMBAYMENTS

INTRODUCTION

The Town of Waterford is located in New London County and is bordered to the east by Groton and to the west by East Lyme. The town has an area of 34.4 square miles of which 40 percent drains into the Thames River; the remainder falls within the Niantic River Basin. During 1970 to 1978, Waterford's population increased 8.5 percent (1970 - 17,227; 1978 - 18,700), which is 80 percent faster than the state average for that same period. Waterford's growth is partly explained by its very low tax rate of 19.0 mils (at 70 percent assessment). The number of Waterford housing units increased at a rate of 13.7 percent during 1970 to 1978, possibly indicating a moderate decrease in average size of households.

The density of the town is 664 persons per square mile, which is almost identical to the state density of 652 and considerably higher than the county average of 370 persons per square mile. Development is divided into the 3 population centers of Morningside Park, Quaker Hill, and downtown Waterford. The major roads linking these population centers to the region include Route 156, U.S. 1, Route 32, and Interstate 95. The town is also served by the Conrail Line, which runs along a major part of Waterford's Long Island Sound coast.

The land use of the town is similar to other rural and suburban towns in the region. As of 1976, over half (54%) of the land in Waterford was undeveloped, while water area, roads, state land, open space and farmland constituted the second largest portion (24%). Residential land was the third largest land use, occupying 17% of land area. Industrial use was fourth (4%), and commercial use fifth (1%). Most commercial development in Waterford is located in a strip along U.S. 1.

The geology of Waterford is significantly influenced by former glacial processes. The topography consists of moderately rolling hills ranging in elevation from 100 to 400 feet, interspersed with large areas of inland wetlands. Examples include the upper reaches of Stony Brook, Nevins Brook, Oil Mill Brook and Green Swamp Brook. The valleys and hillsides have extensive deposits of glacial till, while some areas have till overlain with stratified sand and gravel. Bedrock outcrops are very abundant, indicating shallow bedrock conditions with the thickness of till formations generally ranging up to 25 feet.

The Waterford coast is comprised of three segments: 1) riverfront shoreline along the Thames, 2) the Long Island Sound shoreline from Alewife Cove to the Niantic, and 3) the embayment shoreline of the Niantic estuary. The Thames waterfront is primarily a residential area with a few industrial and commercial sites, including oil storage and warehouse supplies.

This area is obstructed by the railroad line, and generates relatively little boating activity. The south shore along the Sound consists of residential neighborhoods and some state open space. The Niantic shoreline supports important shellfishing, includes prime residential property, and generates moderate levels of boating activity.

Seven major coves are located along the Waterford coast. Four of these coves - Goshen Cove, Keeny Cove, Smith Cove and Jordan Cove - were originally considered for study. Goshen Cove and Jordan Cove were deleted because only limited problems were identified. Keeny and Smith Coves were ultimately chosen because they had significant siltation, pollution and circulation problems.

SMITH COVE

A: Physical Description

Location

The cove is along the western side of the Thames River and is approximately 0.4 miles north of the river confluence with Long Island Sound. The embayment is comprised of an inner cove, which is Smith Cove, and an outer cove called Best View Cove. The Route 32 bridge intersects the two coves at their junction. New London is one-third of a mile to the south and Norwich is 0.8 miles north (See Figure 5.1).

Site Orientation and Configuration

Best View Cove is separated from the Thames by a long solid fill railroad causeway and bridge. The mouth of the cove was originally about 800 feet wide, but is now reduced to less than 25 percent of that width because of the bridge. The cove is roughly circular with a maximum width of 1200 feet. Smith Cove, in comparison, is narrow and horseshoe-shaped. It is 500 feet at its widest point and narrows down to approximately 20 feet at the confluence of Hunt's Brook and the cove.

Tidal Data

Mean tidal range -	2.5 ft.
Spring tidal range -	3.0 ft.
Mean tide level -	1.2 ft.

Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth:	1.4 ft (MLW)
Channel Depth:	No channels present in this embayment

Additional Comments: Though some private dredging has been done in the past, no channel currently exits in the embayment.

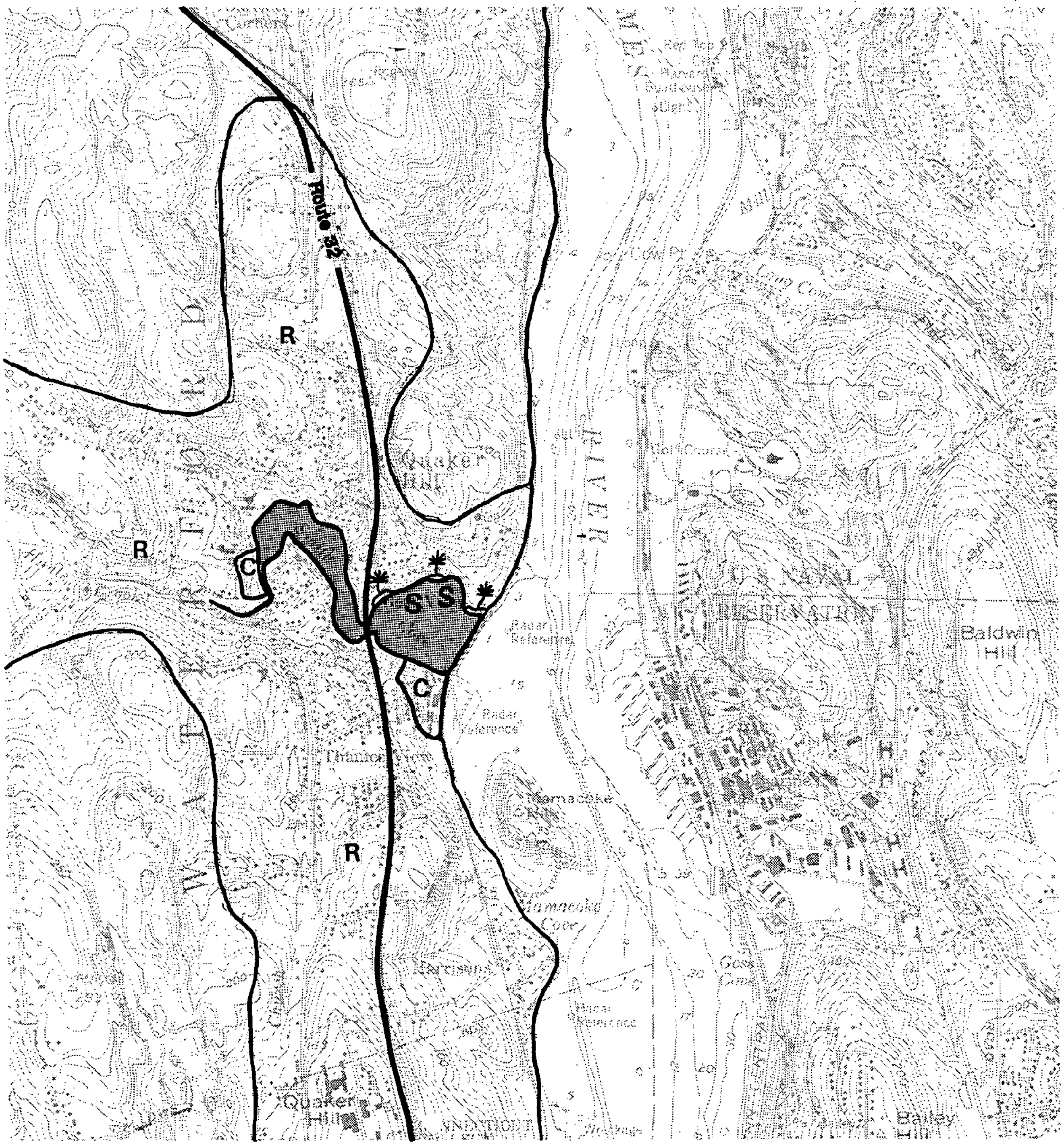
Source: NOAA National Ocean Survey Maps

Basin Hydrology

Regional Drainage Basin: Thames River Basin

Embayment Basin Area: 12.5 square miles

Tributaries to Embayment: Hunts Brook
2 Small Unnamed Brooks



Scale: 1" = 2000'

FIG 5.1 SMITH COVE
ENVIRONMENTAL LAND USE

Legend:

- wetlands
- **A** agriculture
- **R** residential
- **C** commercial/industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Basin Hydrology (con't)

Other Sources of Freshwater Inflow: Impervious surface runoff is supplemented by moderate runoff from local steep sloped areas.

Constrictions to Tidal Flow and Circulation:

Structure	% Constriction	Distance from Mouth
Railroad Bridge #1	75-100	At mouth
Railroad Bridge #2	75-100	At mouth
Route 32 Bridge	0-25	1100 feet

Sources: U.S. Geological Survey Connecticut Drainage Basin Gazeteer, 1981; Conn. Dept. of Environmental Protection

Water Quality Conditions

Upstream Water Quality Classification: A

Embayment Water Quality Classification: SC/SB

Sewer Service Area and Discharge Point: Sewers are currently being constructed to serve the homes along Smith Cove.

Storm Sewer Outfalls: There are several storm sewer outfalls that drain to the embayment; however, the majority of stormwater runoff comes from residential drain pipes and roadside drainage ditches.

Significant Non-Point Pollution Sources: There is some nutrient and BOD loading from soil erosion along the steep slopes of residential property bordering on the embayment.

Shoreline and Bottom Sediment Conditions

Extent of Shoreline Modification: Most of the shoreline modifications in Smith and Best View Coves are associated with waterfront housing. Almost all of the waterfront is developed for housing, and the shoreline is typically terraced along the steep slopes of the banks and stabilized with seawalls, riprap or both. Many of the homes have docks or piers.

Significant Areas of Erosion: The steep slopes of the coves are likely areas of erosion. Once the soil and organic detritus reaches the waters edge at the base of the slopes, there is little chance of additional movement. The steep slopes of Smith Cove minimize the occurrence of wind generated waves, and the small tidal range minimizes the opportunity for transport of sediment out of the cove.

Shoreline and Bottom Sediment Conditions (con't)

Shoaling and Sediment Patterns: The cove is severely silted, making navigation quite difficult. Almost all of the water body is less than 4 feet in depth at low tide. The head of the cove at the confluence of Hunts Brook is very silty, and clearly the shallowest area of the embayment. The potential sources of this sediment are the steep slopes of the cove banks and sediment from Hunts Brook.

Bottom Sediment Conditions - The bottom sediment is very silty, with a large organic content. Most of the sediment appears to come from soil erosion along the embayment banks. The rest probably comes from Hunts Brook, the major tributary to Smith Cove (See Figure 5.1).

Surrounding Lands

Maximum Basin Elevation:

Location	Height
Quaker Hill	170 feet
South Shore	230 feet
West Shore (Hunts Brook basin)	170 feet
North of Old Colchester Road	260 feet

Topography: Almost all of Smith Cove has moderately steep slopes. Property developed for housing is commonly terraced in an effort to stabilize the soil cover.

General Vegetation Characteristics: The area surrounding Smith Cove is moderately developed and much of the vegetation is comprised of residential landscaping.

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Enfield	silt loam	3-8	very poor
Hinckley	gravelly sandy loam	15-35	very poor
Narragansett	extremely stony silt loam	3-15	poor

Surrounding Lands (con't)

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Raypol	silt loam	-	very poor
Ridgebury, Whitman and Leicester	extremely stony fine sandy loams	-	
Haven	silt loam	3-8	very poor
Hollis Charlton	complex	15-35	very poor
Hollis-Rock Outcrop	complex	15-35	very poor
Narragansett-Hollis	complex	3-15	poor

Shellfish and Finfish Resources

The shellfish beds in the area are located along the northern half of Best View Cove. There are no fish runs through the embayment up Hunts Brook. Two freshwater fish found on Hunts Brook during a 1969 biological survey include the Horned pout and the northern muddler. Horned pout are of particular significance because they can survive in adverse environments.

Wetlands

There are no wetlands within Smith Cove; however, there are three small pockets of salt-marsh cord grass (Spartina alterniflora) in Best View Cove. (See Figure 5.1) The three small areas of marsh serve primarily as habitat for aquatic organisms and as a food source for shore birds.

Development of the steep slopes around the embayment has generated considerable erosion which has silted some shoreline areas that might have supported wetlands. Other sections of the shoreline have either been terraced down to the waters edge or stabilized with seawalls.

Since most of this shoreline has already been stabilized, little additional shoreline filling is anticipated. The three remaining areas of marsh are expected to remain intact in the future.

Environmentally Sensitive Areas

There are no significant environmentally sensitive areas within the embayment.

B: Land Use Analysis

Current Shoreline and Water Use

The embayment is used moderately for boating, as some homeowners dock their boats along the waterfront or store them in their front yards. The two major impediments to boating in the embayment are the small depths of the cove due to siltation and the low elevations of the Route 32 highway bridge and railroad bridge.

There are several beaches on the embayment waterfront where residents presumably swim, though no one was observed swimming on the day of the field survey. The embayment also enhances the passive recreation of the area, as the waterbody offers an expansive view of the surrounding landscape.

Current Upland Use

Most of the upland use around the embayment is residential. Exceptions include a roadside foodstand at the head of Smith Cove and a large lumberyard on the south side of Best View Cove. Residential development around the embayment is oriented to focus on the embayment, unlike the development around Poquetanuck Cove, just upriver on the Thames. Waterfront yards are open and offer homes a clear view of the embayment. Here the embayment is clearly regarded as an asset to surrounding property.

Historical and Significant Land Use Changes

Most of the houses bordering on the embayment have been built within the past forty years. Prior to that, the area was undeveloped forest. The most significant change since the 1940's has been the conversion of the area from undeveloped open space to residential use.

The one other significant impact to the area was the construction of Route 32 in 1969. Route 32, which separates Best View Cove from Smith Cove, is a major access road of the area, tying together Route 52 in Montville with Interstate 95 in New London. Construction of the highway required crossing the embayment with a new bridge, and increased soil erosion and siltation within the embayment. Improved accessibility from the new highway increased the residential development pressure around the embayment.

Public Access and Recreational Opportunities

There is only limited public access to the embayment in the form of scenic vistas off Route 32 and from Old Norwich Road. There are no public recreation areas located on the embayment, as all waterfront property is privately owned.

C: Problem Identification

Local Departments and Offices Consulted

Waterford Flood and Erosion Control Board
Waterford Planning Department
Waterford-East Lyme Shellfish Commission

Response from Questionnaires and Local Meetings

The response from local officials on the range of problems affecting Smith Cove differed significantly. However, there was consensus on several major issues. For example, it is agreed that siltation and constriction of embayment circulation are two major problems affecting the embayment. The siltation problem is believed to come from both local and upstream sources, though little is known about the relative contribution of the two sources. The history of the problem dates back approximately 30 years.

The circulation problems of the embayment are directly related to the construction of the railroad causeway and pile-supported bridge, as well as the construction of Route 32 in 1969. Best View Cove experiences significantly reduced circulation due to the railroad bridge, and the circulation of Smith Cove is reduced because of the added constriction of the Route 52 bridge.

According to town officials, the siltation problem has grown worse over the past 30 years, and there is divided opinion on past circulation trends. Essentially, some individuals believe the circulation problem has become worse as the embayment bottom has become increasingly silted, while others believe there is insufficient data at present to support that statement. Not suprisingly, there is also mixed opinion about the future trends of circulation. In an effort to gain a better understanding of siltation dynamics, the Flood and Erosion Control Board plans to measure erosion and sedimentation rates in Hunts Brook and Smith Cove next year. One objective of this research will be to investigate the relationship of siltation to circulation. Hopefully, this will provide a better understanding of historic and future circulation trends.

Response from town officials was also divided over other impacts to the embayment, such as erosion, pollution and eutrophication. The differences among the responses appear to be more the result of the degree of familiarity with the problems than anything else. For example, the Flood and Erosion Control Board is acutely aware of erosion problems in town and thus its opinions about erosion problems are based on close observation. This may be less the case with the Planning Department, which has a broader focus.

Response from Questionnaires and Local Meetings (con't)

It is important to mention here that town officials did indicate separately that erosion, pollution and eutrophication are problems in the embayment.

According to different individuals, these problems have become more severe over time. It is generally agreed that erosion will remain a severe problem in the future, but that pollution, as a result of new sewering, will become less severe in the future. Town officials were uncertain about the future trends of eutrophication in the embayment.

Results of Field Survey and Research

The field survey confirmed the severely silted condition of the embayment and the presence of steep slopes completely surrounding the cove. The gradient of the slopes in many locations exceeds 30 degrees, and thus it is quite reasonable to anticipate erosion problems. Homeowners have gone to great lengths to stem erosion by constructing elaborate terracing, planting, special landscaping, and implementing other stabilization techniques. Still, it is impossible to stop all soil loss.

Ongoing sewer construction has involved building the shoreline of Smith Cove outward and backfilling to lay a sewer pipeline across the embayment. Though the construction appears to be proceeding carefully to minimize impacts, the activity is generating some additional erosion and siltation.

Observations at the mouth of Hunts Brook from Old Norwich Road indicate that this area is the shallowest part of the embayment. Here, Smith Cove is no deeper than two feet. It is interesting to note, however, that as a function of stream flow velocity, the shoreline at the confluence of the brook is not silty as one might expect, but rather coarse and composed of small rocks and grit.

Periodic incidents of high flow scour the area around the head of the cove and transport the fine sediment to deeper waters. Despite indications from research that Hunts Brook is responsible for part of the embayments erosion problem, there was little evidence of signficiant erosion other than the migration of fine sediments.

Results of Field Survey and Research (con't)

Local sources of erosion from new housing construction have slowed significantly over the past ten years, as the neighborhood infilling reaches its prescribed zoning limits. However, some ongoing construction was observed during the survey. Just about all the remaining undeveloped land left is in areas of extremely steep slopes. Consequently, the town should take extra precautions to make sure that future housing development incorporates the most effective erosion control techniques possible.

D: Problem Analysis

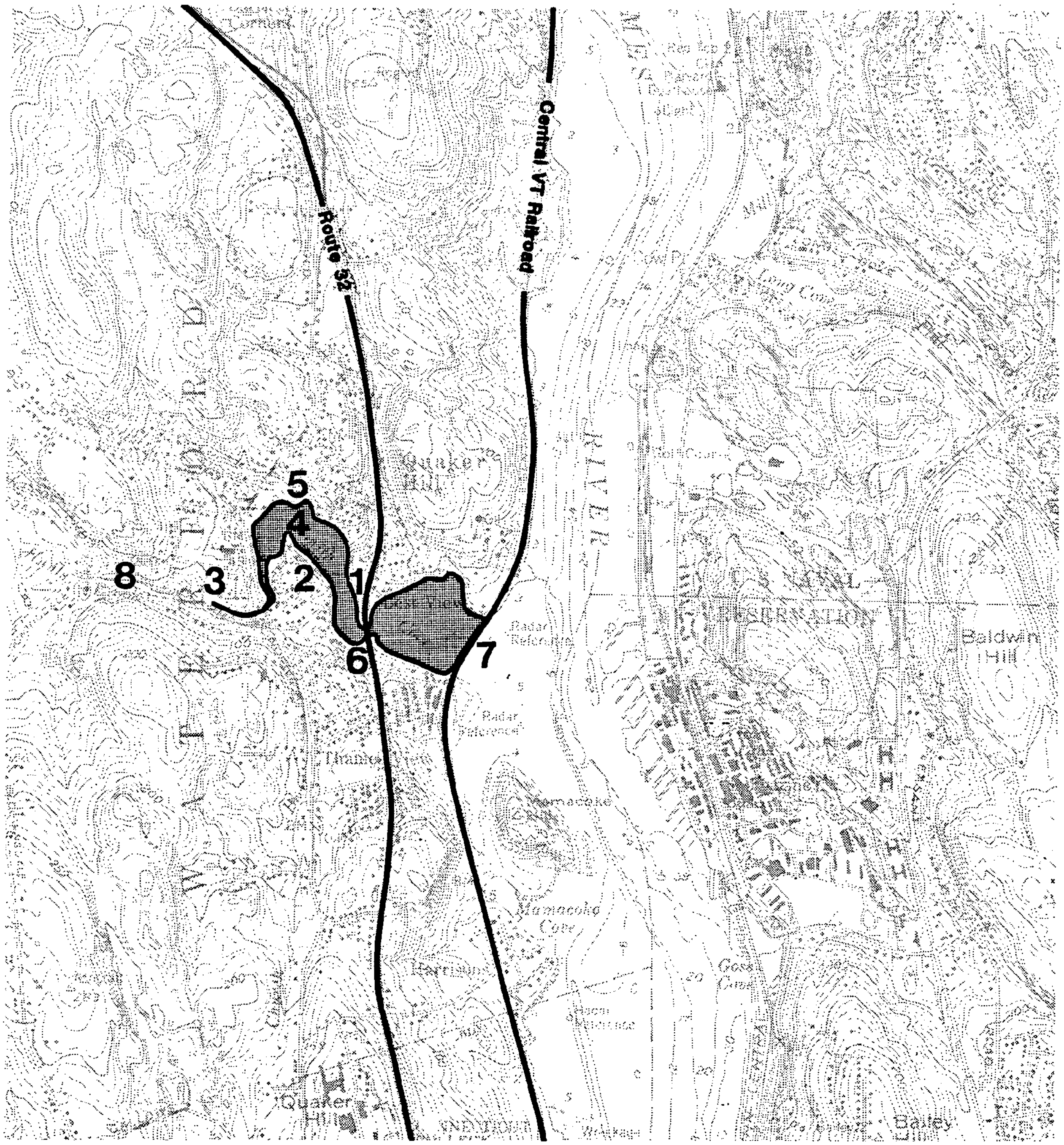
Erosion and Siltation

There is a well documented siltation problem in Smith Cove. Both research and field surveys revealed that the bottom of the embayment is flat with depths of less than 5 feet (MLW) throughout. The head of the embayment at the confluence of Hunts Brook is less than 2 feet deep.

There are three potential sources of silt, but only two sources appear significant. Some Connecticut coastal embayments receive a significant portion of their sediment load from resuspended Long Island Sound sediment, but that is not the case here. The tidal exchange is much too limited to permit significant contribution of sediment from the sound. In addition, the existence of two bridges separating Smith Cove from the Thames River makes this prospect even less likely.

A more likely source of sediment appears to be local erosion of steep banks and predominantly silt loam sediment from around the embayment and the Hunts Brook watershed (see Section A-8 of this Chapter). The Hunts Brook watershed has a history of agricultural use. Agricultural areas within the watershed are located upstream of Millers Pond, along Fire Street and Unger Road (See Figure 5.1). Also, such institutions as the Waterford County School practice agriculture. These agricultural activities commonly generate soil erosion which, in turn, boosts the sediment loading of Hunts Brook.

Another potential source of sediment within the watershed (though probably minor) is fly ash erosion. Fly ash has been dumped in several substantial fill areas by coal users. Fly ash deposits come in contact with at least three tributaries of Hunts Brook. It appears, however, that the chief impact of fly ash is degradation of water quality from leachate drainage from the deposits, rather than direct erosion. Thus, fly ash is regarded more as a water pollutant than as a source of sediment (See Figure 5.2).



Scale: 1" = 2000'

FIG 5.2 SMITH COVE ENVIRONMENTAL PROBLEMS

Problems Areas

1. New interceptor and pumping station built in backfilled coffer dam
2. Terraced yards with steep slopes
3. Hunts Brook contributes some sediment
4. Extensive reservoir of silt
5. Housing construction on steep slopes
6. Highway bridge constricts tidal flow
7. Railroad bridge constricts tidal flow
8. Sources of fly ash

Erosion and Siltation (con't)

Local erosion is caused principally by the very steep slopes surrounding the embayment. Gradients range generally from 15 to 35 percent, and are particularly subject to erosion due to the soil compaction. Soils along the north shore of Smith Cove are primarily gravelly, sandy loams, while the southern slope is composed most of a silty loam, which is particularly inclined to erode. This explains the pattern of small rocks and gravel along the shore and sand and silt in the middle of the cove.

Construction of new housing was particularly active from 1940 to 1970 but has slowed significantly as densities approach prescribed zoning limits. Though most of the erosion caused by housing construction on steep slopes has stopped, the eroded soil from past construction activity still covers the cove bottom.

Circulation Problems

Smith and Best Coves were originally carved by drainage from glacial melt at the end of the ice age. An outer bend of the Thames Riverbed, now known as the northern shore of Smith Cove, is where the river eroded deposits of sand and gravel. The inner bend, now known as the south shore of the embayment, is where the river deposited its silt and fine sand. Today, these ancient shorelines form the steep slopes of Smith Cove and Best View Cove, but they have been somewhat altered by subsequent actions of man.

The railroad solid-fill causeway and pile-supported bridge was built in the nineteenth century. It was the first major cultural feature to constrict the embayment. Prior to its construction, the mouth of Best View Cove used to be more than 1000 feet wide. It is now reduced to less than 200 feet, less than 20 percent of its original width. This alteration probably had the single largest impact on circulation in the embayment. The fact that this bridge has been in place for so long (more than 100 years) explains why the embayment's siltation problem today is so severe.

A second activity that further constricted the circulation of Smith Cove was the construction of Route 32. The highway crossed the embayment by extending fingers of solid fill from opposite shorelines, closing 75 percent of embayment, and spanning the remaining 25 percent with a small bridge. This reduces potential circulation between the two coves to less than 25 percent of its original volume.

The cumulative impact of the railroad bridge and the Route 32 bridge on the circulation of Smith Cove is dramatic, and is clearly shown in the tremendous volume of siltation that has resulted since the construction. The steep soil slopes and inflowing streams deliver sediment to the cove, but the material cannot escape because of the constriction of the mouth. Though dredging might improve circulation within the embayment somewhat, it is not possible to restore the circulation to even near its original level without substantial alterations to the two bridges.

Pollution

Degradation of Smith Cove water is caused by both local and upstream sources of pollutants. The local sources are typically failing septic tanks, soil erosion from steep slopes, fly ash, fertilizers and pesticides from residential yards and organic detritus from both landscaped and natural vegetation along the banks.

As mentioned earlier, fly ash is a potential upstream source of pollution. Ash deposits come in contact with at least three tributaries to Hunts Brook. The ash is chiefly the product of combusted coal and oil from large power plants. Leachate from these deposits eventually drains to Hunts Brook, acidifies the receiving waters, and directly and indirectly impacts the aquatic ecology of the stream and embayment. Fish and other sensitive organisms are adversely effected by both low pH and iron and other minerals that are released by rocks and sediment that come in contact with acidic drainage.

Another potential source of pollution comes from livestock which are raised on land drained by Hunts Brook and its tributaries. A 1969 study on the Hunts Brook Watershed conducted jointly by the state and federal government indicated that cattle were responsible for high coliform concentrations at several locations along the brook. It is also important to note that the study found no visible evidence of upstream contamination of the brook from the use of agricultural fertilizers.

A new sewer line is currently being constructed to serve many of the waterfront homes of Smith Cove. It is expected that once these homes are tied in, there should be a perceptible decline in fecal coliform contamination of the embayment.

KEENEY COVE

A: Physical Description

Location

The cove is located on the eastern shore of the Niantic River system, approximately 1.7 miles from the mouth of the river. Keeny Cove is separated from the upper reaches of the river by Sandy Point, which forms the western shore of the mouth of the cove. The embayment is approximately one-third of a mile from the center of Waterford (See Figure 5.3).

Site Orientation and Configuration

The embayment is roughly linear with its axis oriented NE to SW (See Figure 5.1). The width of the mouth of the cove is approximately 1300 feet and narrows progressively as it penetrates inland. The embayment length (U.S. 1 bridge to tip of Sandy Point) is approximately 4500 feet (See Figure 5.3).

Tidal Data

Mean tidal range -	2.7 ft.
Spring tidal range -	3.2 ft.
Mean tide level -	1.3 ft.

Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth:	1-13 ft. MLW
Channel Depth:	6-13 ft. MLW

Additional Comments: A privately-maintained channel provides boating access to the cove.

Source: NOAA National Ocean Survey Maps

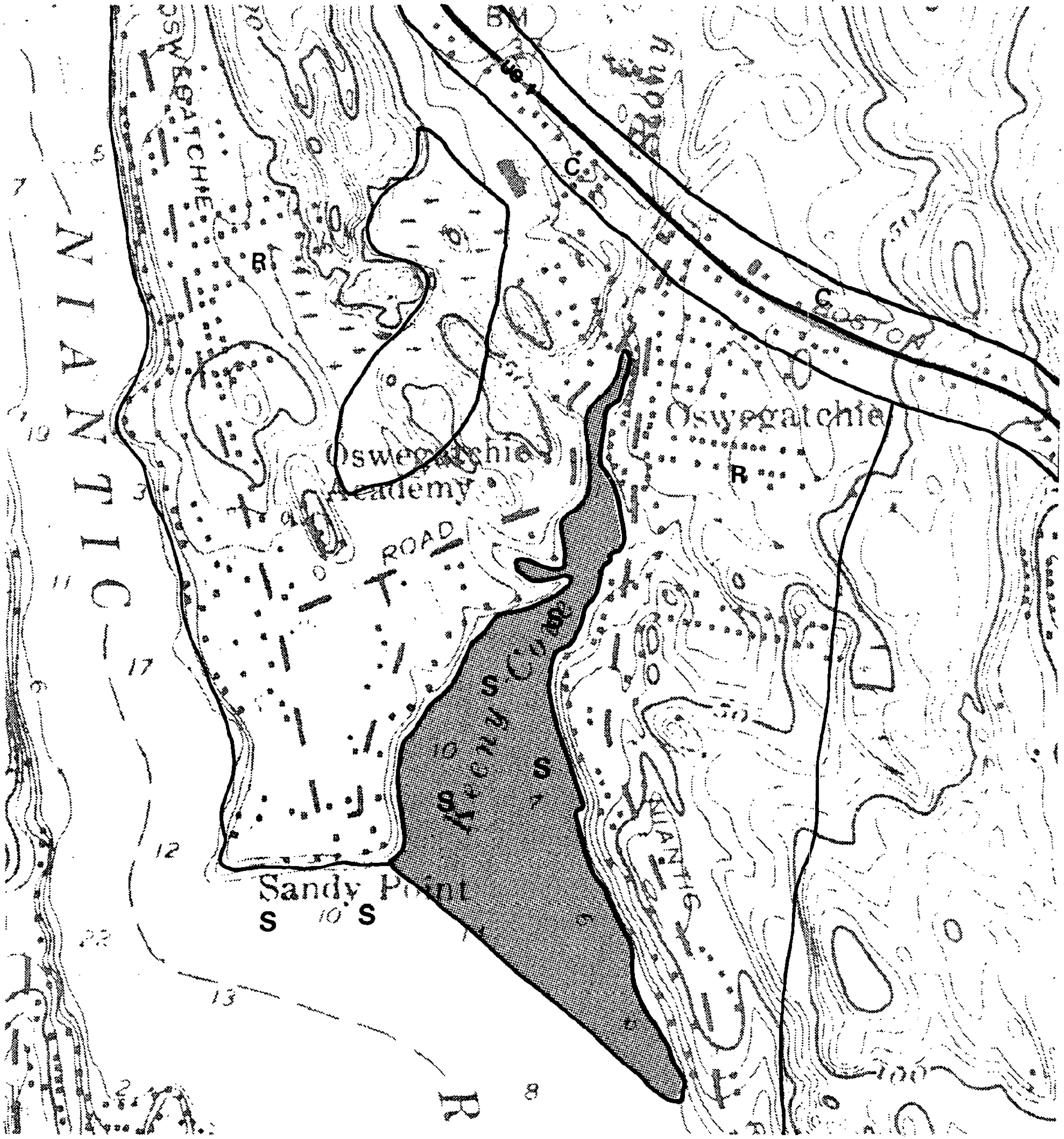
Basin Hydrology

Regional Drainage Basin: Niantic River Basin

Embayment Basin Area: 2.8 square miles

Tributaries to Embayment: Stony Brook
2 Unnamed Brooks

Additional Significant Sources of Fresh Water Inflow: Minor contributions are received from local stormwater runoff.



Scale: 1" = 1000'

FIG 5.3 KEENY COVE
ENVIRONMENTAL LAND USE

Legend:

- wetlands
- **A** agriculture
- **R** residential
- **C** commercial/ industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Basin Hydrology (con't)

Constrictions to Tidal Flow and Circulation: None.

Sources: U.S. Geological Survey, Connecticut Drainage Basin Gazeteer, 1981; Conn. Dept. of Environmental Protection

Water Quality Conditions

Embayment Water Quality Classification: SB/SA

Direct Discharges: None

Sewer Service Area and Discharge Point: There are no sewers serving property within the embayment drainage basin.

Storm Sewer Outfalls: There are several storm sewer outfalls that discharge to the embayment south of the U.S. 1 bridge. In addition, residential drainpipes and highway drainage ditches also discharge runoff to the embayment.

Significant Non-Point Pollution Sources: There is a landfill that is drained by Stony Brook. Both the state and local officials are concerned that leachate may be degrading to the Stony Brook water quality. In addition, the neighborhood surrounding the embayment has been identified as a wastewater treatment problem area. Though there have been preliminary discussions about sewering the study area, the town has not committed itself to engage in facility planning for the area.

Shoreline and Bottom Conditions

Extent of Shoreline Modification: Most of the embayment waterfront has been developed for housing. The east shoreline is the most modified and includes landfilling, riprap, and sewalls. Many of the homes have shoreline patios and private docks. The west side of Keeny Cove is less disturbed, with about half of the shoreline still in its natural state. The other half is filled and stabilized for residential use. There are a few docks along the west shore.

Significant Areas of Erosion: There are no obvious signs of erosion along the embayment; however, it is presumed that the moderately steep slopes along sections of both sides of the cove contribute some soil and organic detritus to the system.

Shoreline and Bottom Conditions (con't)

Shoaling and Sedimentation Problems: Several large glacial boulders located in the center of the cove toward the upper reaches create a shoaling effect for sediment being transported in that area. The depth of the embayment around the rocks is shallow and creates an impediment to motor boats. The sedimentation problem is most severe near the head of the cove, where the water is too shallow to navigate at low tide.

Bottom Sediment Characteristics: The bottom is composed of a mixture of silt and sand with glacially deposited rocks and gravel. Several small deposits of rock are visible in the middle of the embayment at low tide. The silt is presumed to come from Stony Brook and from some erosion of local earthen banks. The sand comes from both the Niantic River and sand that was placed on a public beach on the east side of Keeny Cove.

Surrounding Lands

Maximum Basin Elevation:

Location	Height
Western Shore	130 feet
Eastern Shore	160 feet

Topography: The area surrounding the embayment is very hilly. The immediate eastern shore area of inner Keeny Cove has steep slopes which are developed with housing. The western shore is equally steep but sparsely developed.

General Vegetation Characteristics: The shore area surrounding Keeny Cove is moderately developed. Small stands of trees survive between these developed areas. Overall, the western shore has more trees than the eastern shore. Low elevation areas at the upper end of the cove are vegetated with tall grasses and shrubbery.

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Enfield	silt loam	3-8	very poor
Haven	silt loam	3-8	very poor
Hinckley	gravelly sandy loam	15-35	very poor

Surrounding Lands (con')

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Hollis-Rock Outcrop	complex	15-35	very poor
Raypol	silt loam	0-3	very poor
Ridgebury, Whitman, and Leicester	extremely stony fine sandy loams	0-3	very poor
Rumney	fine sandy loam	-	very low
Tisbury	silt loam	0-3	very low

Shellfish and Finfish Resources

Most of the shellfish beds are located in the southern end of Keeny Cove where the mouth of the cove opens up to the Niantic River. The Niantic estuary is known for its diverse shellfish population, which includes hard shell clams, soft shell clams, razor clams, oysters, and scallops. A particularly productive shellfish bed is located at Sandy Point. Though most of the Niantic River is open to shellfishing, Keeny Cove is closed because of elevated bacteria levels. These high levels are reportedly caused by failing septic systems.

Wetlands

There are very few tidal marshes located within Keeny Cove (See Figure 5.3). Those marshes that do exist are limited to small pockets or fringes of salt-marsh cord-grass (Spartina alterniflora) and (Phragmites communis). The largest marsh, composed of Phragmites, is located just south of Oswegatchie Road. In addition, there is a large freshwater wetland located just north of U.S. 1 which is part of the Stony Brook floodplain (See Figure 5.3).

Most of the cove has been filled and (in many cases) stabilized to the water's edge. This filling activity has occurred mostly over the past 100 years, though some houses date back to the first half of the nineteenth century. Currently, almost all filling activity south of Oswegatchie Road has stopped. Recently, a commercial operator located next to the U.S. 1 bridge over Stony Brook expanded his side lot into the wet floodplain of the brook. Though some steps were taken to control erosion through use of hay bales around the site of disturbance, there still was a loss of wetlands and some minor degradation of local surface water quality. There also is some concern about the origin of the fill and whether the material is clean.

Environmentally Sensitive Areas

All of the Niantic River system is a highly valuable but sensitive habitat for marine life, waterfowl and terrestrial organisms. Refer to Chapter 6 for a full description of its environmental features. In addition, the Reed grass marshes and pockets of cord grass serve as valuable habitat.

The marshes of Keeny Cove south of Oswegatchie Road are a valuable habitat for nesting birds. During the Spring 1981 field survey, a nesting pair of swans was observed in one of these marshes. Also, the vegetation serves as a food source and protective habitat for aquatic organisms.

B: Land Use Analysis

Current Shoreline and Water Uses

Keeny Cove is used for swimming, boating, and other active types of water-related recreation. Residents of the homes that border on the embayment derive considerable use and pleasure from their waterfront location, and view the cove as a significant asset.

Current Upland Use

Almost all of the upland uses surrounding the embayment are residential. The one exception is strip commercial use along U.S. 1, the northern limit of the embayment study area. Most of the homes in the area are single family detached dwellings.

Historical and Significant Land Use Changes

The 1934 aerial photos show that the land around Keeny Cove was primarily used for agriculture and, to a lesser extent, summer recreation. A trolley line traversed the middle section of the cove connecting Oswegatchie directly to Sandy Point and Golden Spur. By 1951, the line had been abandoned and dismantled. Today, the bridge supports in the middle of the cove are all that remain.

By 1951, a significant portion of the agricultural land had become reforested, though some vegetable crops and orchards remained. Considerable growth in housing occurred along Niantic River Road and the residential neighborhood of Oswegatchie.

The significant growth in housing continued through to 1970. Several of the agricultural fields and forests were developed for tract housing, and additional infilling occurred along major roads and sidestreets.

Historical and Significant Land Use Changes (con't)

This trend continued to 1980, but at a slower pace. Today, the region's economy no longer depends on agriculture and many of the once seasonal homes have been converted to year round use. This trend is consistent with the general growth and diversification of Waterford's economy and the expansion of its own commercial and industrial base.

Public Access and Recreation Areas

The town of Waterford owns and maintains a public recreation area on Keeny Cove. The site includes a swimming beach, a play area for children and a picnic area (See Figure 5.3).

Views of the upper reaches of Keeny Cove are available from the Oswegatchie Road bridge. In addition, there is a modest public boat ramp located on the west shore of the cove, off Oswegatchie Road.

C: Problem Identification

Local Departments and Offices Consulted

Waterford Flood and Erosion Control Board
Waterford-East Lyme Shellfish Commission.
Waterford Planning Department.

Response from Questionnaires and Local Meetings

The perceptions of problems facing Keeny Cove vary considerably among town officials. Some officials believe Keeny Cove has a severe pollution problem due to failing septic tanks, while other officials believe that erosion, siltation, and circulation are the more significant problems. Generally, the opinions tend to reflect the expertise or focus of the individuals or agencies voicing concern. For example, the Waterford-East Lyme Shellfish Commission believes that because high bacteria levels have forced the state to close the shellfish beds in the embayment the cove has a severe pollution problem. In contrast, the Flood and Erosion Control Board views erosion and siltation as a significant problem, because of their familiarity with these types of problems.

Response from Questionnaires and Local Meetings (con't)

Despite these differences of focus or expertise, town officials generally agreed on several issues of concern. First, all officials agreed the embayment has a siltation problem, but differed as to the degree of the problem. Description of the siltation problem ranged from minor to moderate, with a majority of officials describing it as moderate. Officials believe that the silt comes from both upstream and local sources, and that the problem is caused by both natural processes and man-made activities.

Officials also generally agreed that the embayment has a pollution problem, and categorization of this problem ranged from moderate to severe. The source was identified as local and man-made: septic tank failures along the shores of the embayment. The problem is believed to be at least 30 years, and has remained the same over that time period. The problem is expected to become less severe as homeowners upgrade their existing septic systems.

Circulation is also perceived as a moderate problem that is caused by the natural construction of the embayment and exacerbated by the man-made and natural siltation of the cove. Flow stagnation is caused by the circulation problem and is particularly apparent in the summer months.

Results of Field Survey and Research

The field survey confirmed the moderately silted condition of the embayment and the high potential for septic failure among waterfront homes. Glacially deposited rock in the middle of the cove and the hourglass shape of the embayment present natural constrictions to tidal exchange. These two features make siltation of suspended sediment particularly likely in the upper reaches of the cove. The rock and silt also make navigation of the upper reaches rather difficult. Though dredging would alleviate part of the silt problem, it would not remove the rocks which are obstacles to navigation.

The origin of the silt was not obvious from the field survey alone, but subsequent research indicates upstream sources of surface runoff and local erosion of steep banks as the two most likely sources. For example, there is some commercial expansion underway off U.S. 1 along Stony Brook. The property owner is currently expanding his side lot with fill, and sediment is eroding into the brook. Housing construction along Stony Brook and Keeny Cove over the past 30 years has also been another likely source of the silt.

Results of Field Survey and Research (con't)

Failing residential septic systems are a significant source of pollution. In some cases, house foundations are no more than 20 feet from the waters edge, providing almost no setback space for septic tanks and leach fields (See Figure 5.4). Though no breakout of leachate was visible during the survey, high fecal coliform counts in previous sampling by the Coast Guard Academy is a good indication that the septic systems are not functioning adequately.

Aside from limited setback problems, the septic systems also operate poorly due to steep slopes along most of the embayment shore. Such conditions provide little opportunity for the soil to renovate the effluent before it drains to the embayment. Also, steep slopes significantly increase the chance of breakout of the leachate. Once breakout occurs and the leachate drains over land to the embayment, the water body is subject to bacterial contamination. Chronically high total and fecal coliform levels in Keeny Cove have compelled the state to keep the cove closed to shellfishing, while the rest of the Niantic River south of the cove (except Smith Cove) remains open.

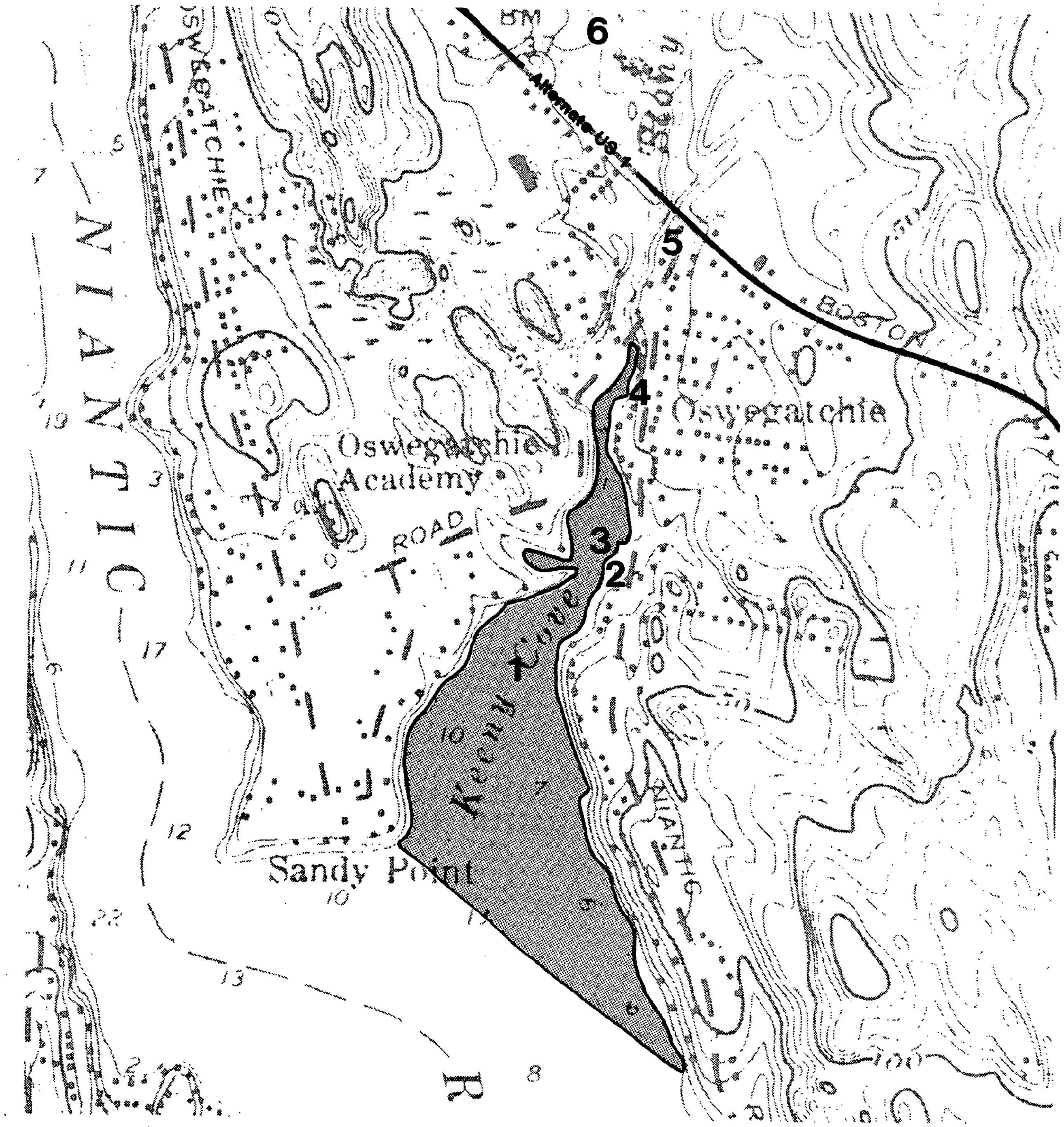
D: Problem Analysis

Siltation

The cove is significantly silted in the northern half where it narrows to a width of less than 200 feet (See Figure 5.4). Glacially deposited rocks located at the narrow reduce tidal exchange with the Niantic River and turn the upper cove area into a settling basin for silt that is transported to the embayment by Stony Brook.

The silt from the brook is also supplemented with erosion from the moderately steep embayment banks and silt loam soils within the watershed. The grade of the cove banks ranges from 15 to 35 degrees, and although the survey revealed no extensive cases of erosion, the banks are presumed to contribute material to the embayment.

One of the critical factors affecting the extent of silt contributed by Stony Brook is the operation of the Stony Brook dam, just north of U.S. Route 1. The dam has created a large freshwater marsh which serves as a natural filter for organic detritus and eroded sediment. Peak flows of the brook periodically disturb sediment in the marsh and transport it downstream to the embayment, but the amount of material transported may vary depending on the dynamics of the flow through the marsh. The Waterford Flood and Erosion Control Board plans to



Scale: 1" = 1000'

FIG 5.4 KEENY COVE ENVIRONMENTAL PROBLEMS

Problem Areas

1. Cove closed to shellfishing
2. Foundations of shorefront houses almost at waters edge
3. Significant siltation
4. Houses on moderate slopes with minimal setback
5. Fill encroaches on Stony Brook floodplain near highway bridge
6. Landfill may be leaching pollutants to Stony Brook

Siltation (con't)

monitor Stony Brook streamflow and sediment transport, so these data should be available soon. Once these factors are better understood, it will be possible to more accurately determine the relative sediment contribution of Stony Brook to the total siltation of the cove.

The other possible, but less likely, source of sediment is suspended sediment from the Niantic River. As presented in Section 2 of Chapter 6, the Niantic River bottom near the mouth of Keeny Cove is composed of a variety of sedimentary materials.

Sandy Point has a predominantly gravel bottom, while other areas near the mouth include hard packed sand or gravel with a cover of silt, mud and fine sand. The silt and mud from this top layer could contribute sediment to Keeny Cove, but the relatively small percentage of silt makes it a less likely source than the two sources discussed earlier. In addition, the small mean tidal range of 2.7 feet provides little tidal energy to disturb the Niantic River sediment. It is doubtful that the river contributes a great deal of sediment.

Pollution

There are three potential sources of water pollution impacting Keeny Cove: 1) septic tank leachate from failing residential systems, 2) surface runoff along the moderately steep banks and from street ends, and 3) contaminated leachate from a town landfill located between U.S. 1 and the Stony Brook floodplain north of U.S. 1. The most likely source of pollution is septic tank leachate, due to the large number of houses which are situated close to Keeny Cove (See Figure 5.4) and the poor suitability of shoreline soils, particularly silt loams. Though no cases of leachate breakout were observed along the shore, water quality sampling conducted by the Coast Guard Academy in 1970 and 1977 indicates that septic systems are contaminating the embayment. Fecal bacterial levels at the mouth of the cove exceeded 100 MPN/per 100 ml during the summer of 1970. In addition, the Connecticut Department of Environmental Protection has identified the shoreline around Keeny Cove as a problem area for its lack of sewers. Currently, however, the town has not conducted any sewer facility planning for this part of the community.

Additional contaminated leachate may be coming from homes located on steep slopes overlooking the embayment. This is particularly the case on the eastern bank, from the public waterfront recreation area up the cove to the Oswegatchie Road bridge.

Pollution
(con't)

Along this segment of shoreline, homes are located approximately 20 to 30 feet from the embayment shoreline at a moderately steep slope of 15 to 25 degrees. Some homeowners have terraced their shorefront property, indicating the steepness of the banks and a concern about soil erosion. As in the case of homes with marginal setbacks, no leachate breakout was observed along the banks, and thus problems can only be inferred from high bacterial levels recorded by the Coast Guard Academy.

The second source of pollution is stormwater runoff. This is particularly a problem along the steep slopes of the embayment, where overland runoff causes erosion of the banks. Little wetland vegetation remains along the Keeny Cove shoreline, providing no natural filter to trap eroded soil and absorb nutrients before they drain to the embayment. The narrow center of the embayment constricts tidal circulation and flushing, and consequently localizes the pollution load. The resultant effect is to magnify the impacts of nutrients and leachate on the embayment water quality. Ultimately, severe BOD and nutrient loading causes algae blooms and depresses oxygen levels.

Drainage from streets and other impervious surfaces surrounding the embayment enters the cove via roadside drainage ditches, street ends (such as the small road leading to the Waterford Park or Keeny Cove), and household drainpipes. The stormwater effluent commonly includes silt; heavy metals, such as lead from car exhaust; and oil and antifreeze, also from cars. This type of stormwater contamination is less significant than erosion or leachate breakout because the area is not densely developed, nor heavily travelled by car.

The third potential source of contamination is a landfill located along the upper reaches of Stony Brook (See Figure 5.4). The town planning office noted that the "junkyard" is a potential source of contamination of the brook, though no analysis has been made of the quality of the leachate entering the brook from the yard. It should also be emphasized here that even if the water were being contaminated by the junkyard, the wetlands of the upper reaches and the pond above the dam at the U.S. 1 bridge might act as a contaminant sink and remove contaminated silt and fixed organics from the water. Thus, the overall impact of the junkyard on Stony Brook and Keeny Cove water quality may be minimal.

PROBLEM SUMMARY

Smith Cove

1.	Siltation	Severe	(a)
2.	Erosion	Moderate	(b)
3.	Circulation Constriction	Severe	(b)
4.	Pollution	Moderate	(c)

Keeney Cove

1.	Siltation	Moderate	(b)
2.	Pollution	Moderate	(b)

KEY: (a) Conditions becoming worse (b) No change (c) Conditions improving

CHAPTER 6 EAST LYME EMBAYMENTS

INTRODUCTION

The Town of East Lyme, in New London County, is a relatively new town by Connecticut standards, having been incorporated in 1839 from Lyme and Waterford. With an area of 34.8 square miles and a population of approximately 13,900 persons, East Lyme has a population density greater than that of the county (421 persons/sq. mile compared to 370 persons/sq. mile). The major industries in the town include boat marinas, sport fishing, electronic manufacturing, warehouses, machine companies and allied resort industries.

East Lyme is a member of the Southeastern Connecticut Regional Planning Agency (SCRPA) and falls geographically between the Connecticut River (to the west) and the Thames River (to the east).

The dominant feature in this coastal community is the Niantic Bay/Niantic River basin. The Niantic River basin covers some 30.4 square miles and is one of the largest along the Connecticut coast.

The State of Connecticut operates public boat facilities on the Niantic River, the Four-mile River, and at Rocky Neck State Park a major regional recreational facility. In all, 18 percent of the town is under state ownership. The town operates a municipal water supply system, but there are no municipal sewers found within the town.

The town of East Lyme has a topography which was formed as the result of glaciation and shoreline erosion. The towns shoreline is characterized by tidal marshes, estuaries, sand beaches and rocky areas of outcropping with steep slopes. The major coastal features in the town include; the Four-mile River, Bride Brook (Rocky Neck State Park), the Pataguanset River and the Niantic River system, which includes Smith Cove.

For this study, the Fourmile River, the Niantic River and Smith Cove were selected for further study. The Bride Brook System was deleted due to previous state funded studies and the Pataguanset River was identified by the Town of East Lyme as having only minor or insignificant environmental problems.

SMITH COVE

A: Physical Description

Location

The cove is part of the Niantic River system and is located approximately 1.15 miles northwest from the Niantic River mouth along the west shoreline (see Figure 6.1). Saunders Point is directly north of the mouth of the embayment, and Pine Grove and the State Military Camp are directly south. Smith Cove is approximately 1.2 miles from the center of the community of East Lyme.

Site Orientation and Configuration

The cove is fairly regular in shape with a narrow inlet. The dimensions of the embayment are roughly 2000 feet long and 1000 feet wide. The mouth is roughly 300 feet wide. The long axis of the cove is oriented north to south, while the inlet channel is oriented east to west (see Figure 6.1).

Tidal Data

Mean tidal range -	2.7 ft.
Spring tidal range -	3.2 ft.
Mean tide level -	1.3 ft.

Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth:	3 feet MLW in Cove
Channel Depth:	4 feet MLW (from Niantic River)

Additional Comments: 6 feet MLW dredged area near boat yard (see Figure 6.1).

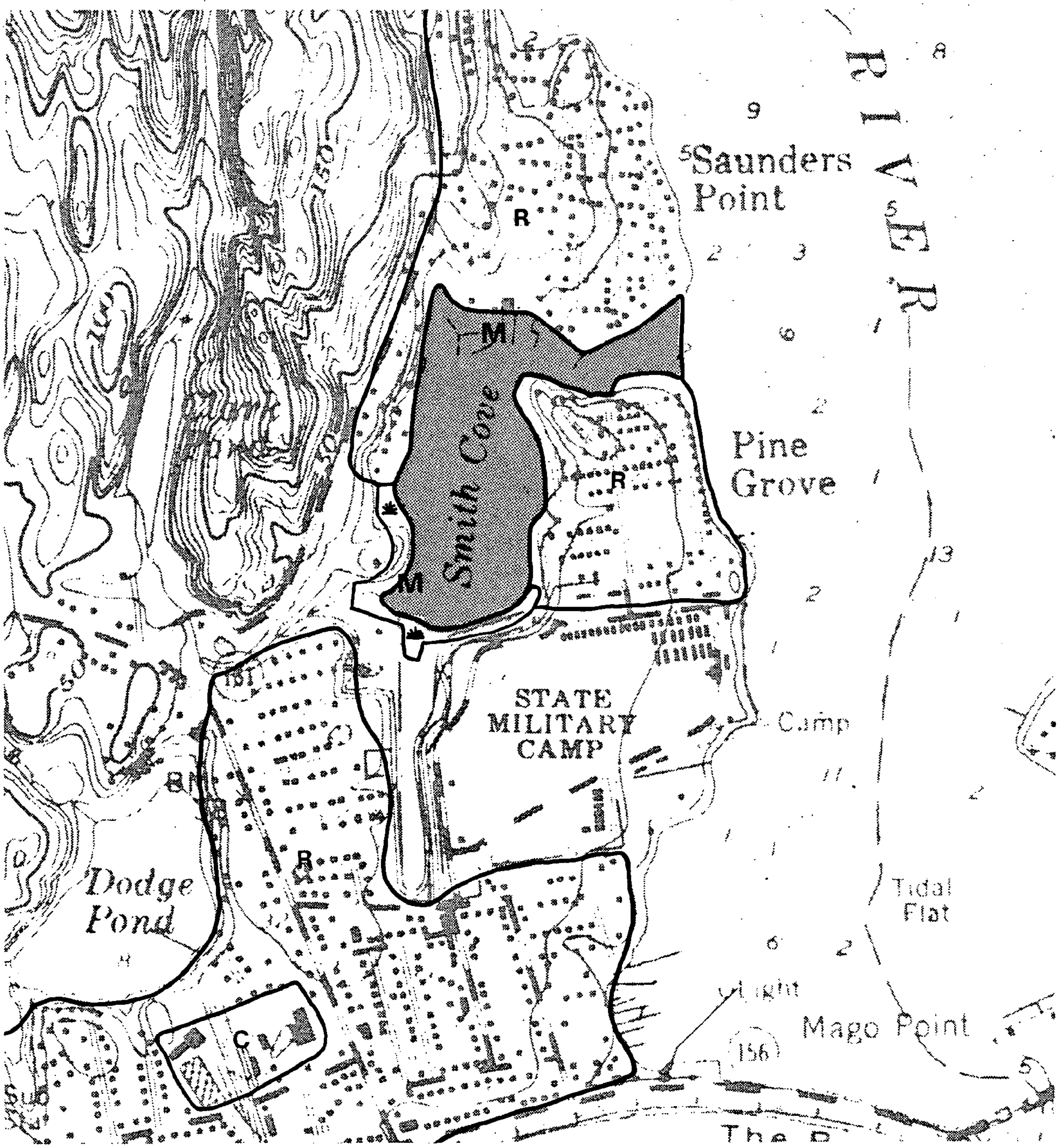
Source: NOAA National Ocean Survey Maps

Basin Hydrology

Regional Drainage Basin: Niantic River Basin
Embayment Basin Area: Less than 1 square mile

Tributaries to Embayment Unnamed Brook from Clark Pond

Other Sources of Fresh Water Inflow: Surface runoff drainage from State Military Camp.



Scale: 1" = 1000'

FIG 6.1 SMITH COVE ENVIRONMENTAL LAND USE

Legend:

- wetlands
- **A** agriculture
- **R** residential
- **C** commercial/industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Basin Hydrology
(con't)

Constrictions to Tidal Flow and Circulation:

Structure	% Constriction*	Distance from Mouth
No structures		

Natural configuration restricts flow (see Figure 6.1) Part of larger Niantic River System

Sources: U.S. Geological Survey Connecticut Drainage Basin Gazeteer, 1981 Conn. Dept. of Environmental Protection

Water Quality
Conditions

Upstream Water Quality Classification: SB/SA (Niantic River)
Embayment Water Quality Classification: SB/SA

Direct Discharges: None

Sewer Service Area and Discharge Point: There are no sanitary sewers in the town of East Lyme.

Storm Sewer Outfalls: None

Significant Non-Point Pollution Sources: Dense residential development is found on Saunders Point and Pine Grove. Military Camp O'Neill and Bayreuther Boatyard have large subsurface sanitary waste disposal systems located on there properties. There are no sewers in the town, and the cove was closed to shellfishing in 1971.

Shoreline and
Bottom Conditions

Extent of Shoreline Modification: A 150 slip marina is located at the northern end of the cove. A large stone pier and several wooden docks are found alng the shoreline. Limited bulkheading in front of residences has occurred. Most of the shoreline is in a natural condition.

Significant Areas of Erosion: No significant erosion problem is present in the embayment.

Shoaling and Sedimentation Problems: The channel to the cove and the cove itself have moderate sedmentation problems. Local boaters and marina operators report that sedimentation rates have increased in the last 3-4 years following maintenance dredging of the Niantic River.

Shoreline and Bottom Conditions (con't)

Bottom Sediment Characteristics: Bottom sediments are reportedly hard packed sand deposits covered with a thin (3-6") layer of silty material. Much of the soil material in the area is stony or gravelly sandy loam.

Surrounding Lands

Maximum Basin Elevation:

Location	Height
Oswegatchie Hill/Mt. Tabor	250+feet
Pine Grove	30 feet
Roadway West of Cove	30 feet

Topography: At north end of Pine Grove 15-35% slopes exist, as well as points on the western side of the cove. These areas are developed with residential housing in back of the slopes.

General Vegetation Characteristics: The eastern and northern sides of the cove are densely developed residential areas with residential landscaping. The southern end of the cove is mostly grassed open space and parking (Military Camp). To the west is a mixture of old field vegetation and wooded land with some residential housing. Two small (less than 1 acre) wetland areas are found in the southwest area of the cove.

Soils:

Name	Characteristics	Slope %	Septic Tank Suitability
Hinckley	gravelly sandy loam	3-15	poor
Hinckley	gravelly sandy loam	15-35	poor
Narragansett-Hollis	complex	3-15	poor
Ridgebury, Whitman, and Leicester	extremely stony fine sandy loam	-	very poor
Rumney	fine sandy loam	-	poor
Typic Udorthents	cut and fill	-	variable
Urban Land	-	-	variable

Shellfish and Finfish Resources

A healthy shellfish community is reportedly present in Smith Cove. Blue mussels and quahogs and are present in moderate quantities with occasional scallops and oysters. Smith Cove is closed to shellfish.

The cove has an abundance of migratory finfish present, with recreational fishing a well established activity by local residents.

Wetlands

Two small (less than 1 acre) fringe wetland areas are found in the southwest corner of the cove. These wetlands are of moderate quality due to invasion of Reed grass and other upland species.

Visually there is little change in the amount or pattern of wetland development in the cove since 1934. Most residential development has occurred in upland areas due to steep slopes along the cove's banks. Heavy sediment loading from construction activities in tributaries that pass through the wetlands has led to a general degradation of the area, as well as invasion of upland vegetation species.

It is unlikely that residential development will directly impact the remaining wetlands through land alteration. Impacts related to the more gradual process (such as surface run-off and sedimentation) that are causing a long-term degradation of these areas.

Environmentally Sensitive Areas

No unique habitat is found in the vicinity of Smith Cove.

B: Land Use Analysis

Current Shoreline and Water Use

Most of the shoreline is in a natural condition. Steep banks are found along the Pine Grove area. A 150 slip marina (Bayreuther Boat Yard) is located on the northern shore of the cove (See Figure 6.1). The southwestern shoreline is mostly natural bank, and exhibits open, undeveloped, vegetated uplands.

The open waters of the cove are used in a limited fashion for mooring of boats.

A stone pier located on the northern end of Pine Grove is used by recreational fisherman and as a boat docking area for local residents.

Current Upland Use

The Pine Grove and Saunders Point areas are densely developed residential areas. Many of the homes are summer cottages that have been winterized for year-round use.

The state military camp is located at the southern end of the embayment.

Historic and Significant Land Use Changes

In the period 1934-1951 significant residential development occurred. Most development occurred on land formerly used for agriculture. Abandoned agricultural lands were revegetated into a mixture of shrub and forest land. The Bayreuther Boay yard was constructed (circa 1946) on open land. Since 1951 residential infilling and winterization of summer cottages has resulted in the dense development on Saunders Point and Pine Grove (See Figure 6.1).

The State Military Camp (during 1980-81) rebuilt the major access road into the camp. This included constructon of a drainage ditch which discharges directly into the southern end of Smith Cove. little additional modification of the shoreline has occurred in the past decade.

Public Access and Recreational Opportunities

There are no State or Federally owned public access points along the banks of Smith Cove. The Pine Grove Neighborhood Association maintains a stone fishing pier. The Bayreuther Boat Yard marina is open to the public for boat use and storage on a fee basis.

C: Problem Identification

Local Departments and Offices Consulted

Town of East Lyme - Board of Selectmen, Planning Commission, Town Engineer, Shellfish Commission, Flood and Erosion Control Board; Marina Operators.

Response from Questionnaires and Local Meetings

Response from the town was mixed, ranging from an assessment that no problems existed to significant concern. Concerns raised included non-point source pollution (runoff and septic system effluent), resulting in a nutrient rich loading of the cove, and the creation of eutrophic conditions.

Results of Field Survey and Research

Results indicate Smith Cove to be in relatively good condition with little field evidence of pollution problems.

Water quality appears good in spite of evidence suggesting sediment loading from road-construction (Military Camp) and the presence of a large marina operation (Bayreuther Boat Yard, see Figure 6.1).

Heavy sediment loading was observed due to construction in the drainage ditch adjacent to the new access road to Camp O'Neill. This problem should abate with revegetation following construction.

D: Problem Analysis

Flushing and Circulation Constriction

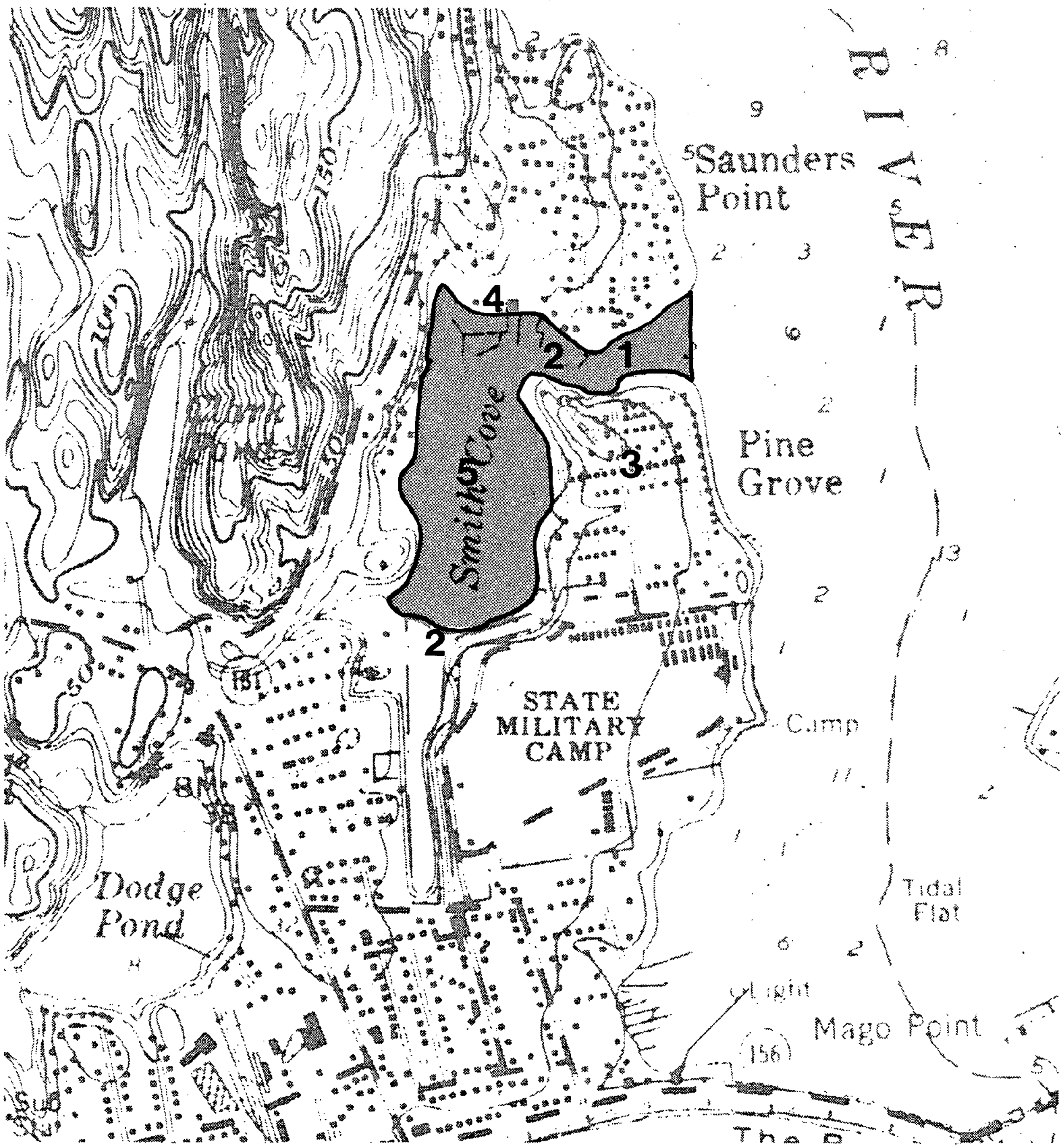
The natural 'dog-leg' shape of the entrance channel to Smith Cove, the lack of significant stream flow into the cove, and a poor tidal exchange rate of the Niantic River system (see discussion of Niantic River) creates a poor flushing potential for Smith Cove. The poor flushing characteristics are historical in nature, and will not change unless drastic alteraton of the Cove channel or entrance to the Niantic River occurs. Recent dredging of the Niantic River probably produced a minor increase in flushing rates for Smith Cove.

Siltation and Sedimentation

Since there are no major streams or tributaries to the cove, the major source of sediment is probably surface runoff from upland areas, and transport of suspended sediment from the Niantic River system. Any change in flushing rates or sediment loading of the Niantic River will directly affect the Smith Cove system, although the impact will probably be minor. The Niantic River channel was dredged by the Army Corps of Engineers in 1970. Since that time, additional dredging was funded by non-corps sources.

It was reported by local marina operators that siltation and sedimentation rates appear to have increased since the last maintenance dredging of the Niantic River (1975-1977). If the reports are accurate, they may be attributed to a slight increase in sediment transport due to increased flushing rates or increased development and erosion in the Niantic system. Neither the rate nor the amount of sediment deposition appears to be significantly impacting the cove (see Figure 5.2).

Navigation of the embayment is still possible, although some large-draft boats do have difficulty at low water.



Scale: 1" = 1000'

FIG 6.2 SMITH COVE ENVIRONMENTAL PROBLEMS

Problem Areas

1. Natural configuration restricts tidal exchange/flushing
2. Sediment loading from drainage channel/river
3. Winterization of summer cottages and potential septic leakage
4. Marina operation
5. Area closed to shellfishing

Water Quality Degradation

As with the entire Niantic River system, the greatest concern to Smith Cove is water quality degradation. The tidal waters of Smith Cove, west of a north-south line through the easterly extremity of Saunders Point (see Figure 5.2) are closed to shellfish harvesting (effective date 6/25/71). This closure is not due to direct discharges, but rather from non-point sewage effluent in the cove. Many of the old homes in the area have been converted from summer cottages to year-round use. Development (on soils classified by SCS as poor filters) has introduced septic systems into an area with incompatible soils, and has probably created septic contamination of the embayment and shellfish.

The town of East Lyme currently does not have any sewers. However, the Niantic Coastal Basin Plan indicates wastewater facility "needs" planning will be undertaken shortly. Until a system is built, shellfish closures and current water quality classifications should remain.

NIANTIC RIVER

A: Physical Description

Location

The Niantic River forms the municipal boundaries of both Waterford and East Lyme. It is surrounded by the community centers of Waterford, Niantic, and East Lyme. The City of New London lies 4 miles to the east and Old Saybrook is approximately 11 miles to the west. For the purposes of this report, Keeney Cove (Waterford) and Smith Cove (East Lyme) will be treated separately from the Niantic River, and are covered individually in their own sections (see Figure 6.3).

Orientation and Configuration

The Niantic River is one of the largest embayments along the Connecticut coast. It is roughly 3.5 miles long (confluence of Lakes Pond Brook to the mouth) and 0.6 miles at its widest point. The embayment is roughly linear and its axis is oriented north to south (see Figure 6.3).

Tidal Data

Mean tidal range -	2.7 ft.
Spring tidal range -	3.2 ft.
Mean tide level -	1.3 ft.

Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth:	1-22 ft.(MLW)
Channel Depth:	6-8 ft.(MLW)

Additional Comments: Control depth with 50-100 feet width dated August 1970.

Source: NOAA National Ocean Survey Maps

Basin Hydrology

Regional Drainage Basin: Niantic River Basin
Embayment Basin Area: 30.4 square miles at mouth

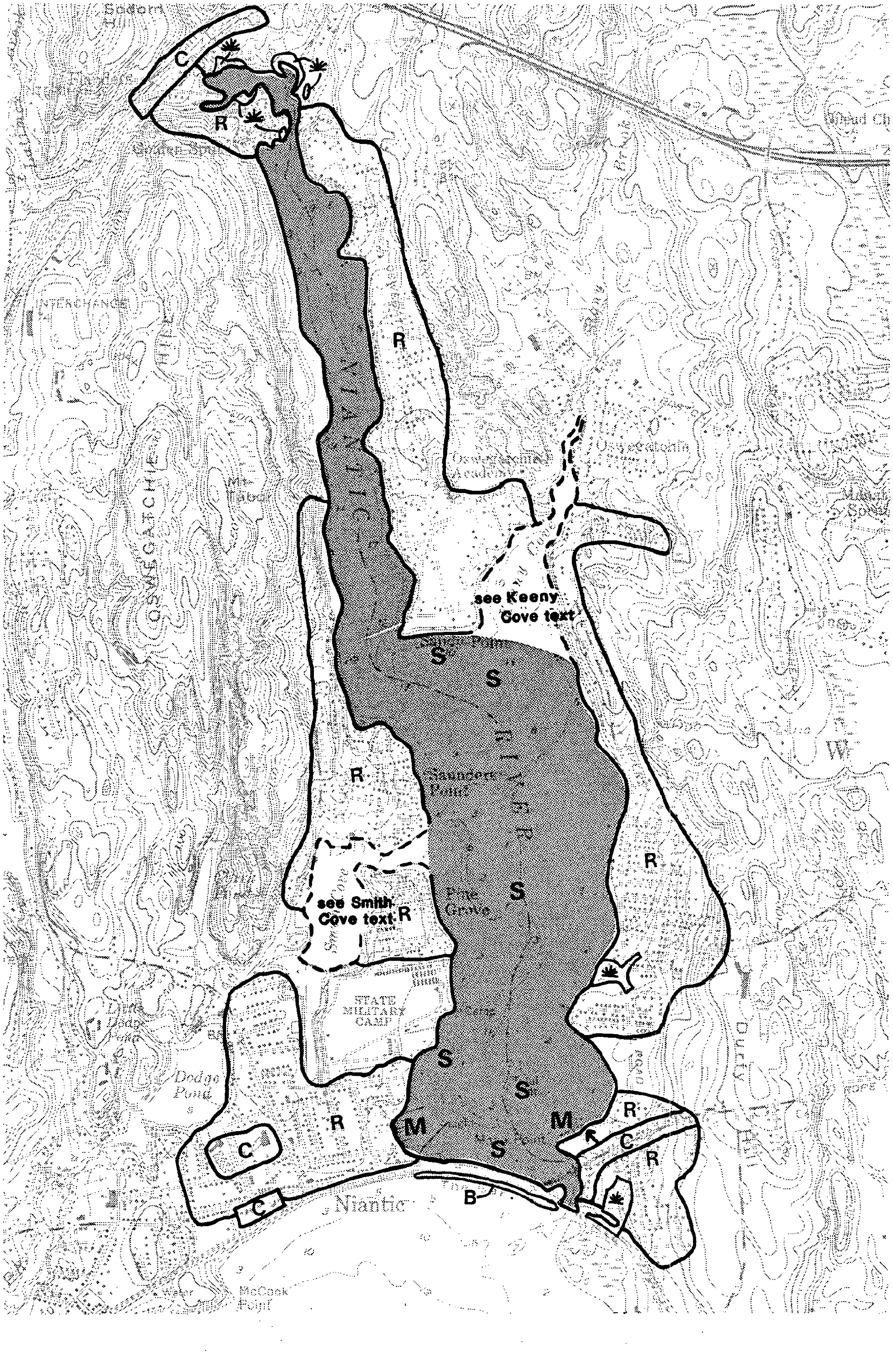
Tributaries to Embayment:
- Latimer Brook
- Stony Brook
- Old Mill Brooks
- Green Swamp Brook
- Smith Cove
- Keeney Cove

Scale: 1" = 2000'

FIG 6.3 NIANTIC RIVER ENVIRONMENTAL LAND USE

Legend:

(wetlands symbol)	wetlands	B	beach
A	agriculture	M	marina
R	residential	S	shellfish beds
C	commercial/ industrial	→	public access


C
R
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see Keeny
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see Smith
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STATE
MILITARY
CAMP
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S
M
M
R
C
R
R
C
S
C
B
Niantic
Saunders
Point
Pine
Grove
Dodge
Pond
McCook
Point

Basin Hydrology (con't)

Additional Comments: Though some private dredging has been done in the past, no channel currently exits in the embayment.

Constrictions to Tidal Flow and Circulation:

Structure	% Constriction	Distance from Embayment
Railroad Bridge 120' width (45' navigation clear) at mouth	75-100	
Highway Bridge 200' width 65' navigation clear) At mouth	75-100	

Sources: U.S. Geological Survey Connecticut Drainage Basin Gazeteer, 1981 Conn. Dept. of Environmental Protection

Water Quality Conditions

Embayment Water Quality Classification: SB/SA upstream of State Military Camp. No classification at mouth. GB/GA nearby. Latimer Brook - Not classified (A), Stony Brook - SB/SA, Oil Mill Brook - A.

Direct Discharges: None

Sewer Service Area and Discharge Point: There are no sewers in East Lyme. The southeastern portion of the river (which lies in Waterford) is sewered. From a location on the east shore opposite Saunders Point (East Lyme) northward, there are no sewers (see Figure 6.3).

Storm Sewer Outfalls: None

Significant Non-Point Pollution Sources: Dense residential development in upland areas may provide standard non-point runoff pollutants (fertilizer, animal waste, oil-related street wastes, etc.).

Shoreline and Bottom Conditions

Extent of Shoreline Modification: The western, northern and eastern shores remain relatively unchanged. The southern shore has been modified with marinas, boat ramps and piers. Little of the original shoreline remains.

Shoreline and Bottom Conditions (con't)

Shoaling and Sedimentation Problems: Shoaling and sedimentation are historic problems in the areas near the mouth of the river and inside Niantic Bay. These areas have been dredged several times in order to maintain a proper navigation channel.

Bottom Sediment Characteristics: Bottom sediments in the river system range from mud and fine sand to gravel. Sediments near the mouth of the river south of the tide flats are mostly fine sand with scattered development of eelgrass (see Figure 6.3).

North of Squaw Flats (between Camp O'Neill and the eastern shore) sediments are mostly mud with a mixture of mud and fine sands (see Figure 6.3). At sandy point, gravel is the predominant bottom sediment. Most of the remaining river bottom is hard packed sand or gravel with thin layers of silt, mud, and fine sand on top, generally only a few inches thick.

Surrounding Lands

Maximum Basin Elevation:

Location	Height
Mt. Tabor (to west)	250 feet
Hills to Northwest/east	100-150 feet
Durfy Hill (to southeast)	120 feet

Topography: Almost the entire shoreline of the Niantic River is bounded by slopes of 15 to 35% either Hinckley gravelly sandy loam or Hollis complex (rock outcrop). Lands near the mouth of the system are relatively flat (0-3% slope).

General Vegetation Characteristics: Land cover at the southern end of the river is mostly grassed open space; parking lots (no veg. cover); or residential plantings (lawns). Two large forested areas are found on the eastern shore (south of Keeny Cove) and on the western side from Saunders Point to Golden Spur (see Figure 6.3). The remainder of the upland areas are developed with private residences, and land cover ranges from open lawns to woods. There are no active agricultural fields in the area.

Soils:

Name	Characteristics	Slope %	Septic Tank Suitability
Adrian and Palms	mucks	-	very poor
Beaches		-	very poor

Soils:
(con't)

Name	Characteristics	Slope %	Septic Tank Suitability
Canton	very stony fine sandy loam	15-25	good
Enfield	silt loam	3-8	poor
Haven	silt loam	0-3	poor
Haven	silt loam	3-8	poor
Hinckley	gravelly sandy loam	15-35	poor
Hollis-Charlton	complex	15-35	poor
Hollis	rock outcrop complex	3-15	very poor
Hollis	rock outcrop complex	15-35	very poor
Narragansett	extremely stony silt loam	15-25	poor
Narragansett-Hollis	complex	3-15	poor
Pawcatuck	mucky peat	-	very poor
Paxton	very stony fine sandy loam	8-15	poor
Paxton & Broadbrook	extremely stony soils	3-15	poor
Raypol	silt loam	-	poor
Ridgebury, Whitney, & Leicester	extremley stony fine sandy loam	-	very poor
Rumney	fine sandy loams	-	poor
Tisbury	silt loam	0-3	poor
Typic Udorthents	cut and fill	-	variable
Urban Land	-	-	variable
Westbrook	mucky peat		very poor
Woodbridge sandy loam	extremely stony fine	3-15	poor

Shellfish and Finfish Resources

The Niantic River system supports a healthy and diverse shellfish population of steamers, quahogs, cherrystone clams, and razor clams, as well as abundant numbers of scallops and some oysters. Although shellfish resources are present, the Golden Spur area, Keeny Cove and Smith Cove are all closed to harvest of shellfish. This is due to elevated pollutant levels and the poor circulation characteristics of these areas.

The towns of East Lyme and Waterford share a shellfish commission to regulate shellfish harvests within the estuary. Scalloping represents a significant economic resource to the Niantic Region and the resource is closely regulated.

Wetlands

The Niantic River system is one of the largest embayments on the Connecticut Coast, but has had suprisingly little saltmarsh or wetland loss associated with it. This is the result of natural processes and a lack of wetland filling associated with development, as 1934 aerial photographs show approximately the same amount of wetland as 1981 photos. Small pockets of wetlands are found on the eastern shore, near the mouth and at the northern tip of the Golden Spur area (see Figure 6.3).

Environmentally Sensitive Areas

The few pockets of saltwater wetlands represent a limited habitat for a variety of species in the area. The steep slopes and undeveloped forested lands of Oswegatchie Hill and Mt. Tabor, which lie to the west of the embayment, are important to a wide range of wildlife, including hawks and birds of prey, such as the osprey, that fish the waters of the upper Niantic.

B: Land Use Analysis

Current Shoreline and Water Use

The Niantic River supports a large number of recreational and commercial boats. The numerous marina/boatyards in the basin have slips to accommodate over 340 vessels. Most of the marinas are found at the southern end of the river, near its mouth.

The river is used for a full range of water-based recreation, including power boating, sailing, swimming, fishing, shellfish harvesting, water skiing as well as a variety of winter uses.

Most of the shoreline is natural bank and slope. Some waterfront land owners have built private docks, piers, and groins, but the shoreline remains relatively unmodified.

Current Upland Use

With the exception of the forested western slope of the upper reaches of the Niantic, most of the upland area has been developed for residential housing and commercial activities. There is no industry located along the banks of the river. Housing development is moderately dense to very dense, and the areas are generally zoned for small lots (see Figure 6.3).

The State of Connecticut operates the State Military Camp on the southwestern bank of the river for training National Guardsmen.

Historical and Significant Land Use Changes

Prior to 1934 much of the upland was cleared for agricultural use. Little residential development was present beyoud a single line of waterfront homes that were mostly large summer residences.

The period 1934-1951 exhibited rapid growth in the cottage industry, marina development and a conversion of agricultural lands to residential uses. From 1951 to the present, significant residential infilling has occurred, along with cottage conversion for year-round occupancy. Marina development more than doubled to its present size, and the state constructed a public boat ramp (see Figure 6.3).

Public Access and Recreational Opportunities

The State of Connecticut operates a public boat launch at the southeast corner of the river, and several town piers have been constructed on the waterfront. As previously described, a wide variety of water-based recreational opportunities exist in the area.

C: Problem Identification

Local Departments and Offices Consulted

Town of East Lyme - Board of Selectmen, Planning Commission, Town Engineer, Shellfish Commission, Flood and Erosion Control Board; Marina Operators.

Response from Questionnaires and Local Meetings

Local response to problems were mixed, ranging from no concern to moderate concern for a number of long range trends, such as sedimentation, pollution, and eutrophication. During local meetings, it was pointed out several times that the Niantic River system is a rarity in both its size and its relatively unpolluted, and undisturbed condition.

Results of Field Survey and Research

The field visit confirmed the lack of severe problems associated with the embayment. There is little or no industrial development within the drainage basin and water quality appeared to be excellent. Several large marinas are found close to the mouth of the river, and a distinct channel leading to these areas can be seen at low tide. In addition, large mud flats exposed at low tide exhibit abundant shellfish populations. Shorelines near piers and docks are covered with broken and empty oyster and clam shells dropped by sea birds. Shorelines show little erosion problems, even on areas of steep slopes.

In general, the Niantic system appeared healthy, clean and in relatively good condition. Problems that exist, relate to sedimentation and pollution from septic systems.

D: Problem Analysis

Flushing and Circulation Constriction

Extensive studies on the Niantic River estuarine system were carried out by the U.S. Coast Guards Office of Research and Development between 1969 and 1974. This research identified several key factors about the circulation characteristics of the system, including:

- a complex circulation regime exists within the river
- approximately 27 days (average) is required for full tidal flushing
- tidal flow is restricted due to the narrow channel under the Route 1 and Railroad bridges (see Figure 6.4).

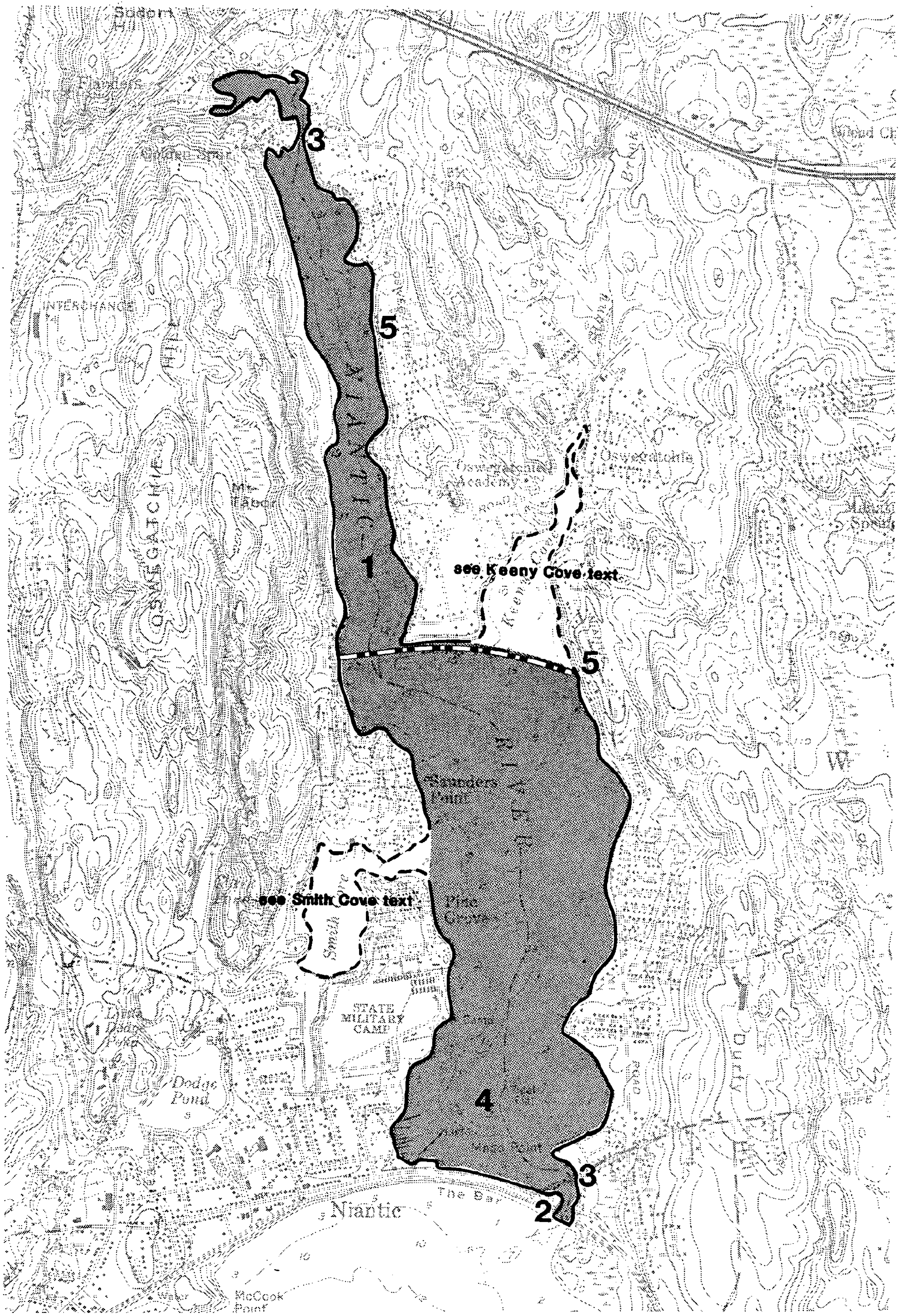
The study concluded that "the Niantic River may be regulated as a naturally eutrophic estuarine system, capable of supporting a highly productive plankton biomass." In addition, in spite of the poor circulation and long tidal exchange factors, the system "remains relatively unpolluted and somewhat of a rarity in that it lacks significant commerical or industrial development along its shores". Recent (1975-77) dredging did result in improved tidal flushing near the mouth, but increased tidal velocities may be responsible for increased suspended sediment transport further up into the embayment. Marina operators in Smith Cove report an increase in the rate of silt and sediment deposit since the latest dredging. This reported increase however, is not significantly impacting the estuarine system.

Scale: 1" = 2000'

FIG 6.4 NIANTIC RIVER ENVIRONMENTAL PROBLEMS

Problem Areas

1. Upper half of bay is closed to shellfishing
2. Railroad bridge constricts flow
3. Highway bridge (Rt. 1) constricts flow
4. Shellfish loss associated with low tides in winter
5. Wastewater problem area



3
5
1
see Keeny Cove text
5
Saunders Point
see Smith Cove text
Pine Grove
STATE MILITARY CAMP
Dodge Pond
4
3
2
Niantic
The Bar
McCook Point

Water Quality Degradation

Water quality degradation through septic system failures is perhaps the greatest problem affecting the Niantic River system. The town of East Lyme, which borders the western half of the embayment, has no sewer system, and only portions of the Town of Waterford (eastern side) are sewered. Waterford, through a recently prepared wastewater facilities plan, has acknowledged this problem, and has identified the residential development areas bordering the eastern shore of the Niantic as sewer needs areas. Construction of sewers in these areas would most likely result in the reopening of shellfishing in the upper reaches of the Niantic. Water quality classification for the Niantic is currently SB with a goal of SA. Latimer Brook, the main tributary to the upper reaches of the Niantic is identified as Class A water.

For additional analysis on portions of the Niantic River System, see Smith Cove, Sec. 6.7 and Keeny Cove, see 5.1.

FOURMILE RIVER

A: Physical Description

Location

The river is located on the East Lyme/Old Lyme border. Rocky Neck State Park is directly east of the river and the village of South Lyme lies to the west. The mouth of the Fourmile River is approximatey 1.75 miles south of the point, the Connecticut Turnpike crosses the river.

Site Orientation and Configuration

The river channel runs in a north-south direction and is quite narrow in width ranging from 50 to 200 feet. From its mouth, the length of the river's tidal influence is approximately 0.8 miles. The river empties into a horseshoe shaped embayment which is exposed to the sound (see Figure 6.5). This outer embayment is approximately 800 feet wide and is formed by the area between Lands End (Rocky Neck) and Point O'Woods (Old Lyme).

Tidal Data

Mean Tidal Range -	2.7 ft.
Spring tidal range -	3.2 ft.
Mean tide level -	1.3 ft.

Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth:	Not Available
Channel Depth:	Not Available

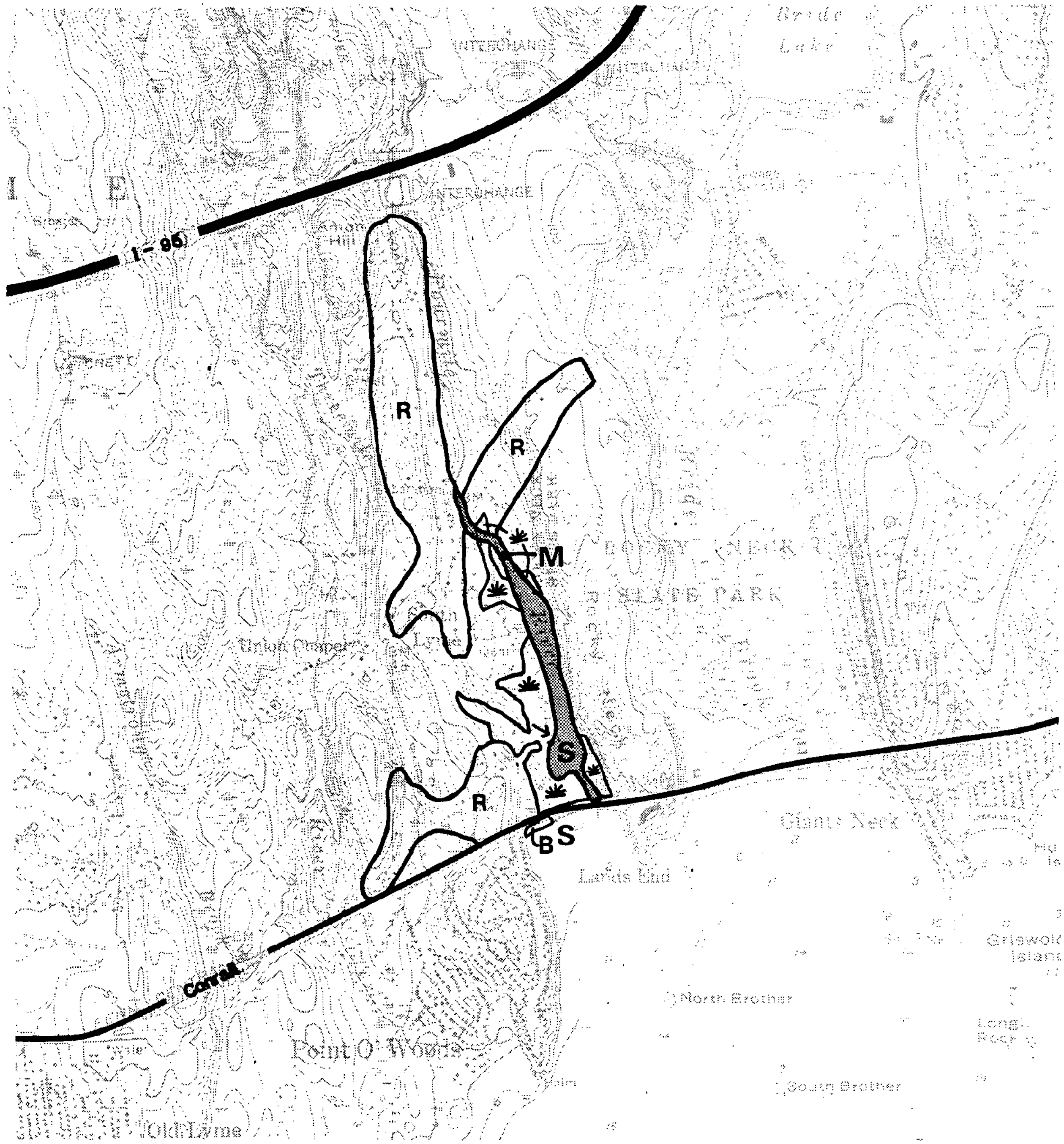
Additional Comments: Area has not been previously dredged. Field observations indicated a depth of from 1-5 feet at MLW.

Source: NOAA National Ocean Survey Maps

Basin Hydrology

Regional Drainage Basin: Niantic River Basin
Embayment Basin Area: 6.56 square miles
Tributaries to Embayment: None in addition to Fourmile River System

Other Sources of Freshwater Inflow: Surface runoff from adjacent upland.



Scale: 1" = 2000'

FIG 6.5 FOURMILE RIVER ENVIRONMENTAL LAND USE

Legend:

(wetlands symbol)	wetlands	B	beach
A	agriculture	M	marina
R	residential	S	shellfish beds
C	commercial/ industrial	→	public access

Constrictions to Tidal Flow and Circulation:

Structure	% Constriction	Distance from Mouth
Railroad Bridge 20 feet wide (9 ft vertical clearance MHW) At Mouth	50-75	

Sources: U.S. Geological Survey Connecticut Drainage Basin Gazeteer, 1981 Conn. Dept. of Environmental Protection

Water Quality Conditions

Upstream Water Quality Classification: B/A

Embayment Water Quality Classification: SB/SA

Direct Discharges: None

Sewer Service Area: There are no public sewers within the watershed of the tidal portions of the Four-Mile River. Development in the vicinity of the river is mostly low-density, with large lot size (see Figure 6.5). The region coastal basin plan indicates that non-point source pollution from urban runoff does not appear to be significant.

Storm Sewer Outfalls: None.

Significant Non-Point Pollution Sources: In the Town of Lyme, a sanitary landfill is located upstream of the tidal range, but within the watershed of the Fourmile River. Visual inspection identified a distinct change (degradational) in water quality within the receving waters immediately downstream of the landfill. The river is currently classified B at this point, and SB in the tidal portions.

Shoreline and Bottom Conditions

Extent of Shoreline Modification: The eastern shoreline has not been modified. On the west bank a public boat ramp has been developed approximately 1000 feet upstream from the mouth of the river. At the rivers head, a boat yard and marina have been developed in the saltmarsh along the rivers edge.

Significant Areas of Erosion: No significant areas of erosion are present in the embayment.

Shoreline and Bottom Conditions (con't)

Shoaling and Sedimentation Problems: The Fourmile River maintains a fairly clean bottom through tidal flushing, however, the mouth of the river south of the railroad bridge has shoaled in, and restricts both tidal flow and boating traffic.

Bottom Sediment Characteristics: Field observations indicate a scoured bottom with no signficant silt or mud deposits. Major soils in the area are Westbrook mucky peat, and Rummey fine sandy loam. Predominant upland soils are Hollis complex-fine silt and loam. Erosion of these coastal soils undoubtedly contribute to the sedimentation problems in the embayment south of the rivers mouth (see Figure 6.5).

Surrounding Lands

Maximum Basin Elevation:

Location	Height
On East-Rocky Neck State Park Ridge	100 feet
On West-Several Small Hills	50 feet

Areas of Steep Slopes: The entire east side of the river is bordered by a steep rock face ridge (Rocky Neck State Park) (see Figure 6.5).

General Vegetation Characteristics: Saltmarsh development fringes the entire river system, excluding steep shore areas of Rocky Neck Park. The abutting upland areas are mostly forested, with some residential landscaping.

Soils:

Name	Characteristics	Slope %	Septic Tank Suitability
Canton	very stony fine sandy loam	8-15	good
Canton	very stony fine sandy loam	15-25	good
Charlton	very stony fine sandy loam	3-8	good
Hinckley	gravelly sandy loam	3-15	poor
Hollis	rock outcrop complex	3-15	very poor

Soils:
(con't)

Name	Characteristics	Slope %	Septic Tank Suitability
Hollis	rock outcrop complex	15-35	very poor
Raypol	silt loam	-	poor
Ridgebury, Whitman, & Leicester	extremely stony fine sandy loams	-	very poor
Tisbury	silt loam	0-3	poor
Westbrook	low salt mucky peat	-	very poor
Woodbridge	very stony fine sandy loam	0-3	poor
Gravel Pit	-	-	variable
Rumney	fine sandy loam	-	poor

Shellfish and Finfish Resources

The river is open to shellfishing, but visual observations and discussions indicate only a limited interest in harvests. No official shellfish resource data was available, but local residents report small harvest of quahogs and oysters. Anadromous fish runs of trout and bass were also reported.

Wetlands

Location (See Figure 6.5) - Extensive saltmarsh development fringes almost the entire Fourmile river system up to the limit of tidal influence. Little change is evident since 1934 for most of the river.

Two marinas and a state owned boat ramp have been developed on a small portion of the wetlands. Adjacent uplands are zoned large lots (2+ acre) residential with only a few houses currently constructed (see Figure 6.5).

It is unlikely that further wetland filling will occur, unless the state chooses to expand the boat launch facilities it currently operates.

Environmentally Sensitive Areas

The wetland areas (south of the two marinas to the railroad bridge) supports a diverse population of migratory waterfowl, and nesting habitat for native species. This relatively undisturbed environment is an important wildlife resource for the region.

Environmentally Sensitive Areas (con't)

Rocky Neck Park borders the east side of the river with relatively steep hillsides. These undeveloped forested lands add to the relative "natural" quality of the Fourmile River, and increase the diversity of species habitat available in the area.

B: Land Use Analysis

Current Shoreline and Water Use

Most of the shoreline is still undeveloped. A State Boat Launching Ramp has been constructed on marshland some 1,000 feet northwest of the river's mouth. Two marinas operate at the head of the tidal waters (see Figure 6.5). These marinas and the State Launching Ramp cater mostly to shallow draft power boats, since the restriction the fixed railroad bridge at the river's mouth places on sailboats.

The river itself is shallow, and little use is made of it for water based recreation except for boating. There are no bathing facilities in the area. Rocky Neck State Park, (adjacent to the River) provides these facilities.

Current Upland Use

The entire eastern upland area is part of Rocky Neck State Park, and is currently undeveloped forest land. The western shore upland is a low-density residential development, with remnants of an abandoned gravel pit operation.

Historical and Significant Land Use Changes

Review of historical aerial photographs (1934/1951) indicated no development along the banks or in upland areas prior to 1934. Between 1934 and 1951 an access road was cut on the western upland, and a few residences were developed. There were no marina facilities prior to 1951. Between 1951 and 1970, the State developed its boat launching facilities, and the current marina facilities were constructed. Additional residential development occured at a slow pace. The current picture has changed little since 1970. Additional residential development has occurred but is still characterized by low-density and large lot size.

No significant natural changes or modifications to the Fourmile River system are apparent since 1934.

Public Access and Recreational Opportunities

The state operated boat ramp on the western shore, and Rocky Neck State Park to the east provide public access and recreational use of the Fourmile River.

C: Problem Identification

Local Departments and Offices Consulted

Town of East Lyme - Board of Selectmen, Planning Commission, Town Engineer, Shellfish Commission, Flood and Erosion Control Board; Marina Operators.

Response from Questionnaires and Local Meetings

No significant problems or concerns were identified through the questionnaire or at local meetings. In subsequent discussions with marina operators, concerns over shoaling and limitation to navigation at the river's mouth were brought up.

Moderate concerns were raised about possible water quality and eutrophication problems.

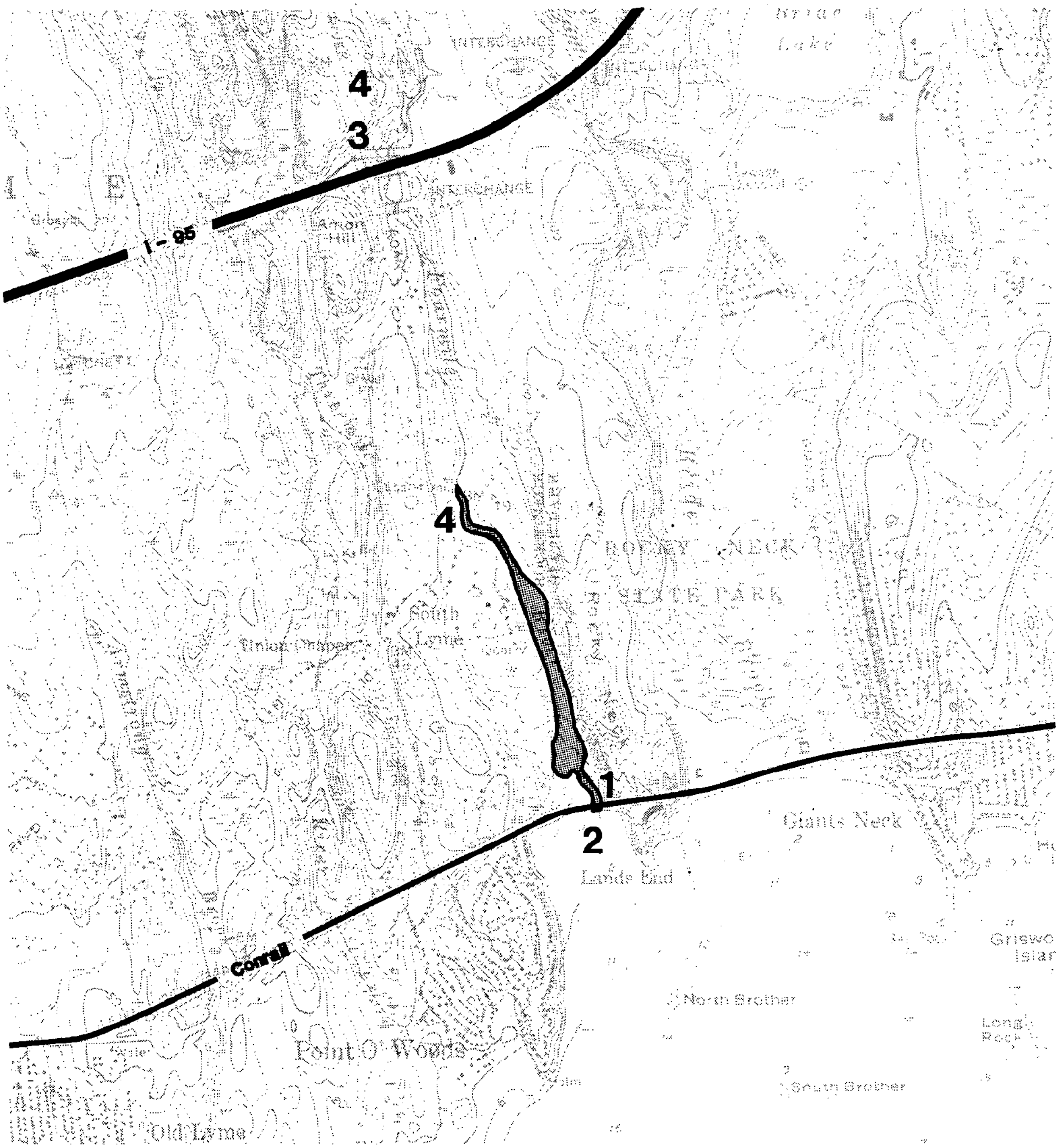
Results of Field Survey and Research

Research and field work indicate the Fourmile River system to be a relatively healthy and unpolluted river with no significant environmental problems. Visual observations and review of a state feasibility study for dredging verify the occurance of shoaling and sedimentation problems at the mouth of the river, west of Rocky Neck (Lands End) (see Figure 6.6).

D: Problem Analysis

Sedimentation and Siltation

South of the mouth of the Fourmile River is a horseshoe shaped embayment (see Figure 6.6). This embayment lies between Point o' Woods and Land's End. The natural shoaling pattern of Long Island Sound in the embayment acts to transport off-shore sediment material into this area where it settles out, creating near shore shoaling. Navigation charts for the area indicate depths of only 0.5 to 2 feet at Mean Low Water (see Figure 6.6).



Scale: 1" = 2000'

FIG 6.6 FOURMILE RIVER ENVIRONMENTAL PROBLEMS

Problem Areas

1. Railroad bridge constricts tidal flow
2. Sand shoal near mouth restricts navigation
3. Sanitary landfill in upstream watershed
4. Upland residential development

Sedimentation and Siltation (con't)

The natural channel of the Fourmile River has been partially maintained due to tidal flow and flushing. The narrow mouth opening, created by the railroad causeway, slows tidal waters down considerably prior to entering the estuary. This acts to increase the rate of sediment settling out in the area inside of the river's mouth. This creates navigation problems in the area between the state boat ramp and the river's mouth. Upon leaving the constricted channel (at the railroad causeway), sediment in suspension is deposited, increasing bar size (see Figure 6.6).

The source of the bar sediment material is predominantly from Long Island Sound.

Water Quality Degradation

The Fourmile river is classified SB in its tidal portions. It is unlikely that this classification is due to casual factors in the downstream portion, but rather from introduction of pollutants in the upstream reaches of the river. Of particular concern is leachate from the town of Lyme's santiary landfill which is located adjacent to the river (see Figure 6.6). Water quality (color and clarity) at a point immediately downstream of the landfill is markedly different than upstream portions. No water quality data other than biological classification was available, therefore it is difficult to ascertain the specific impacts of the landfill on the tidal portions of the river. In order to determine these impacts, further detailed analysis may be warranted.

PROBLEM SUMMARY

East Lyme			
1.	Sedimentation in entrance channel	Moderate	(a)
2.	Bacterial pollution (shellfish closures)	Moderate	(c)
3.	Poor flushing/circulation	Moderate	(b)
4.	Eutrophication	Minor	(b)
Niantic River			
1.	Siltation of river navigation channel	Moderate	(a)
2.	Bacterial pollution (shellfish closures)	Moderate	(c)
3.	Eutrophication	Minor	(b)
4.	Poor flushing/circulation conditions	Moderate	(b)
Fourmile River			
1.	Siltation at mouth of river	Moderate	(a)
2.	Bacterial pollution (shellfish closures)	Moderate	(b)
3.	Water quality concerns	Moderate	(a)
4.	Circulation restrictions	Minor	(b)

KEY: (a) Conditions becoming worse (b) No change (c) Conditions improving

CHAPTER 7 ESSEX EMBAYMENTS

INTRODUCTION

The Town of Essex is located in Middlesex County, inland from Long Island Sound along the tidal reaches of the Connecticut River. Essex is on the west bank of the river and is situated between the coastal community of Old Saybrook to the south and Deep River to the north. The town boundaries include 10.5 square miles that drain to the Connecticut River. During 1970 to 1978, the community's population increased 3.8 percent (1970-4,911; 1980-5,100). This growth was 0.9 percent less than the overall state increase, and significantly less than the county increase of 10 percent. The population density of the town is 486 persons per square mile, 25% less than the state density of 652.

The Essex riverfront is unusually irregular due to the indentations of South Cove, Middle Cove and North Cove (See Figure 7.1). The three embayments add considerable length to the waterfront and provide large areas of protected water for moorage and marina facilities.

Of the three Essex embayments, North Cove is the largest and includes extensive stretches of wetlands, particularly those of Great Meadow. South Cove, which has a more developed shoreline, is the second largest and is directly connected to Middle Cove, the smallest of the three embayments. Middle Cove is also the most sheltered of the three embayments. No major streams flush these water bodies, and all of the embayments are somewhat sheltered from northwest winds by the rising elevation of the western shore. Thatchbed Island encloses these embayments, and consists of vegetated alluvial deposits that are constantly reworked by stream action.

The historic downtown area of Essex is located on a peninsula between North and Middle Coves. Marina facilities are principally clustered along the North Cove waterfront of the downtown, and have expanded significantly since 1960. No sewers serve the densely developed business district along Main Street, and wastewater treatment in this section of town is a major concern. Sewer proposals for the downtown have been controversial because residents believe sewer-induced growth impacts may be more significant than any benefits to local water quality. The community is now a highly desirable place to live, and local business and residential development pressures have made town officials very growth conscious.

Historically, the community has served as an industrial and a seafaring center. Most housing and commercial development concentrated in the eastern part of the town due to the strategic location of the waterfront. Since World War II, however, much of the town's residential growth has occurred inland; and since the 1960's, industry has followed. Some of the older industrial buildings that remain in the eastern part of town have been converted for commercial or light industrial use.

Old industrial buildings along Falls Brook and other industry upstream of North Cove significantly impacted the local environment, especially the water quality. Contaminated sediments and several remaining outfalls continue to impact the system. North Cove was originally considered for inclusion in this report but was found to be the most studied and best understood of the three embayments.

By comparison, little is known about the environmental quality of the other two embayments. Middle Cove was ultimately chosen over South Cove because the tidal flow is more constricted, the shoreline is more developed, and the sedimentation problems are more significant.

MIDDLE COVE

A: Physical Description

Location

The cove is along the western bank of the Connecticut River, approximately 7 miles upriver from the mouth. The Middlesex Highway (Route 154), which lies to the west, is the closest major highway. The Town of Essex forms the northern and eastern shore of the cove and Thatchbed Island forms the southern shore. Old Saybrook is roughly 4 miles south of Middle Cove. Chester is approximately 4.5 miles north of the cove.

Site Orientation and Configuration

The cove is roughly oval in shape (see Figure 7.1), with its long axis oriented NW to SE. The shoreline is generally regular, with two inlets providing direct access to the Connecticut River and to South Cove. The dimensions of the embayment are approximately 800 feet by 1600 feet.

Tidal Data

Mean tidal range -	3.0 ft.
Spring tidal range -	3.6 ft.
Mean tide level -	1.5 ft.

Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth:	2-6 ft. (MLW)
Channel Depth:	4-6 ft. (MLW)

Additional Comments: A privately-maintained channel provides boat access to a small marina on the northern shore of the cove (See Figure 7.1).

Source: NOAA National Ocean Survey Maps, Air Photo Analysis

Basin Hydrology

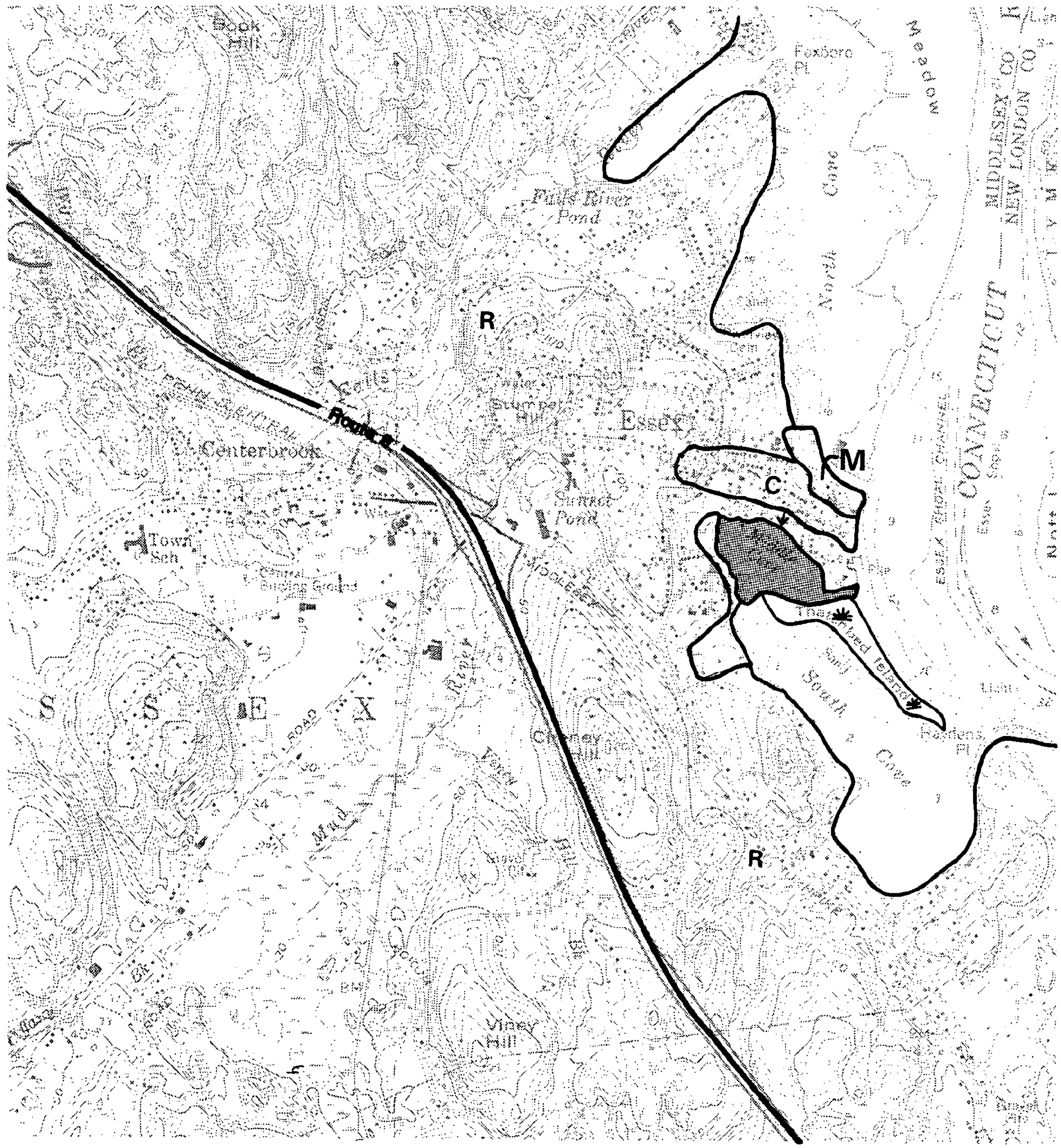
Regional Drainage Basin: Connecticut River Drainage Basin

Tributaries to Embayment: None

Other Sources of Fresh Water Inflow: Limited amounts of stormwater runoff from local impervious surfaces.

Constrictions to Tidal Flow and Circulation: None

Sources: U.S. Geological Survey, Connecticut Drainage Basin Gazeteer, 1981; Conn. Dept. of Environmental Protection



Scale: 1" = 2000'

FIG 7.1 MIDDLE COVE
ENVIRONMENTAL LAND USE

Legend:

- wetlands
- **A** agriculture
- **R** residential
- **C** commercial/ industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Water Quality Conditions

Upstream Water Quality Classification: SBC

Embayment Water Quality Classification: SBC

Direct Discharges: None

Sewer Service Area and Discharge Point: No sewers currently service the embayment uplands. Some town officials believe that houses along several of the streets on the northern shore may discharge their sewage directly to the outer cove or river by way of a common pipe. No definite data are available on this matter.

Storm Sewer Outfalls: Storm sewers drain sections of the western and northern shores and discharge the effluent directly to Middle Cove.

Significant Non-Point Pollution Sources: Most of the Middle Cove waterfront is bulkheaded or seawalled and backfilled to provide lawns and waterside terraces for waterfront houses. Excess lawn fertilizer, pesticides and soil erosion may provide moderate levels of pollutants to the embayment.

Shoreline and Bottom Sediment Conditions

Extent of Shoreline Modification: Almost all of the Middle Cove shoreline has been filled and stabilized for residential use. The two most common forms of filling constriction are seawalls and bulkheads. A few of the homes have docks, and there is a small marina located on the northern shore. One small section of shoreline remains as marsh, but is obstructed by an old stone road built seaward of the water's edge. Most of the filled shorefront land is level and not much higher than the mean tide levels due to the minimal tidal range.

Significant Areas of Erosion: The only area of significant erosion is a small earthen island west of Thatchbed Island exhibiting an eroding shore line.

Shoaling and Sedimentation Problems: At present, Middle Cove is dredged periodically to maintain access to the Connecticut River for the local marina. The origin of the sediment is most likely river sediment transported into the cove by tides, wind and river flow. The cove tends to act as a settling basin for suspended sediment because it is enclosed from the river by both a peninsula extending from downtown Essex, and Thatchbed Island.

Shoreline and Bottom Sediment Conditions (con't)

Bottom Sediment Characteristics: The bottom sediment is composed of fine silts with a large clay component. The color of the sediment ranges from brown to grey, depending on the organic content of the material.

Surrounding Lands

Maximum Basin Elevation:

Location	Height
Western Shore	100 ft.
Eastern Shore	20 ft.
North Shore	100 ft.

Topography: The area exhibits moderate relief. There are no steep slopes immediately suro̊unding Middle Cove. A formation of Paxton fine sandy loam (20% grade) exists on the western shore but is over 0.4 miles inland from the cove shoreline.

General Vegetation Characteristics: Essex is moderately developed along Main Street (See Figure 7.1). The western shoreline of the cove is less developed and is vegetated with large mature trees and some grassy fields.

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Agawam	fine sandy loam	0- 3	very poor
Agawam	fine sandy loam	3- 8	very poor
Beaches	complex	-	very poor
Canton	very stony fine sandy loam	8-15	very good
Hollis-Charlton	fine sandy loam	3-15	very poor
Hollis-Charlton	complex	15-35	very poor

Surrounding Lands (con't)

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Paxton	fine sandy loam	3- 8	poor
Paxton	fine sandy loam	8-15	poor
Paxton	fine sandy loam	15-25	poor
Rumney	fine sandy loam	-	very poor
Sudbury	sandy loam	0- 3	very poor
Typic Udorthents	cut and fill		variable
Westbrook	mucky peat		very poor

Shellfish and Finfish Resources

Little is known about the status of shellfish in Middle Cove. All coastal waters in Essex are closed to shellfishing because of water pollution levels.

Wetlands

The two remaining tidal wetland areas are Thatchbed Island and a large consol- idated marsh in the northwest section of Middle Cove (See Figure 7.1).

Thatchbed Island is long and narrow. It is completely covered with marsh vegetation which serves to stabilized the unconsolidated sediment. The other marsh is circular in shape and surrounded by residential development. The vegetation provides an important habitat for birds and estuarine organisms, and serves as a filter for nutrient loaded runoff, eroded soil, and organic detritus.

Most of the cove shoreline was marsh in the past, but has since been filled and stabilized for marinas and residential development. Some of the waterfront homes date back to the late eighteenth century, indicating that at least part of the waterfront has been filled for almost 200 years. The existing seawalls are mostly poured concrete and have been built within the past 50 years. An old abandoned solid fill causeway still remains next to the marsh in the northwest section of the embayment.

At present, most of the shoreline has already been stabilized, so little additional filling can occur. It is anticipated that the two remaining marshes will be preserved in their existing natural state.

Environmentally Sensitive Areas

Great Meadows, Thatchbed Island, the marshes of Foxboro Point and Haydens Point are four important habitat regions. The first three areas are principally wetlands, while the fourth area is forested upland. Rare aquatic plants, such as horned pond weed and tidewater arrowhead, grow along the Great Meadow shoreline. Other more common plants include cordgrass (Spartina alterniflora), cattails, panic grass (Panicum virgatum), pompass grass reed (Phragmites) and False Indigo. Deer, racoon, possum, weasel, and muskrat are among the mammals found in the meadows.

The Foxboro Point marshes are an important habitat for shore birds and estuarine organisms. The salinity of North Cove in that area is very low.

Thatchbed Island is similar to that of Great Meadow, but the island is lower lying and has no land bridge to the mainland, limiting access by mammals.

The elevation of Haydens Point ranges from sea level to 90 feet and is primarily an upland environment. It serves as an important local habitat for birds, mammals, and other terrestrial species of wildlife.

B: Land Use Analysis

Current Shoreline and Water Use

Middle Cove has some of the most desirable waterfront property in Essex. Use ranges from passive recreation to swimming and boating. Only one marina can be found in the cove, and its located along the northern shoreline. The facility can accomodate approximately 35 large motor and sail boats, but offers little upland area for winter storage. A boat ramp is also available on the site. The only other dock on the cove is the remnant of the former marina that has now been converted to housing. It is doubtful that the current owner will restore the aging docks, but he may replace them with smaller docks in keeping with the new residential use.

Current Upland Use

All of the immediate upland use is residential, except for the 35-slip marina on the northern shore. The commercial mainstreet is approximately one to two blocks north of the cove.

Public Access and Recreational Opportunities

A small waterfront park exists on the north shore (east of the marina). The park is designed primarily for strolling and visual access to Middle Cove.

C: Problem Identification

Local Departments and Offices Consulted

Essex Conservation Committee and Connecticut River Estuary Regional Planning Agency.

Response from Questionnaires and Local Meetings

Town and regional agency officials both cited siltation, pollution, and constricted tidal flow as the significant problems of the embayment. The regional planning agency also noted that the area was experiencing a mixture of natural and man-made erosion, particularly along the shores of Thatchbed Island. The problems are believed to be mostly moderate, but siltation is considered to be severe. Despite the silty conditions, neither the town nor agency officials thought there were any eutrophication problems. Respondents also believed that most of the current impacts would become more severe in the future. One solution proposed to mitigate future impacts is to incorporate regulatory controls for soil erosion and sediment loss in the existing town zoning and subdivision regulations.

Results of Field Survey and Research

An on-site survey of the embayment revealed that at least part of the cove was being dredged. Spoils from the operation were being placed on a former marina site that was recently subdivided for housing. Many of the old pile-supported marine piers are still present but are in poor shape due to ice damage and rot. A small vegetated earthen island has steep banks and shows obvious signs of erosion. These conditions may be related to nearby dredging or may be caused by boat wakes from vessels using the one remaining marina in Middle Cove.

Aside from the housing subdivision, no additional construction is underway on the waterfront. Most of the surrounding land (except for tidal marshes) is developed, and there is little room left for residential infilling.

Results of Field Survey and Research (con't)

The town is currently considering sewering the central business district, but residents are concerned that such action would induce additional development in downtown areas that are already too congested. Despite these fears, Essex has received moderate pressure from the state to review their wastewater treatment needs and replace or rehabilitate their failing septic tanks and cesspools.

D: Problem Analysis

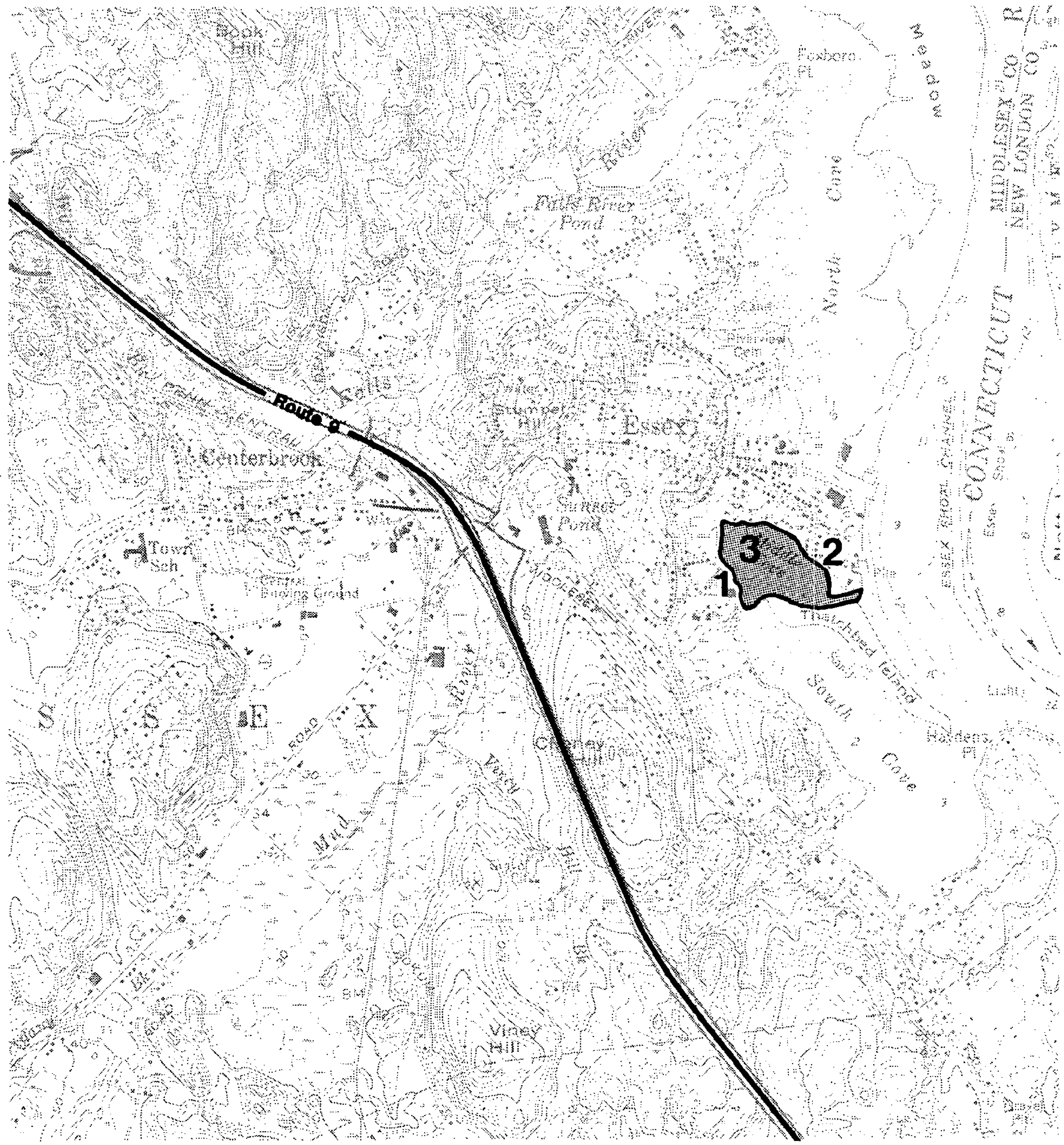
Flushing and Circulation Constriction

The constricted tidal flushing of Middle Cove is due to its natural configuration (See Figure 7.2). Thatchbed Island is located at the mouth of the cove and restricts tidal exchange and boating access to two channels. The inlet, allowing direct access to the river, is 100 feet wide, while the other channel leads to South Cove and is approximately 300 feet wide. Local officials indicated that one of the best ways to improve tidal flushing of the embayment is to dredge the cove. Dredging was being conducted during the month of the field observations and will likely be conducted again in the future on a regular basis. Tidal flushing is limited by natural processes, and cannot be considered as an issue of existing environmental concern.

Sedimentation

The constricted characteristics of the embayment make it an ideal settling basin. Sediment laden river water enters the cove during flood flows, and settles on the cove bottom. The cove is protected from physical dynamics that resuspend sediment, such as storm surge, waves, and flooding. The local shoreline provides a small amount of shelter from wind and wave action, reducing bottom agitation and removal of sediments.

The physical energy absorbed by Thatchbed Island may erode some of the island's sediment into the channel and cove. Two small islands off the southern end of Thatchbed Island are only a small fraction of their original size, and their erosion presumably contributed to the sedimentation of the embayment.



Scale: 1" = 2000'

FIG 7.2 MIDDLE COVE ENVIRONMENTAL PROBLEMS

Problem Areas

1. Filling of shorefront property
2. Suspected direct discharge of domestic sewers
3. Closed to shellfishing

Erosion

Most of the local erosion is limited to Thatchbed Island and two other small islands at its southern end (See Figure 7.2). The suspected causes include boat wakes, wave reflection off sea walls and bulkheads, and the shifting of bottom sediment to fill in adjacent dredged channels. Much of the erosion is a natural response to the physical dynamics of a river and tidal flow. It is difficult to determine, even with the aid of aerial photos, whether the islands have experienced a net loss in area, or whether the local erosion is offset by accretion in other parts. It is likely that the current erosion rates will continue.

Water Pollution

The storm sewer (and possible santiary sewage) outfalls may represent a moderate and difficult problem to mitigate. Despite their likely contribution to nutrient loading during storm events, there was no indication by local officials of any known eutrophication problems. This probably indicates that even though the cove is subject to some siltation, it experiences flushing capable of removing any storm-contributed nutrients.

Periodic dredging, which improves tidal circulation and flushing, may reduce the future likelihood of localized pollution problems.

PROBLEM SUMMARY

Middle Cove

1.	Flushing and Circulation Constriction	Moderate	(b)
2.	Sedimentation	Moderate	(b)
3.	Erosion	Moderate	(b)
4.	Water pollution	Moderate	(b)

KEY: (a) Conditions becoming worse (b) No change (c) Conditions improving

CHAPTER 8 CHESTER EMBAYMENT

INTRODUCTION

The Town of Chester is located in Middlesex County and is the northern most coastal community on the Connecticut River. The town is on the west bank of the river with Haddam directly to the north and Deep River to the south (See Figure 8.1). Chester's size is 15.2 square miles, all within the Connecticut River drainage. The community is rural and has a population density of only 223.6 persons per square mile, about one-third of the state average of 651.8 (1978 census data). Over the past decade, Chester has restored the historic downtown to improve the local economy. The success of this project has made Chester an increasingly attractive community in the region, helping to increase population significantly during 1970 to 1978. During this period the town exhibited a 14% population growth rate (1970-2,982; 1980-3,400), as compared to a statewide growth rate of 4.7%.

The geology of the area is shaped by both past glaciation and current alluvial processes. Most of the riverfront area is level, while the inland topography consists of moderate slopes rising to a little over 450 feet. As is common in formerly glaciated areas, the lowlands between the hills are flat and swampy. Almost all of the surface drainage from the town flows to Pattaconk Creek, which is also known as Chester Creek in the lower reaches.

Chester's downtown is situated along a series of mill ponds created on the river to provide water power for the town's first industry. The stone dams of the ponds still remain intact and help regulate water flow into Pattaconk Creek. They also provide some flood protection for structures on the lower reaches of the floodplain.

The largest highway serving the town is Route 9 (Middlesex Turnpike), which parallels the river in the eastern part of town. No bridges link Chester directly to Lyme or East Haddam on the other side of the Connecticut River, but a ferry near Fort Hill does provide regular service. A railroad line also runs along the river parallel to Route 9A.

Most residential development is in the eastern third of the town, along Route 9A and the streets winding into downtown Chester. Historically, less importance was placed on developing the waterfront due to the wide expanse of wetlands, the lack of a good harbor at the mouth of Pattaconk Creek, and the importance of being near a source of water power.

The steeper terrain of inland Chester provided the necessary elevation drop for water power, and provided desirable homesites that were well drained and away from the flooding of the coastal marshes.

Today, Chester retains little of its past industry. Many residents live in Chester and work in service oriented jobs in the small downtown area or commute to nearby business centers.

PATTACONK CREEK (Chester Creek)

A: Physical Description

Location

The embayment is located along the western bank of the Connecticut River, approximately 13 miles upstream from the mouth. Haddam is located approximately 6.5 miles north of the creek, and Essex lies 5.5 miles south. The community of Lyme faces the creek mouth on the opposite shoreline of the Connecticut River (See Figure 8.1).

Site Orientation and Configuration

The lower reaches of the creek are geometric in shape because the banks have been filled and stabilized for use in a marina. Upstream of the intersecting railroad bridge, the creek bed and banks are undisturbed and meander within a wide flood plain. Route 9A intersects the creek approximately 0.6 miles from the mouth. For the purpose of this report, 1.8 miles of the creek are considered as part of the study area.

Tidal Data

Mean tidal range -	2.7 ft.
Spring tidal range -	3.2 ft.
Mean tide level -	1.3 ft.

Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth:	1-9 ft. (MLW)
Channel Depth:	5-9 ft. (MLW)

Additional Comments: A privately dredged channel provides access from marina to Connecticut River.

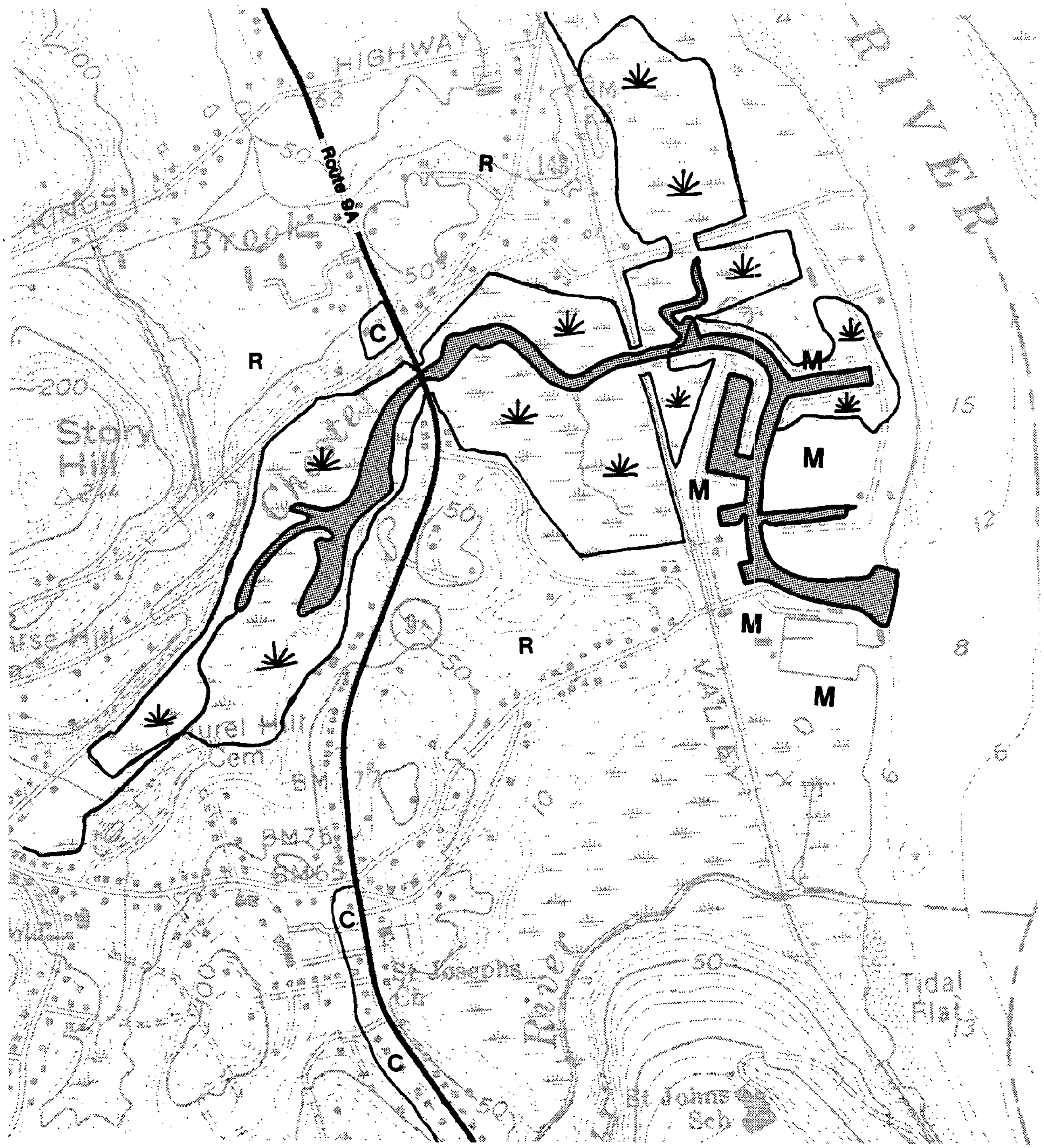
Source: NOAA National Ocean Survey Maps

Basin Hydrology

Regional Drainage Basin: Connecticut River drainage basin

Tributaries to Embayment: Great Brook

Additional Significant Sources of Fresh Water Inflow: Waterhouse Brook, to the north of Pattaconk Creek, drains to the tidal marshes at the mouth of the creek. Burr Brook and Pattaconk Reservoir drain into Cedar Lake, and along with Cedar Swamp form the upper watershed of Pattaconk Creek.



Scale: 1" = 1000'

FIG 8.1 PATTACONK CREEK ENVIRONMENTAL LAND

Legend:

- wetlands
- **A** agriculture
- **R** residential
- **C** commercial/industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Constrictions to Tidal Flow and Circulation:

Structure	% Constriction	Distance from Mouth
Railroad Bridge	75-100	0.5
Route 9A Highway Bridge	75-100	0.9 miles

Sources: U.S. Geological Survey, Connecticut Drainage Basin Gazeteer, 1981; Conn. Dept. of Environmental Protection

Water Quality Conditions

Upstream Water Quality Classification: A

Embayment Water Quality Classification: B

Direct Discharges: None

Sewer Service Area and Discharge Point: The town currently has no sanitary sewers.

Storm Sewer Outfalls: Stormwater sewers are not centralized and drain from several areas of town directly into Pattaconk Creek.

Significant Non-Point Pollution Sources: Stormwater runoff comes from the impervious surfaces, such as roads, small parking lots, and roof tops of the downtown, particularly around the developed shorelines of Upper Pond and Jennings Pond.

Shoreline and Bottom Conditions

Extent of Shoreline Modification: The segment of the creek from the creek mouth to the railroad bridge has been channelized, expanded, and stabilized with bulkheads for a marina facility. Aside from channelization of the main creek banks, there are three connecting channels which have been excavated in the marsh floodplain to expand boat slip capacity. Some of the original wooden bulkheads of the marina are now old and in disrepair. Between the railroad bridge and the Route 9A bridge, the shoreline is undisturbed. Above the Route 9A bridge, the shorefront was altered in small segments for residential property development. Extensive channelization of the creekbed and stabilization of pond shorefront has occurred near and in the center of Chester (See Figure 8.1).

Shoreline and Bottom Conditions (con't)

Significant Areas of Erosion: The most visible signs of erosion during the field inspection were associated with the deteriorating sections of the old marina bulkheads. In some places the timber was completely rotted away, permitting sections of the bank to slough off into the creek.

Bottom Sediment Characteristics: The bottom sediment is very silty with a significant clay component. The river is very turbid, even during periods of low flow, and contributes fine particulates to the creek bottom at slack tide.

Shoaling and Sedimentation Problems: Because of the low, fixed spans of the bridge, navigation is primarily restricted to the lower reaches of the creek below the railroad bridge. The area above that point is heavily silted, and most of the river is no deeper than one to two feet at low tide. Below the railroad bridge, currents tend to scour the bottom along the main channel and maintain greater channel depths. This natural action is supplemented with periodic dredging by the marina operator. Unstabilized side channels tend to be more silted in and thus less navigable. Segments of the main channel with deteriorated bulkheads are also becoming an increasing source of sediment.

Surrounding Lands

Maximum Basin Elevation:

Location	Height
Stony Hill (north shore)	244 ft.
South Shore (west of Route 9A)	224 ft.
Chester Center (north of Ferry Rd)	230 ft.

Topography: The coastal area is flat and gradually rises inland to moderately rolling hills. The north bank of Pattaconk Creek (along Ferry Road) has very steep slopes (50% grade). Both the north and south banks of Jennings and Griswold Ponds also have moderately steep slopes. There are no steep slopes immediately east of Route 9A.

General Vegetation Characteristics: Vegetation east of Route 9A is primarily freshwater wetlands. Development is concentrated west of Route 9A, principally on the less steep slopes. Large trees are therefore most common in areas with steep slopes.

Surrounding Lands
(con't)

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Agawam	fine sandy loam	3- 8	very poor
Canton	very stony fine sand	8-15	very good
Ellington	silt loam	0- 3	very poor
Hinckley and Manchester	gravelly sandy loams	15-35	very poor
Hollis-Carlton	fine sandy loams	3-15	very poor
Hollis-Charlton	complex	15-35	very poor
Merrimac	sandy loam	0- 3	very poor
Merrimac	sandy loam	3- 8	very poor
Paxton	fine sandy loam	3- 8	poor
Paxton	very stony fine sandy loam	8-15	poor
Podunk	fine sandy loam	8-15	very poor
Rumney	fine sandy loam	-	very poor
Saco	silt loam		very poor
Suncook	loamy sand		very low
Typic Udorthents	cut and fill	-	variable
Walpole	sandy loam		very poor
Westbrook	mucky peat		very poor
Windsor	loamy sand	0- 3	very poor
Windsor	loamy sand	3- 8	very poor
Gravel Pit	-	-	-

Shellfish and Finfish Resources

Little is known about the status of shellfish in Pattaconk Creek. As Pattconk Creek is virtually a freshwater system, it is assumed that any species present would be tolerant of low salinities.

The Connecticut Department of Environmental Protection recognizes Pattaconk Creek as a potential anadromous fish pathway and spawning area.

Wetlands

Location (See Figure 8.1): Freshwater marshes are located on both sides of the creek from the marina at the mouth to the segment of the embayment just upstream of the Laurel Hill Cemetery.

The extensive marshes east of Route 9A are part of Connecticut River coastal plain. Immediately west of Route 9A, the marshes form an island in the open water body of the creek and are also located in pockets between the water's edge and the moderate to steep slopes of the shoreline.

Historically, wetlands have been filled and excavated at the mouth of the creek to develop the marina. Additional acreage along the lower reaches was destroyed by channeling the creek. Both the railroad bridge and causeway and the Route 9A bridge were built on former wetlands.

Current Trends: Most wetland filling has stopped. However, if demand for marina space increases as projected, local marine operators may seek to excavate and develop additional marshes to expand slip and storage capacity.

Environmentally Sensitive Areas

Location: The two major sensitive areas are the expansive freshwater tidal marshes along the lower reaches of Pattaconk Creek and Cedar Swamp at the southwestern head of the creek's watershed. Wetlands of this compositon and diversity are essentially confined to the Connecticut River and are a unique and especially valuable type of tidal wetland.

These marshes provide a valuable food source to birds and estuarine organisms as well as serving as a flood retention area and natural biological filters for eroding soils and organic detritus. Cedar Swamp, the largest inland wetland in Chester, is well isolated from development, and provides both valuable habitat and a food souce to wildlife.

B. Land Use Analysis

Current Shoreline and Water Use

Several boating facilities are located at the mouth of the creek and are as follows:

1) Pattaconk Yacht Club
2) Springfield Yacht Club
3) Chester Creek Marina: 160 slips; boat lift; upland storage for 125 boats; diesel fuel and gas available; boat repair service.
4) Parker's Boat Yard: 64 slips; boat lift; some upland storage; boat repair service.
5) Connecticut River Marina (upland storage area borders on embayment): 300 slips; boat lifts; indoor and outdoor boat storage; gas available; boat repairs; boat sales; hardware store; restaurant.

The facilities are moderately to heavily used and represent the largest boating center in the town. The main marina channel is sufficiently deep for 30-40 foot long vessels. Most of the boating is restricted to the creek segment east of the railroad bridge, due to the low elevation of the fixed-span bridge and the minimal depths of the silty upstream channels. Above the Route 9A bridge, the creek is used for passive recreation and some limited use by shallow-draft boats. The millponds near the downtown are no longer harnessed for their water power. Their primary use is now for passive flood control.

Current Upland Use

The uplands surrounding the embayment are used for boat storage, repairs, sales, and car parking. A restaurant serves patrons of the Connecticut River Marina.

Scattered single family houses and several roads surround the marsh floodplain between the railraod line and Route 9A.

A few homes exist on the waterfront immediately west of Route 9A. A roadside restaurant is located right next to the Route 9A bridge.

Housing density increases along the embayment shoreline approaching the center of town and becomes a mixture of residential and commercial use around the three mill ponds (Upper Pond, Jennings Pond, Griswold Pond).

Limited development exists along the upper reaches of the creek and around the head of the watershed such as Cedar Swamp, Cedar Lake, and Pattaconk Reservoir.

Historical and Significant Land Use Changes

Historical photos from 1934 show most of the floodplain east of Route 9A completely inundated with floodwater from the Connecticut River. The only nearby feature in the floodplain east of the railroad line that is not submerged is Fort Hill, which rises 60 feet above mean sea level. Assuming that these flood conditions are normal, such conditions would have severely restricted development in low areas.

Construction of several additional dams on the Connecticut River since the 1930's controlled extreme flow conditions and permitted some development of the floodplains. Aerial photographs from 1951 show the initial development of a marina in the lower reaches of Pattaconk Creek, consisting of a series of boat tie-ups parallel to a natural shoreline. By 1970, sections of the creek east of the railroad had been stabilized. Part of the floodplain was being filled for ancilliary facilities, while other areas were being cleared in preparation for excavation of side channels. By 1980, the side channels had been fully excavated and piles had been driven for boat slips. The 1980 aerial photographs also showed a more intensive use of the upland areas as compared to the 1970 photos.

Conversely, the waterfront of the upper reaches of the creek is less intensively used today than in the past. The mills that once relied on water power have been replaced by commercial and service-related businesses, and industrial development in town is located away from the floodplain. Today, historic renovation is improving the downtown commercial area and making it more attractive for business. So, in some respects, land along the mill ponds is more intensively used than 20 years ago, as new tenants move into formerly abandoned buildings. Some new houses have been built along Pattaconk Creek and this trend is expected to continue as the town grows.

Public Access and Recreation Opportunities

The marinas and yacht clubs offer a wide range of boating opportunities with easy access to the Connecticut River. The Chester Creek Marina offers a 20 foot wide boat ramp for public use with a minimal use charge.

The public can also gain access to the creek at the Route 9A bridge, although there are no recreational facilities at this location.

Public Access and Recreation Opportunities (con't)

Visual access to the creek is afforded from several roads at the edge of the floodplain, as well as along the ponds in the center of town.

The headwaters of the creek fall within Cockaponset State Forest. Cedar Lake Road and several light duty service roads provide access to this large tract. Water recreation is discouraged by the state, because the park water bodies serve as local reservoirs for public water supply.

C: Problem Identification

Local Departments and Offices Consulted

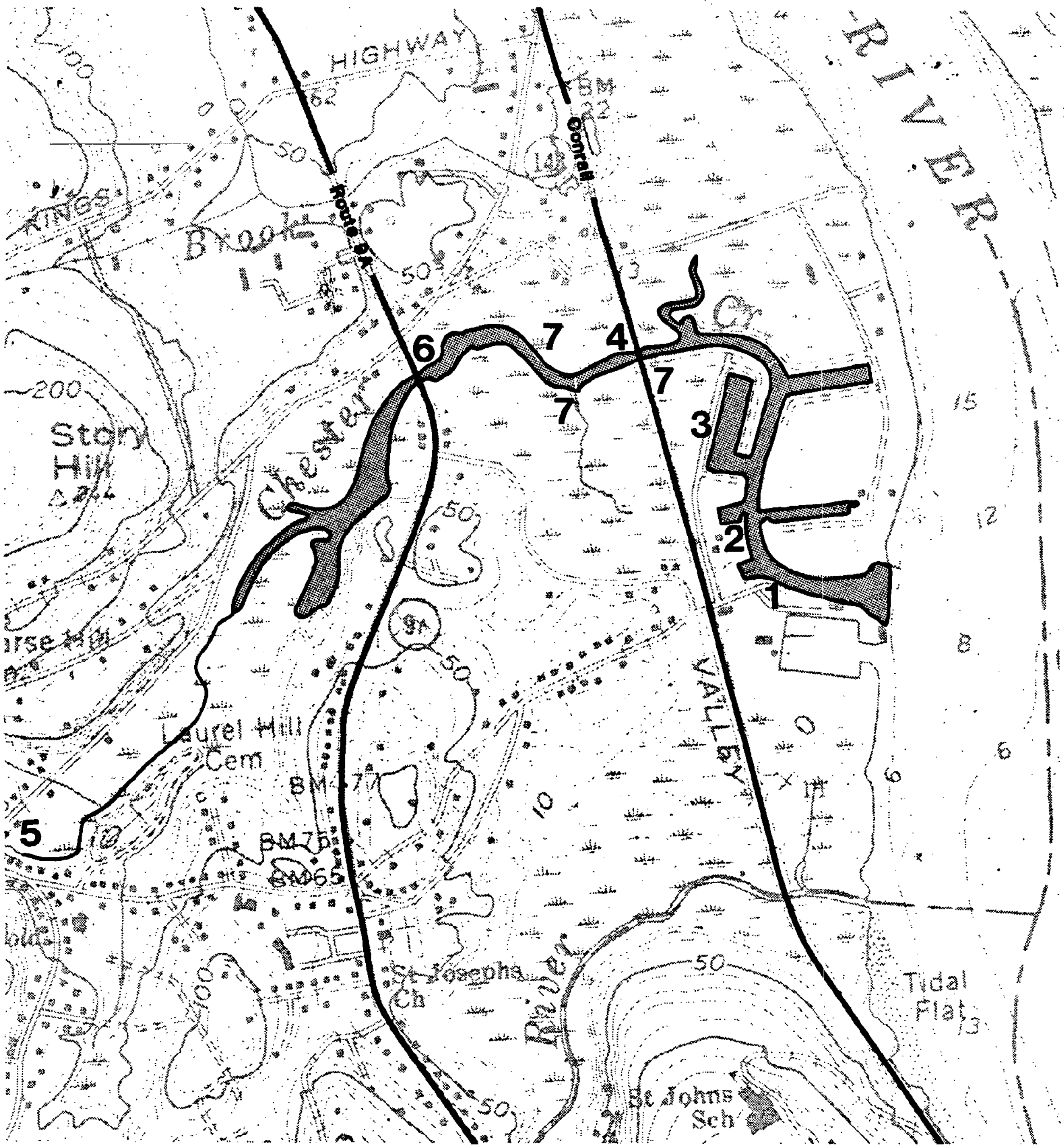
Chester Conservation Commission and Chester Planning and Zoning Commission.

Response from Questionnaires and Local Meetings

The two major problems cited were siltation and pollution. Town officials agreed that these two problems were of moderate concern. Erosion was noted as a minor problem (See Figure 8.2).

The siltation within the creek and marinas is believed to be mostly natural though it may be aggravated by the irregular configuration of the marina. The natural erosion component is caused by upstream soil erosion, fluvial sediment transport, and some erosion of stream banks below the Conrail bridge. Officials were uncertain as to how long the siltation problem had existed, and did not know whether the problem had become more or less severe over time. There was a general feeling that the problem would remain the same or become more severe in the future.

Pollution of the creek is believed to be caused by failing septic systems and direct discharge of stormwater and sewerage into the embayment. Though little is known about historic changes in severity of the problem, it is thought that the water pollution problem dates back over fifty years. The local water pollution control authority is currently formulating plans to construct a sewage treatment system to eliminate point source discharges and faulty septic systems. The projected completion date of the project is sometime during 1982.



Scale: 1" = 1000'

FIG. 8.2 PATTACONK CREEK ENVIRONMENTAL PROBLEMS

Problem Areas

1. Eroding shoreline
2. Decaying wooden bulkheads
3. Marina debris (crankcase oil, paint, scrap metal)
4. Railroad bridge constricts tidal flow
5. Stormwater runoff from downtown center
6. Highway bridge constricts tidal flow
7. Unique tidal wetlands (freshwater)

Response from Questionnaires and Local Meetings (con't)

Though no specific reference was made to a tidal constriction problem in the embayment, the Conservation Commission did indicate that removing the railroad and Route 9A bridges would reduce tidal constriction and reduce the siltation problem. The Commission also noted that the condition of the tidal marshes around the bridges was excellent and showed high productivity. It should be noted here that patterns of siltation associated with tidal constrictions above the railroad bridge are of minor concern, because of the limited use of the upper reaches of the creek for navigation and other purposes.

Results of Field Survey and Research

The field survey confirmed the shallow bottom conditions within the creek west of Route 9A. The tide was nearly out at the time of the visit and large areas of intertidal flats and low-lying wetlands were fully exposed. Though the water was very murky, it appeared that a significant portion of the bottom was no more than one to two feet below MLW.

The segment of the creek between Route 9A and the railroad line was deeper and meanders within a wide, well-vegetated floodplain. It is difficult to infer recent trends in this segment, but it is likely that the construction of the bridges permitted marsh vegetation in the floodplain to encroach on the creek channel. Large debris was scattered in the floodplain vegetation, indicating that exceptionally high tides and storms flood much of the floodplain. The outer edges of the floodplain are becoming more like uplands as mature vegetation colonizes these areas.

The mouth of the creek, east of the rail line, was filled and channelized during marina construction. Part of the main channel immediately east of the railroad bridge has been stabilized recently with new bulkheads. This renovated area of the marina is now used for tying up large boats (greater than 30 feet). The less improved sections of the marina are further downstream, near the confluence of the Connecticut River. There, the old bulkheads of the main channel are so deteriorated that large sections of planking are severely rotted or absent. In some instances the now exposed banks have eroded inland up to seven feet. The eroded sediment is presumed to contribute to the channel's siltation problem.

Results of Field Survey and Research (con't)

Several side channels have been excavated to increase the slip capacity of the marinas. The shoreline of these channels has not been stabilized and shows obvious signs of erosion. These side channels are more susceptible to siltation because of lower water velocity and less frequent flushing.

The upland development surrounding the marina channels is limited to several work sheds, a few boat launch lifts, boat storage areas and junk piles of old machinery and discarded boat supplies. Several of the engine blocks appeared to be leaking crank case oil and could be a minor source of pollution. Overall, the upland areas are only moderately used. If business continues to expand, marina operators could more intensively develop existing upland areas to make more efficient use of already filled wetlands areas. This should reduce the need to fill and destroy additional wetlands.

D: Problem Analysis

Siltation and Flow Constriction

The steep slopes and fine soils of the uplands surrounding the middle and upper reaches of Pattaconk Creek contribute to the siltation problem of the lower reaches. Prior to construction of the railroad and Route 9A, it is likely that the embayment exhibited sufficient flushing. Peak stream flow conditions probably flushed much of the silt out into the Connecticut River, and periodic flooding spread fine silt over the inundated creek floodplain.

In addition, construction of the two bridges has increased tidal flow constriction of the creek, and now causes more frequent inundation of the floodplain upstream of Route 9A. The Route 9A bridge is approximately one-third the natural width of the creek channel and backs up floodwaters during peak flow periods. The solid fill causeway and bridge abutments of the railroad further restrict movements of water through the floodplain during flood conditions. As a result, the floodplain above the railroad causeway has become a sizeable reservoir for fine sediment. Though silt-laden waters from the Connecticut River may contribute to the siltation within the creek, most of the silt appears to come from upstream sources.

Deteriorating bulkheads along the developed waterfront aggravate the siltation problem. Tidal action and flood conditions erode the exposed marina shoreline and deposit the sediment into navigational channels. This forces frequent dredging by marina operators to maintain Connecticut River boating access.

Pollution

Most of the creek's pollution comes from failing septic tanks and nutrient-loaded stormwater runoff. The septic tanks fail primarily because they are located in areas with steep slopes and poor soils. The steep slopes (except areas of rock ledge) are composed of gravelly, sandy loams, and provide little filtering of waste effluent, particularly the nitrogenous wastes. These wastes are also found to flow to the surface on steep slopes (over 15 percent grade). The gradient of Hinckley and Manchester gravelly soils in Chester exceeds 15 percent, and ranges up to 35 percent. Such conditions provide little opportunity for effective on-site rehabilitation of failing systems. Chester is countering this problem by planning for a small-scale wastewater treatment system. No final details are available presently, but construction is expected to proceed sometime in 1982.

Pollution from stormwater runoff is more difficult to correct, because of its diffuse nature. Some of it drains into the creek from streets and parking lots via old storm drains, while other runoff simply drains down nearby slopes. Accelerated erosion and nutrient loading are common impacts from the runoff. In Chester, many of the stormwater drains and outfalls are old and typically date back to the nineteenth or early twentieth century.

PROBLEM SUMMARY

Pattaconk Creek

1.	Flow Constriction	Major	(b)
2.	Siltation in the Upper Reaches	Minor	(b)
3.	Siltation in the Lower Reaches	Major	(a)
4.	Pollution	Minor	(b)

KEY: (a) Conditions becoming worse (b) No change (c) Conditions improving

CHAPTER 9 OLD SAYBROOK EMBAYMENTS

INTRODUCTION

The Town of Old Saybrook is located in Middlesex County and forms the western bank of the mouth of the Connecticut River. The community has an area of 15.2 square miles, of which 75 percent drains directly to Long Island Sound, while the remaining 25 percent falls within the Connecticut River drainage basin. Population of Old Saybrook has increased 9.8 percent from 1970 to 1978 (8,468 to 9,300 respectively). The increase is more than twice the state average and attests to the popularity of the historic coastal community.

Most of the town's shoreline fronts on the Connecticut River and includes two developed peninsulas: Saybrook Point and Fenwick (see Figure 9.1). Directly north of these two communities lies the expansive tidal marshes of Ragged Rock Creek. The Conrail line crosses the northern section of the marsh and is closely paralleled by Interstate 95. Both the railroad and I-95 cross the river approximately three miles north of the river mouth (see Figure 9.1). Another large marsh about one-third the size of Ragged Rock Creek is bordered by Ferry Point and Ayres Road.

The southern shore of Old Saybrook faces Long Island Sound. The low lying coastal plain was once part of the Connecticut River's large alluvial delta during the glacial melt. Changing sea level, large scale deposition and longshore currents have reworked the substrate to form large lowland areas drained by a vast network of tidal creeks. The four main tidal creeks that drain the lowlands in Old Saybrook are Mud Creek, Oyster River, Back River and Plum Bank Creek.

Old Saybrook's coastal plain has been significantly changed by development. The Conrail line runs along the northern edge of the coastal plain, impounding freshwater systems and disrupting the natural flow of freshwater to coastal estuaries. The U.S. 1 roadbed and other parallel streets have caused similar effects just south of the railroad (see Figure 9.1). Several neighborhoods, such as Saybrook Manor and Knollwood, have been built on filled wetlands. The overall effect has been to constrict natural flow and to increase surface runoff from the impervious surfaces of development. The cumulative impact of these drainage changes is degraded water quality, a decline in biological productivity, and increased soil erosion and embayment deposition.

Approximately 50 percent of Old Saybrook's Long Island Sound shoreline remains in a fairly natural state. It is the human activity at the interface between development and natural lands that tends to impact the remaining natural resources of the area. The drainage basins of Mud and Haggar Creek drain into Indiantown Harbor and are the focus of investigation in this chapter. These basins typify the type of interface just described and were chosen because of reported sedimentation problems, poor circulation and eutrophication.

INDIANTOWN HARBOR

A: Physical Description

Location

The embayment is located on the Long Island Sound shoreline betwen Cornfield Point (near Knollwood) and Old Kelsey Point (see Figure 9.1). Directly to the east of the Harbor is Great Hammock Beach and Plum Bank Beach. Chalker Beach is to the west. The harbor is approximately 3 miles from the center of Old Saybrook. U.S. 1 parallels the harbor shoreline 0.4 miles to the north of the embayment.

Site Orientation and Configuration

The harbor is very wide, open and exposed from the south. Private breakwaters enclose the outer harbor on both the east and west sides of the mouth of Mud Creek. The entrance to the creek between the breakwaters is approximately 140 feet wide and widens to 450 feet inside the breakwaters. Approximately 650 feet up the creek, the bed narrows again and water access is maintained through a privately dredged channel.

Tidal Data

Mean tidal range -	4.1 ft.
Spring tidal range -	4.7 ft.
Mean tide level -	2.0 ft.

Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth:	0-4 ft. (MLW)
Channel Depth:	2-4 ft. (MLW)

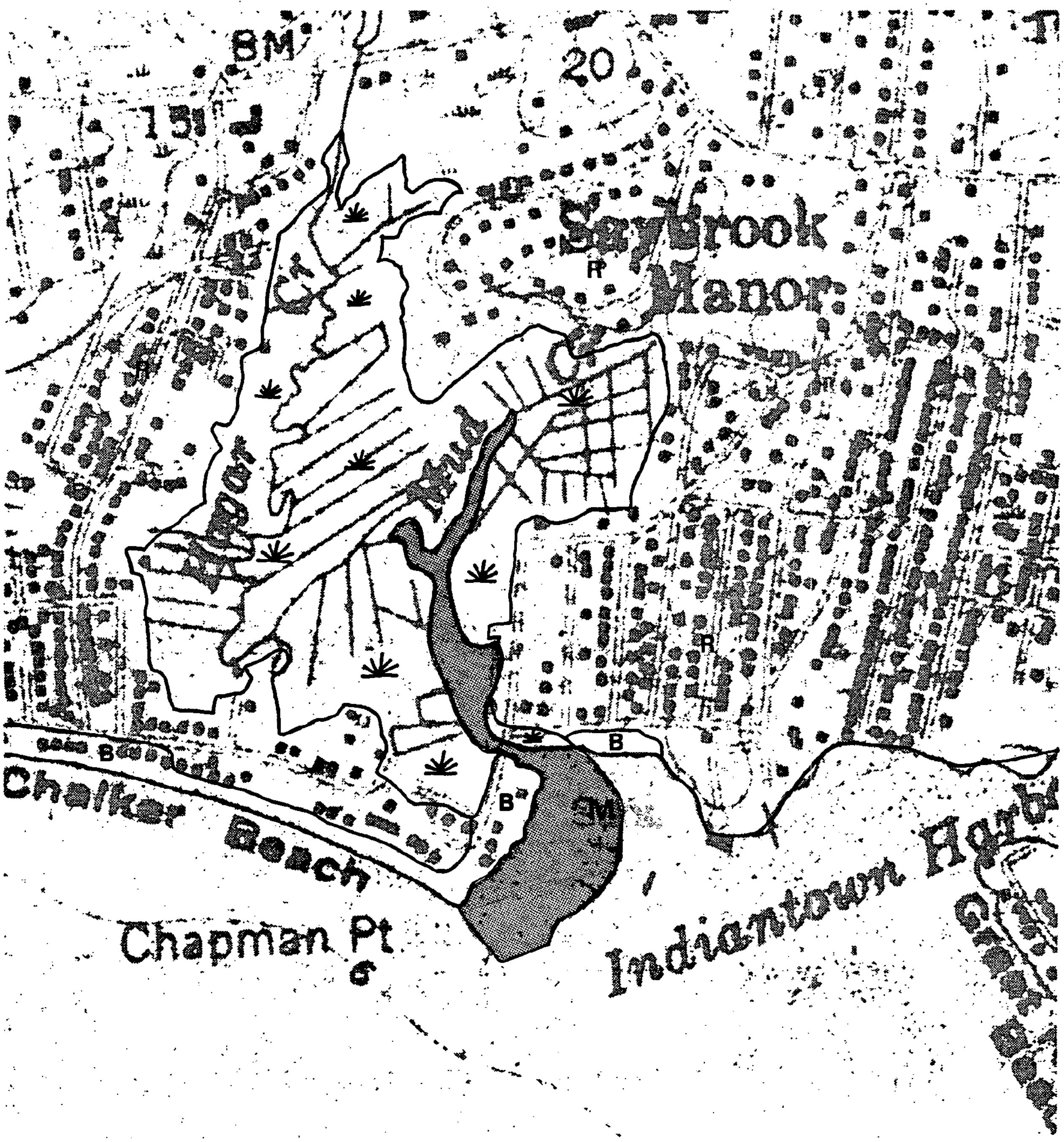
Additional Comments: A privately-maintained channel provides boating access from the marina to Long Island South (see Figure 9.1). A jetty was extended in 1981 to help prevent shoaling at the mouth and improve storm protection for boats.

Source: NOAA National Ocean Survey Maps, Air Photo Analysis.

Basin Hydrology

Regional Drainage Basin: Central Connecticut Drainage Basin

Tributaries to Embayment: Mud Creek
Haggar Creek



Scale: 1" = 666'

FIG. 9.1 INDIANTOWN HARBOR ENVIRONMENTAL LAND USE

Legend:

- wetlands
- **A** agriculture
- **R** residential
- **C** commercial/industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Basin Hydrology (con't)

Other Sources of Fresh Water Inflow: Some direct runoff from the Indiantown residential development and drainage from U.S. 1.

Constrictions to Tidal Flow and Circulation:

Structure	% Constriction	Distance from Mouth
East and West Breakwaters	75-100	At Mouth
Highway Bridge	50-75	700 ft.

Sources: U.S. Geological Survey, Connecticut Drainage Basin Gazeteer, 1981; Conn. Dept. of Environmental Protection

Water Quality Conditions

Upstream Water Quality Classification: B/A

Embayment Water Quality Classification: SB/SA

Direct Discharges:

Source	NPDES Permit #	Waste Characteristics
R.R. Donnelley and Sons Co.	CT 0002038	Thermal discharge, large septic system, variable pH

Sewer Service Area and Discharge Point: The area around the embayment is well sewered, including Saybrook Manor and Chalker Beach.

Storm Sewer Outfalls: None known

Significant Non-Point Pollution Sources: Residential runoff

Shoreline and Bottom Sediment Conditions

Extent of Shoreline Modification: The lower reaches of Mud Creek have been stabilized with a bulkhead and seawall on the east side, and a series of groins and a seawall on the west side. The extent of shoreline modification upriver of the Indiantown community bridge is limited to a bulkheaded docking area on the east side of the creek. Jetties extend from both the east and west sides of the mouth of Mud Creek.

Shoreline and Bottom Sediment Conditions (con't)

Significant Areas of Erosion: The beach on the west shore near the mouth of Mud Creek is stabilized with groins in an attempt to stem a steady loss of sand from that shorefront area. There also appears to be some minor erosion of the river banks just above the bridge where the east shore bulkhead ends.

Shoaling and Sedimentation Problems: According to a representative of the Indiantown Association, navigation of the main channel has been compromised by a constant shoaling problem at the mouth of the harbor. In the spring of 1981, the Association extended the western breakwater in an attempt to solve the problem. The extension was designed by W. Frank Bohlen of the University of Connecticut Marine Sciences Institute, after analyzing data gathered during 1977 through 1979.

Bottom Sediment Characteristics: The sediment within the river is fine with a moderate clay content. The sediment becomes progressively coarser approaching the mouth, grading from silty clay to sand. A typical sample of the sand can be found on the eroding western shoreline near the groins at the mouth of the river.

In a technical report, Frank Bohlen of the University of Connecticut asserted that the coarser material is carried into the outer harbor area by longshore transport, while the fine material comes from the tidal creek. Though the sand transport system appears to be driven by tidal currents, Dr. Bohlen believes wind-generated waves play a more important part in the process.

Patterns of sediment transport appear to be seasonal. For most of the year east to southeast storms appear dominant, transporting materials east to west. West to east transport occurs during the more common westerly winds, but in much smaller quantities. The western breakwater slows longshore transport, while onshore waves sweep sediment into the mouth of the harbor. The most prevalent wave approach is from the south, providing more material transport into the harbor.

Surrounding Lands

Maximum Basin Elevation:

Location	Height
Haggar Creek; upper reaches	30 ft.
Mud Creek; upper reaches	10 ft.

Surrounding Lands (con't)

Topography: The area is part of the coastal plain and is relatively flat.

General Vegetation Characteristics: There are large expanses of wetlands surrounding Indiantown Harbor. Indiantown Village is landscaped with trees and shrubs.

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Adrian and Palm	muck	-	very poor
Agawam	fine sandy loam	0-3	very poor
Agawam	fine sandy loam	3-8	very poor
Beaches	-	-	very poor
Hinckley	gravelly sandy loam	0-3	very poor
Hollis Charlton	fine sandy loam	3-15	very poor
Merrimac	sandy loam	0-3	very poor
Merrimac	sandy loam	3-8	very poor
Ridgebury Whitman and Leicester	extremely stony fine sandy loam	0	very poor
Montauk	very stony fine sandy loam	3-8	poor
Scarboro	muck	-	very poor
Sudbury	sandy loam	-	very poor
Typic Udorthents	cut and fill	-	variable
Walpole	sandy loam	-	very poor
Westbrook	mucky peat	-	very poor
Windsor	loamy sand	0-3	very poor

Shellfish and Finfish Resources

Clams are found predominantly in the outer part of the harbor, while for the first time in many years, oysters are re-establishing themselves upstream of the Mud Creek bridge. All shellfish areas in Indiantown Harbor and its tributaries are closed.

Wetlands

All of the wetlands are located north of the Mud Creek bridge and are situated in the floodplain of Mud Creek and Haggar Creek (See Figure 9.1). The tidal portion extends to about 300 feet south of U.S. 1. Freshwater wetlands extend inland to the Conrail line.

The wetlands are part of an expansive undeveloped coastal plain. They provide a food habitat and serve as an important natural biological filter for soil, detritus, and excess nutrients.

The Indiantown site was originally wetlands until the early twentieth century, when it was filled as part of a development scheme. Additional acreage was planned to be filled, but was halted by the Depression of the 1930's. Lack of interest prevented development from continuing in the 1950's, and the Connecticut Wetlands Act has strongly discouraged development since the late 1960's.

No additional wetlands should be filled if the wetlands regulations are actively enforced, as there appears to be little apparent local interest in further development of these areas.

Environmentally Sensitive Areas

The wetlands of Haggar and Mud Creeks, because of their large size, are particularly valuable habitat. The wetlands are described in sub-section A-10. (See Figure 9.2 for their specific location).

B: Land Use Analysis

Current Shoreline and Water Use

The enclosed harbor is the site of the Indiantown Association's marina, and is also used for swimming and recreation by waterfront property owners (see Figure 9.1). Bathing beaches are located immediately outside the harbor, both east and west of the breakwaters. Much of the sand of the eastern-most beach of the community is actually former dredge spoil from the harbor mouth.

Current Shoreline and Water Use (con't)

The Indiantown marina is cooperatively owned by the Neighborhood Association, and consists of a dock and a series of floating finger piers. The finger piers and other seasonal equipment are stored in the boathouse lot near the Mud Creek bridge. A utility dock next to the bridge is used to launch and take out the finger piers.

Current Upland Use

Almost all of the land use surrounding the embayment is residential, except for the community boathouse and parking lot storage area. There is a small children's playground next to the eastern beach.

Historical and Significant land Use Changes

The developed land surrounding the embayment used to be wetlands. Site development started in the 1920's with a grid of roads through the wetlands, and the area was gradually filled in with houses. As the development grew in size, the Neighborhood Association chose to develop amenities such as swimming beaches, the marina and the clubhouse. In the 1960's, one eastern beach at Indiantown was extended seaward approximately 150-200 feet with sandy dredge spoils. The former beach was elevated by filling, and is used as a children's playground.

The east and west jetties at the mouth of Mud Creek were designed to form an enclosed harbor. This had significant effects on both the tidal flushing of the creek and the longshore transport of sediment. During the 1970's, the Association upgraded their marina facility and constructed finger piers inside the eastern jetty.

Most of the amenities of Indiantown are water-oriented and have gradually increased the intensity of use of the waterfront. Today, the planned development is almost complete and supported by the road network used to initially develop the area.

Public Access and Recreational Opportunities

The land surrounding the embayment is private. Use of waterfront facilities is restricted to homeowners and friends of the Association. Shore areas that are covered by tidal action are owned by the state and available for public use.

C: Problem Identification

Local Departments and Offices Consulted

Old Saybrook Waterfront Commission
Raymond F. Varley, Representative of Indiantown Association

Response from Questionnaires and Local Meetings

The Indiantown Association noted that the harbor experiences a severe sedimentation problem, a moderate erosion problem and a minor natural loss of wetlands. Constriction of tidal flow, eutrophication and a decline in estuarine productivity were also mentioned.

Pollution was not mentioned as a cause of the eutrophication problem and productivity decline. In addition, no specific examples of these two problems were offered as supportive evidence.

Erosion, sedimentation and wetlands loss are all believed to be natural phenomena. These problems are believed to have existed for at least 25 years and are expected to become more severe in the future.

Sedimentation is believed to be the most significant problem, and hopefully will be reduced through construction of the western breakwater extension. Despite shellfish and finfish losses, the condition of the tidal marshes remains excellent and their productivity is still rated high.

Results of Field Survey and Research

The field survey confirmed the shoaling problem at the mouth of the harbor, and two incidents of erosion (see Figure 9.2). One erosion site is a beach on the western shore inside the jetties. Several groins have been erected in an attempt to trap sand and stabilize the shoreline in this area. The second site of erosion is just north of the Mud Creek bridge and community boathouse on the eastern side of the creek (see Figure 9.2). At this point, the shoreline appears to have recently moved inland at least 10 feet.

The site visit also provided an opportunity to look at the new jetty construction. The jetty has been extended approximately 200 feet at an angle of about 20^{o} east of its original alignment. This extension forms a slightly narrower inlet and places the end of the jetty at an angle to approaching storm waves, rather than facing them head on.

Scale: 1" = 666'

FIG. 9.2 INDIANTOWN HARBOR ENVIRONMENTAL PROBLEMS

Problem Areas

1. Closed to shellfishing
2. Jetties constrict tidal flow
3. Beach erosion
4. Accelerated sedimentation behind breakwater
5. Shore erosion
6. Bridge constricts tidal flow

Results of Field Survey and Research (con't)

As mentioned in an earlier section, University of Connecticut marine scientist W. Frank Bohlen was hired by the Indiantown Association to investigate the inlet shoaling problem. During 1977 to 1979, he gathered and analyzed data and outlined three alternative solutions. Alternative #1 included only dredging at a frequency of once every five years. This was the frequency calculated as necessary to maintain a depth of 2 to 4 feet. Alternative #1 was discouraged due to the rising costs of dredging and problems finding suitable dredge disposal sites.

Alternative #2 provided for both extension of the breakwater and dredging, while Alternative #3 went one step further and also included the removal of the boulder field directly off the western breakwater. Ultimately, the Association chose Alternative #2 because of cost and long-term impacts. Dr. Bohlen did recommend, however, that the Association conduct field surveys to determine the effects of the offshore rocky shoal area and seriously consider removing that formation also.

D: Problem Analysis

Circulation Reduction and Sedimentation

The breakwater was extended at an angle to purposely reduce the cross-sectional area of the harbor inlet in an effort to accelerate tidal flows and maintain a deeper channel. Though this strategy may succeed at the mouth (where the Association has noted chronic shoaling), it may also further reduce tidal exchange inside the harbor. Reduced tidal exchange may serve to further localize pollution problems, thus allowing a further degradation of water quality. Also, reduced circulation may decrease the average salinity of the embayment system, leading to a change in the species composition of the estuary.

It is also recognized that the Association's marina is located in an area of the harbor that is particularly susceptible to sedimentation. The objective of the breakwater extension is to minimize the transport of coarse material into the harbor. In the process, however, the extension may create conditions more favorable for the deposition of finer material transported to the marina site from the two tributary creeks. The magnitude of this potential problem is difficult to measure without further research.

Erosion

An unintended effect of the breakwater extension may be to further erode the western shoreline of the harbor. Sand flow to that shoreline had already been significantly reduced by the existing breakwater, and the extension may aggravate the problem. The result may be increased scouring and perhaps a further recession of the shoreline.

Wetlands loss north of the Mud Creek bridge is also caused by erosion and is probably caused by natural movement of the creek channel. The eastern shore is stabilized, so it does not erode at all. The constriction of the channel, caused by the bridge probably increases local erosion.

Erosion of the east bank of wetlands upstream of the utility dock is occurring precisely where the bulkhead ends. This pattern of erosion is probably the result of natural channel erosion acting on an unstabilized section of shoreline. Trying to correct the problem by bulkheading the eroding segment might shift the focal point of erosion upstream.

Water Pollution and Eutrophication

Though no specific examples of water pollution problems or eutrophication were cited by the Association or recorded during the field survey, there are several water pollution problems that may exist in the embayment. First, Haggar and Mud Creeks drain from inland areas that may be contributing pollutants either from non-point sources such as U.S. 1 highway runoff, or from point sources such as effluent from failing septic systems. These upstream sources may be responsible for the B water quality classification that exists for this water body. A second source may be non-point pollution from the lower reaches of the embayment, specifically Indiantown and other adjacent neighborhoods that border on the embayment marshes and creeks. Once again, the contamination could be from failing septic systems, or stormwater runoff carrying pollutants from non-point sources.

Once it reaches the embayment, any pollutant can be concentrated in the embayment due to the reduced flow exchanges. This serves to concentrate pollutants over time and magnifies their impacts to the ecosystem. Since no obvious signs of pollution or eutrophication were observed, however, it is difficult to accurately identify existing problems without further research.

PROBLEM SUMMARY

Indiantown Harbor

1.	Circulation Constriction	Minor	(a)
2.	Sedimentation	Moderate	(b)
3.	Erosion	Minor	(b)
4.	Water Pollution and Eutrophication	Minor	(b)

KEY: (a) Conditions becoming worse (b) No change (c) Conditions improving

CHAPTER 10 WESTBROOK EMBAYMENTS

INTRODUCTION

The Town of Westbrook, Middlesex County, is located within the Connecticut River Estuary Region. Incorporated in 1840 the town's 16.2 square miles support a current population of approximately 4,900 persons. Westbrook maintains a marine oriented economy with a capacity of close to 2,000 boat slips at 15 area marinas. A total of more than 25,000 trips were logged by recreational craft through the mouth of the town's two major rivers, the Patchogue and the Menunketesuck.

The town's population increases significantly during the summer months due to an inflow of summer residents and boaters. In 1970, there were an estimated 1,960 seasonal housing units, on lots as small as 1/4 acre, located in the town. Most of these are concentrated in an area south of Route 1, near the waterfront. More recently, the trend has been for conversion of these cottages for year-round use, which in many cases taxes existing sanitary disposal facilities.

The major part of the town is drained by the Patchogue River, with the Menunketesuck river draining the western part of the town. These rivers join at their mouths and share a common channel to Long Island Sound.

The geology of the area is divided into two major sections; a coastal plain area and an uplands (above 50 foot elevation). The highest elevation in the town, 220 feet, is found in the town's northwest corner.

Both the Patchogue and Menunketesuck Rivers were considered for inclusion on this study. The Patchogue River was deleted from detailed study because the river has been extensively and recently evaluated by the Army Corps of Engineers for dredging studies. The Menunketesuck River has been included, and analysis of the river follows.

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MENUNKETESUCK RIVER

A: Physical Description

Location

The mouth of the river is on Long Island Sound, approximately 3 miles east of the center of Clinton and approximately 4 miles west of Old Saybrook (See Figure 10.1). The lower reaches are crossed by U.S. 1 and approximately 0.5 miles north of that point the river is crossed by the Conrail line. West Beach lies immediately to the east of the river mouth and Grove Beach lies to the west.

Site Orientation and Configuration

Westbrook Harbor lies at the confluence of the Menunketesuck and Patchogue Rivers. The river is approximately 300 feet wide near the mouth and narrows to approximately 200 feet as it approaches the intersection of U.S. 1. Horizontal clearance under the bridge is only about 55 feet. Though the river is ralatively straight south of the U.S. 1 bridge it meanders significantly north of that point.

Tidal Data

Mean tidal range -	4.1 ft.
Spring tidal range -	4.7 ft.
Mean tide level -	2.0 ft.

Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth:	0.5 ft. (MLW)
Channel Depth:	5 ft. (MLW)

Additional Comments: A channel is privately maintained to the river mouth. Federal projects maintain a 6-1/2 foot MLW channel to Long Island Sound.

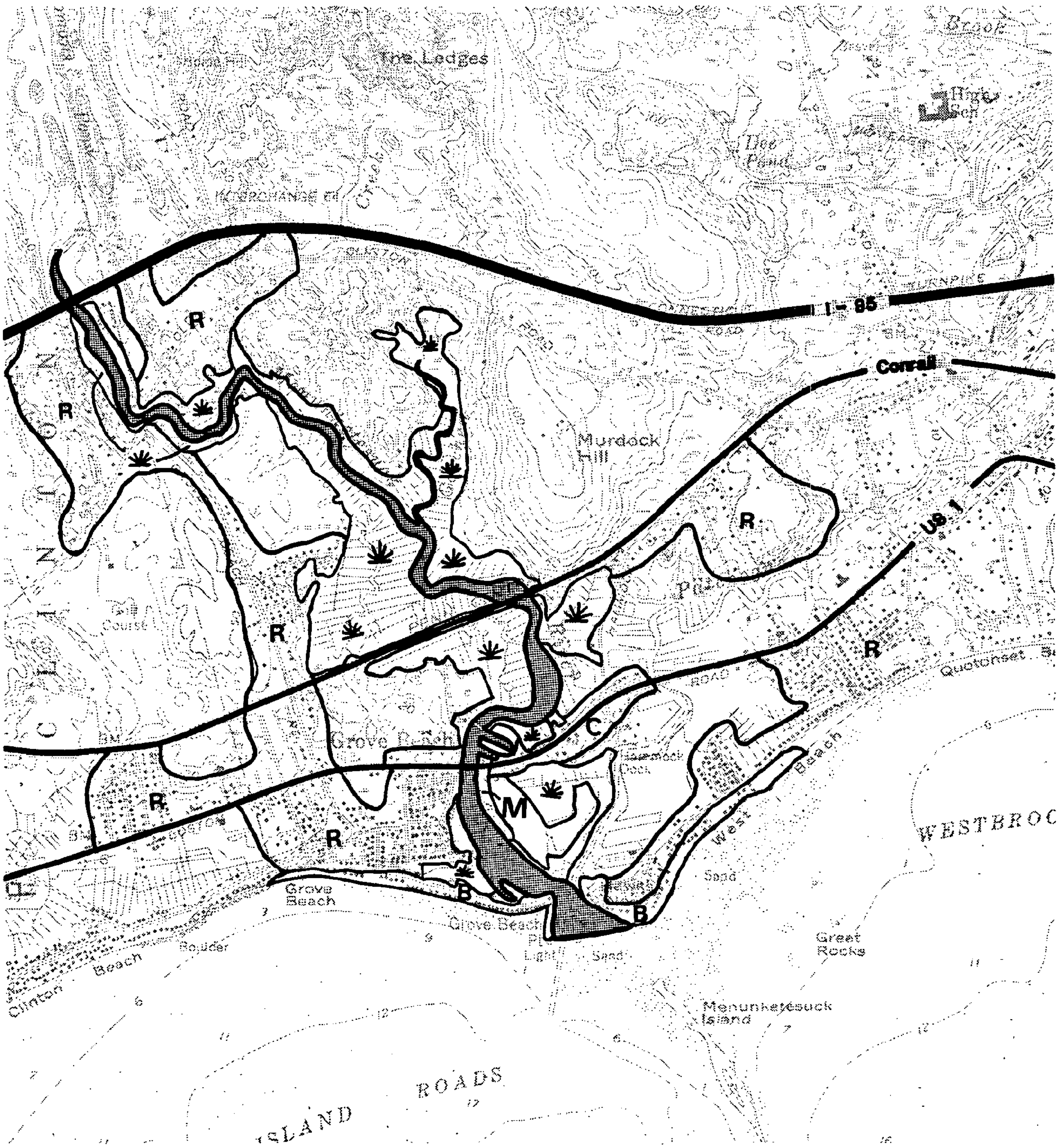
Source: NOAA National Ocean Survey Maps

Basin Hydrology

Regional Drainage Basin: Central Connecticut Coastal Basin
Embayment Basin Area: 17.59 square miles at mouth

Tributaries to Embayment: Gatchen Creek
Plane Brook
unnamed brooks

Other Sources of Freshwater Inflow: Surface runoff from developed upland areas, highways and railroad right-of-way.



Scale: 1" = 2000'

FIG 10.1 MENUNKETESUCK RIVER ENVIRONMENTAL LAND USE

Legend:

- wetlands
- A agriculture
- R residential
- C commercial/industrial
- B beach
- M marina
- S shellfish beds
- → public access

Constrictions to Tidal Flow and Circulation:

Structure	% Constriction*	Distance from Mouth
Route 1 Highway Bridge	0-25	1000 feet
Railroad Bridge	0-25	2000 feet

Sources: U.S. Geological Survey Connecticut Drainage Basin Gazeteer, 1981 Conn. Dept. of Environmental Protection

Water Quality Conditions

Upstream Water Quality Classification: A, upstream of Interstate 95

Embayment Water Quality Classification: SB/SA

Direct Discharges: None

Sewer Service Area: Entire residential development adjacent to river are classified as "problem areas". The Grove Beach neighborhood and development along Route 1 (east of the river) have not been sewered. The Town of Westbrook has developed a sewer avoidance program. North of the railroad bridge there are no problem areas identified.

Storm Sewer Outfalls: None

Significant Non-Point Pollution Sources: In addition to the problem areas listed above, the large number of marine users represent a significant non-point pollution source.

Shoreline and Bottom Conditions

Extent of Shoreline Modification: The shoreline between the embayment mouth and railroad bridge has been extensively modified, and boatyards, marinas, dredge spoils, piers and docks have been constructed. The shoreline is undisturbed north of the railroad bridge (See Figure 10.1).

Significant Areas of Erosion: The river bank is eroding in various locations, with the most significant erosion occuring near the railroad bridge (See Figure 10.1).

Shoreline and Bottom Conditions (con't)

Shoaling and Sedimentation Problems: The natural meandering configuration of the river creates sediment traps in areas of recent dredging (marinas). These areas have been dredged on a regular basis by marina operators. In addition, the Menunketesuck River has been dredged (under federal permit) four (4) times since 1968. The most recent dredging occurred in 1976.

Bottom Sediment Characteristics: Bottom sediment samples were taken by the Army Corps of Engineers (ACE) prior to dredging in 1976. Results show bottom sediments outside the mouth of the river to be dark grey silts and fine sands with shell fragments. Sampling at the river mouth indicated black fine sand and organic silts. These samples were similar to that of other harbors along the north shore of Long Island Sound. The organic content was indicated by the ACE as typical of productive, sheltered estuaries that receive considerable amounts of organic detritus from tidal wetlands and upland sources.

Surrounding Lands

Maximum Basin Elevation:

Murdock Hill (to east)	110 feet
Salt Meadow Wildlife Refuge (northeast)	60 feet
Hill West of Route 145	50 feet
Near Headwaters	450 feet

Topography: Steep slopes are found in the area of the Salt Meadow Wildlife Refuge, and northeast of the railroad tracks on Murdock Hill. The remaining area is relatively level (See Figure 10.1).

General Vegetation Characteristics: Extensive wetlands can be found north of the railroad bridge and on the west bank of the river between the highway and railroad bridges. Most of the surrounding uplands are forested. In areas south of the bridge, the shores are lined with a saltmarsh fringe. The upland areas have been extensively modified, and have few vegetated areas beyond residential lawns.

Soils:

Name	Characteristics	Slope %	Septic Tank Suitability
Adrian and Palms	Mucks	-	very poor
Agawam	fine sandy loam	3-8	poor
Beaches	-	-	very poor
Canton	very strong fine sandy loam	3-8	good
Canton	very strong fine sandy loam	8-15	good
Carlisle	muck	-	very poor
Hinckley	gravelly sandy loam	3-15	poor
Hollis-Charlton	complex	15-35	poor
Hollis	rock outcrop	3-15	very poor
Merrimac	sandy loam	0-3	poor
Paxton	fine sandy loam	3-8	poor
Paxton	very stony fine sandy loam	3-8	poor
Paxton	very stony fine sandy loam	8-15	poor
Paxton & Broadbrock	extremely stony soils	15-35	poor
Ridgebury, Whitman and Leicester	extremely stony fine sandy loam	-	very poor
Scarboro	muck	-	very poor
Sudbury	sandy loam	0-3	poor
Typic Udorthents	cut and fill	-	variable
Walpole	sandy loam	-	poor
Westbrook	mucky peat	-	very poor

Soils:
(con't)

Name	Characteristics	Slope %	Septic Tank Suitability
Woodbridge	very stony fine sandy loam	3-8	poor
Woodbridge	extremely stony fine sandy loam	3-15	poor
Gravel Pit	-	-	variable

Shellfish and Finfish Resources

Oysters are reportedly found as far as one mile upstream of the mouth. Hard shell clams and blue mussels in all age classes are plentiful in the lower reaches of the river. However, the waters of the Menunketesuck have been closed to shellfish harvesting, since 1971.

The Menunketesuck has annual runs of alewives and smelt, and serves as an important nursery for juvenile menhaden, winter flounder, atlantic mackerel and other marine species. Atlantic silversides, mummichogs, sculpins and juvenile flukes also inhabit the embayment.

Wetlands

Location (See Figure 10.1) - Considerable amounts of both tidal and freshwater wetlands are present within the Menunketesuck River. The Salt Meadow National Wildlife Refuge, located adjacent to the river (north of the railroad) was established in 1971 and includes some 50 acres of highly productive saltmarsh. These marshes contain some of the deepest deposits of peat in the northeastern United States; up to 33 feet in certain places.

These wetland areas have been faced with development pressures over the years, resulting in loss of marsh to marina use, residential development and commercial operations.

Environmentally Sensitive Areas

The wetlands and uplands of the Salt Meadow National Wildlife Refuge represent a significant resource for the State. An osprey (federal endangered species) nesting platform is located on federal land just north of the railroad bridge. In addition, the highly productive saltmarsh in the lower reaches of the Menunketesuck (below the railroad bridge) are feeling development pressures for alternate uses. A substantial amount of dredging has already occurred in this area for new boat basins. It is likely that these high levels of activity will continue in the future.

B: Land Use Analysis

Current Shoreline and Water Uses

As previously indicated, the shoreline and waters of the lower (below the railroad bridge) Menunketesuck are intensely developed for water-based recreation. Two boat basins of 300 and 400 feet long were developed in the late 1960's on the east side of the river, just north of the Route 1 bridge. Some 15 marinas with a capacity of 2,000 boats currently operate in the vicinity of the Menkentsuck/Patchogue Rivers (See Figure 10.1). Recreational boats with drafts up to 6 feet logged approximately 25,600 trips up the rivers in 1974.

Historical and Significant Land Use Changes

The Army Corps of Engineers (ACE) reports that marina development begin in Westbrook in 1956, with he dredging of the Patchogue River. This was followed by private development and dredging of the Menunketesuck in the early 1960's.

Historical photographs indicate no marine development at the junction of the two rivers in either 1934 or 1951.

Upland areas have shown significant growth and development of housing since 1934. Development first focused on summer cottages and homes, and was followed by winterization of many of these cottages and infilling development in the Grove Beach area. Grove Beach is currently highly developed - densely populated area.

Public Access and Recreational Opportunities

A public boat launch on the Menunketesuck is provided near the headwaters at the point where Old Clinton Road crosses the river. This landing is used by many boaters and canoeists. A town dock is also located on the Patchogue River, and boaters can easily use this facility and reach the mouth of the Menunketesuck in a matter of a few minutes (See Figure 10.1).

Public access is also available to the Menunketesuck through the Salem Meadow National Wildlife Refuge.

C: Problem Identification

Local Departments and Offices Consulted

Town of Westbrook -Board of Selectmen, Shellfish Commission, Planning and Zoning Commission.

Response from Questionnaires and Local Meetings

Response from local officials indicated that there were no significant problems identifiable that were not already under study or under abatement by the Town. This included sedimentation and erosion problems, water quality problems and wetland encroachment problems.

Results of Field Survey and Research

The result of research, field work, and meetings verify the statement made in the previous section. The town has recently developed an ordinance establishing harbor lines and development zones in the waterway. New regulations regarding a health code for new and existing marinas has also been recently developed.

These new regulations, coupled with a clear local directive to improve the environmental quality of the Menunketesuck and Patchogue Rivers has resulted in a condition that is currently stable, and will most likely be improving in the near future.

D: Problem Analysis

Three major problems of concern to the Menunketesuck River are; degraded water quality; conversion of wetlands to other use; and sedimentation and erosion control.

Water Quality Degradation

The headwaters of the Menunketesuck are classified as Class A. The tidal waters are classified SA, but do not meet the standards for this classification, therefore should be rated SB.

The Menunketesuck has been closed to shellfishing since 1971. This is most likely due to a combination of septic tank system failures, storm runoff and discharges from boat waste holding tanks.

The upland areas of Grove Beach and along Route 1 have been identified by the State DEP as "problem areas" for septic system use. In Westbrook's case, this is most likely due to densely developed areas of summer homes that have been converted to year-round use without careful control of septic systems.

The predominant soils in the Grove Beach area are Merrimac sandy loams, which are identified by SCS as having severe limitations for septic tank leaching fields.

Water Quality Degradation (con't)

In addition, the 20,000 boat trips recorded annually through the channel at the mouth represent a potentially significant source of water pollution.

In regard to both of these issues (marine users and domestic septic systems) the Town of Westbrook has taken an aggressive approach in responding to the problems. The town is using strict enforcement of health regulations and new subdivision review ordinances as part of a sewer avoidance program to combat sewage problems. Marine problems have been addressed in a new, strict ordinance regarding health codes for new and existing marinas. Marinas are required to provide adequate sanitary facilities, waste disposal facilities (pump-outs) and fresh water. Adherance to these ordinances will go a long way in improving the rivers water quality.

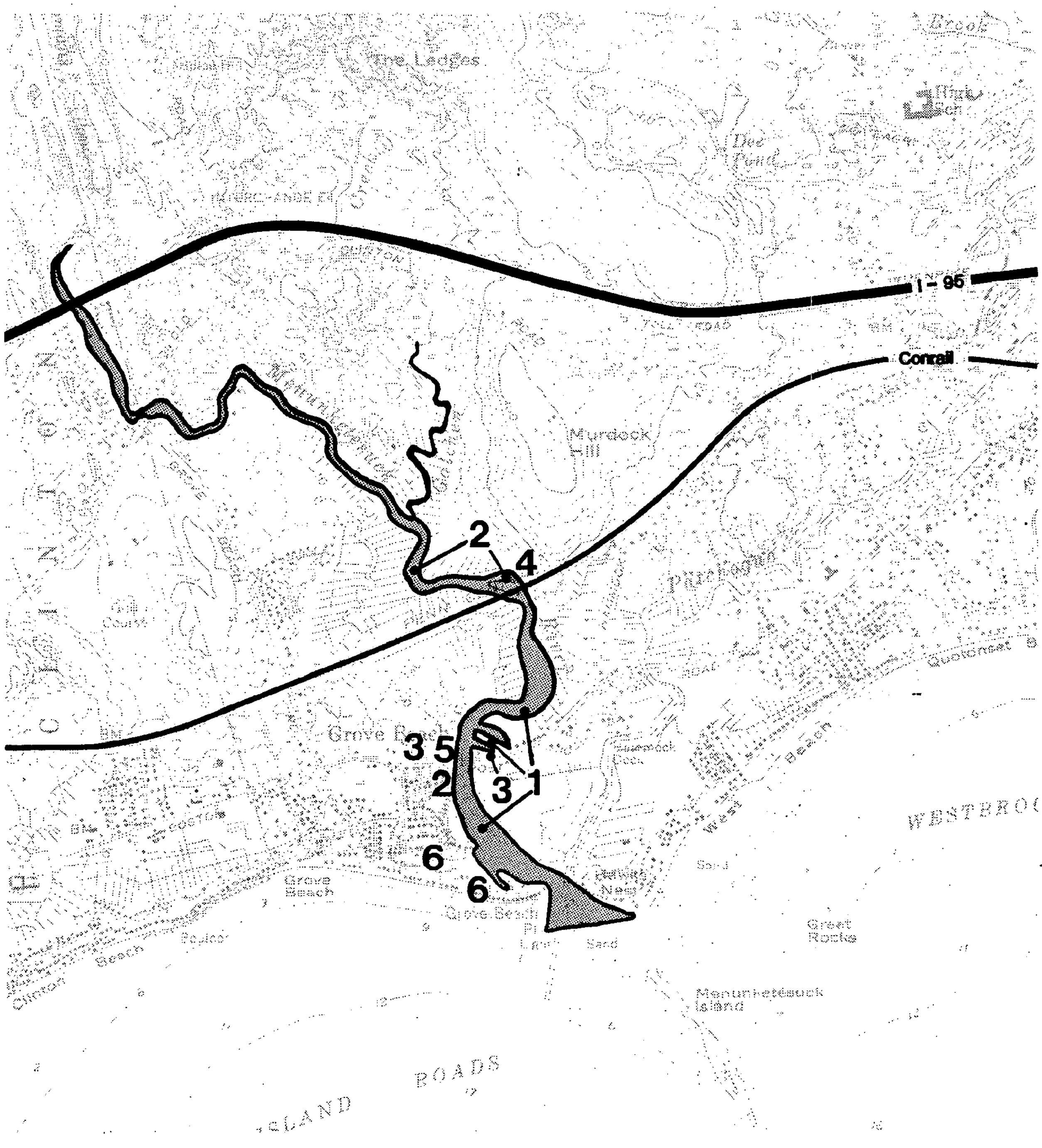
It is important to note here however, that even though the river does not meet its SA classification and is closed to shellfishing, this does not mean it is seriously polluted. The Department of Environmental Protection has monitored the water quality in the Menunketesuck River over several summers, and the results show consistently high levels of dissolved oxygen (near saturation levels), and low turbidity. The bacterial pollution controlling shellfish closures is reportedly worst in the Patchogue River, especially in areas closer to the town center (See Figure 10.2).

Conversion of Wetlands

A significant portion of the once productive saltmarsh found in the lower reaches of the Menunketesuck - Patchogue estuary have been destroyed by filling. Most of this filling occurred in the late 1950's and early 1960's, although marina development and dredging is still going on. The Tidal Wetlands Act, P.A.695, makes it unlikely that additional marinas will be built, and state policy supports the preservation of coastal wetlands. The reality however, is that coastal wetlands are still being impacted by direct conversion. Upland development is also continuing, and will have both direct and indirect impacts that may damage the wetland resource.

Sedimentation and Erosion

The lower reaches of the river does experience regular problems with siltation. This problem has been effectively dealt with through federal dredging projects (the navigation channel through the mouth) and private dredging projects by local marina operators. Dredge spoil has been deposited on Duck Island,



Scale: 1" = 2000'

FIG 10.2 MENUNKETESUCK RIVER ENVIRONMENTAL LAND USE

Problem Areas

1. Heavy boat/Marina development
2. Streambank erosion
3. Dredge spoils dumping
4. Railroad constricts flow
5. Highway bridge constricts flow
6. Residential development/winterization of summer homes

Sedimentation and Erosion (con't)

located just north of the confluence of the two rivers (See Figure 10.2). This has resulted in the filling and loss of marshland. Also, water and sediment draining back into the estuary has resulted in localized, increased turbidity and sedimentation.

The upper reaches of the Menunketesuck have been experiencing some moderate erosion of river banks. This process is a natural one, as the force of the meandering river cuts through parts of the marsh. The rate of natural erosion has increased due to wave action from boat wakes. The river has a posted 5 mph speed limit; but local residents report this is often exceeded, and the levels of power boat use on the upper portions has increased in recent years. The damage caused by boat wakes is unnecessary, and can be reduced through strict enforcement of wake and speed laws.

PROBLEM SUMMARY

Menunketesuck River

1.	Riverbank Erosion	Moderate	(a)
2.	Siltation Near Marinas	Moderate	(a)
3.	Bacterial Pollution	Moderate	(c)
4.	Water Quality Concerns	Moderate	(a)
5.	Circulation restrictions	Minor	(b)

KEY: (a) Conditions becoming worse (b) No change (c) Conditions improving

CHAPTER 11 GUILFORD EMBAYMENTS

INTRODUCTION

The Town of Guilford, located in New Haven County, was first settled in 1639. The original stone homestead of Rev. Whitfield still stands and is a historical landmark for the region. From this beginning, the town has grown to its present population of approximately 16,000. This represents an increase in population of 29.6 percent since 1970, making Guilford the second fastest growing town on the Connecticut coast. The neighboring town of Madison (east of Guilford) is the fastest growing, with a 31 percent population increase since 1970.

Guilford's large size of 46.6 square miles exhibits a population density of only 335 persons per square mile. This is signficantly below the county average of 1,284 persons per square mile, and is almost equal to the density of 340 persons per square mile found in Middlesex County which borders Guilford.

Guilford is located in the geographic center of the Connecticut coast line, and the town is a member of the South Central Connecticut Regional Planning Agency (SCCRPA). The town is 13 miles east of New Haven, and 17 miles west of the Connecticut River mouth.

Guilford Harbor is the major coastal embayment within the town, and receives the combined drainage of the West River, Sluice Creek, East River and the Neck River. The shoreline is mostly saltmarsh with a few rock outcrops at Mulberry Point, Chaffinch Island, and Guilford Point. The entire Guilford Harbor area experiences rapid shoaling and is exposed to a fetch of 20 miles from the southeast to the southwest. Although all of the drainage areas mentioned above were considered for further study, the West River System was experiencing the most acute problems and was chosen for detailed analysis. In addition, the Little Harbor area, a small embayment located on the western side of town, was selected for further analysis due to acute problems associated with circulation and sedimentation.

WEST RIVER

A: Physical Description

Location

Guilford Harbor is located at the mouth of the West River approximately 1.3 miles from the Guilford business district (See Figure 11.1). The center of Branford is aproximately 9 miles to the west and Madison is 5.5 miles to the east. Guilford Point lies directly east of the river mouth, and Mulberry Point lies directly west. Both U.S. 1 and Conrail intersect the river north of Guilford Harbor.

Site Orientation and Configuration

The 0.75 mile long reach (from the mouth to the Conrail bridge) is roughly straight and oriented NW to SE. Above the Conrail bridge, the river meanders considerably as it narrows from 200 feet to about 50 feet. The length of the river considered in this report extends from the mouth to the U.S. 1 Bridge, and is about 2.45 miles in length.

Tidal Data

Mean tidal range -	5.4 ft.
Spring tidal range -	6.2 ft.
Mean tide level -	2.7 ft.

Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth:	0-3 ft. (MLW)
Channel Depth:	None

Additional Comments: Private dredging done in 1968, 1975, and 1976, no federally maintained channel exists.

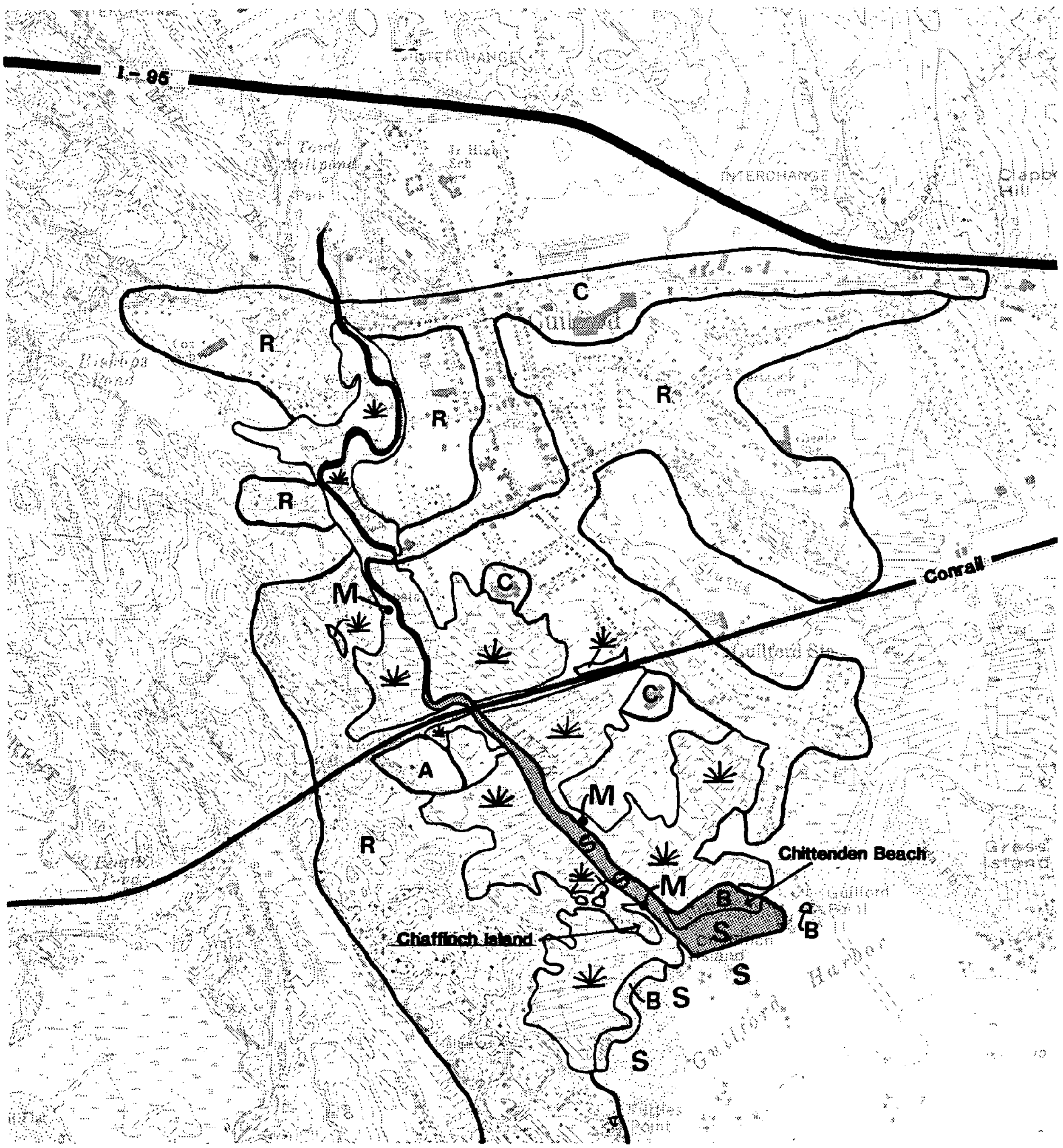
Source: NOAA National Ocean Survey Maps

Basin Hydrology

Regional Drainage Basin: Central Connecticut Coastal Basin
Embayment Basin Area: 18.22 square miles

Tributaries to Embayment: Small Feeder Brooks
Spinning Brook
Bishops Pond
Town Mill Pond

Other Sources of Freshwater Inflow: Minor surface runoff from upland areas (gentle slopes).



Scale: 1" = 2000'

FIG. 11.1 WEST RIVER ENVIRONMENTAL LAND USE

Legend:

- wetlands
- **A** agriculture
- **R** residential
- **C** commercial/ industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Basin Hydrology (con't)

Constrictions to Tidal Flow and Circulation:

Structure	% Constriction	Distance from Mouth
Railroad Bridge	0-25	4,000 feet
Route 146 Bridge	0-25	6,500 feet

Sources: U.S. Geological Survey Connecticut Drainage Basin Gazeteer, 1981 Conn. Dept. of Environmental Protection

Water Quality Conditions

Upstream Water Quality Classification: A-upstream of embayment, Spinning Mill Brook - B/A.

Embayment Water Quality Classification: SB/SA.

Direct Discharges:

Source	NPDES Permit #	Waste Characteristics
Guilford Water Treatment Plt. (located upstream of tidal influence)	DEP/WPC/060-020	Water treatment plant filter backwash

Future Status of Discharges: Will continue unabated. Permit expires June 25, 1984.

Sewer Service Area and Discharge Point: Most of the upland development areas are not sewered. However, partial control of known problem areas is accomplished by use of community leaching fields. These community leaching fields include areas along Route 1, Route 146 and in the Guilford Center area. Residences on the western bank of the river are not sewered (See Figure 11.1).

Storm Sewer Outfalls: None.

Significant Non-point Pollution Sources: Areas of upland residential development and marinas provide varius amounts of non-point pollutants, including road salts, oil, and boat waste discharges.

Shoreline and Bottom Conditions

Extent of Shoreline Modification: Two marinas have been built on the shoreline, and represent the extent of major shoreline changes. Extensive salt marsh development is present along the remainder of the stream banks.

Shoreline and Bottom Conditions (con't)

Significant Areas of Erosion: Bank erosion is found at the mouth of the river west of Guilford Point and east from Tuttles Point to Chaffinch Island (See Figure 11.1). River bank erosion is also present in areas adjacent to railroad and highway crossings.

Shoaling and Sedimentation Problems: Rapid shoaling has occurred in Guilford Harbor. Since the last dredging of the West River, heavy sedimentation has occurred resulting in the creation of mudbanks that surface at low tide. Because of this shoaling problem, boats with any significant draft cannot use the embayment during or near low tide.

Bottom Sediment Characteristics: Bottom sediments are silty clays transported from the sound by wave action and from upstream erosion. Mud deposits are found along the shore and in the waters off Chaffinch Island (See Figure 11.1). Past dredging indicated that the bottom fine deposits are underlain by sandy clays.

Surrounding Lands

Maximum Basin Elevation:

North of Bishops Pond	120 feet
Several Hills on West Side of the river	50-60 feet

Topography: There are no steep slopes on the east side of the river. Slopes of 8-15% are found on some of the many small hills bordering the west side of the river (See Figure 11.1).

General Vegetation Characteristics: The river is bounded by extensive saltmarsh development. The upland vegetation includes by forest on the west and residential landscaping to the east.

Soils:

Name	Characteristics	Slope %	Septic Tank Suitability
Adrian & Palm	mucks	-	very poor
Agawam	fine sandy loam	0-3	poor
Beaches	-	-	very poor
Branford	silt loam	0-3	poor
Branford	silt loam	3-8	poor

Soils:
(con't)

Name	Characteristics	Slope %	Septic Tank Suitability
Charlton-Hollis	fine sandy loams	3-15	good
Cheshire-Holyoke	complex	3-15	poor
Ellington	silt loam	0-3	poor
Hinckley	gravelly sandy loam	0-3	poor
Hinckley	gravelly sandy loam	3-15	poor
Hollis	rock outcrop complex	15-35	very poor
Holyoke-Cheshire	complex	3-15	poor
Holyoke-Cheshire	complex	15-35	very poor
Holyoke	rock outcrop complex	3-15	very poor
Holyoke	rock outcrop complex	15-35	very poor
Ninigret	fine sandy loam	0-3	poor
Podunk	fine sandy loam	-	poor
Raynham	silt loam	-	poor
Ridgebury, Whitman, & Leicester	extremely stony fine sandy loam	-	very poor
Rumney	fine sandy loam	-	poor
Typic Udorthents	cut and fill	-	variable
Walpole	sandy loam	-	poor
Westbrook	mucky peat	-	very poor
Wilbraham & Menlo	extremely stony soils	-	very poor

Shellfish and Finfish Resources

A well established oyster population is found in the river. An oyster bed located approximately halfway between the Guilford Yacht Club basin and the railroad crossing has developed across the river and may reduce flushing during tidal exchange.

Shellfish and Finfish Resources (con't)

Other shellfish in the area of the West River and Chittenden Beach include; ribbed mussels, hard shell clams, scallops (on beach) and soft shell clams.

Finfish which inhabit in the river include: flounder, menhaden, alewifes and snapper blues.

Wetlands

As Figure 11.1 illustrates, extensive saltmarsh is found within the tidal influence of the West River. Saltmarsh development covers several hundred acres, with upland areas in forest or urban/ residential development. A large area of the marshland on the eastern bank was covered with dredge spoil material during the development of the Guilford Yacht Club in the 1950's. Most of the marshland in the river system has remained relatively stable, while marshland exposed to the Sound outside of the mouth has been constantly eroding from wave action.

Environmentally Sensitive Areas

The marshlands of the West River system are a significant resource for species habitat and biological production. These areas also provide a coastal flooding buffer between the Long Island Sound and developed upland areas.

B: Land Use Analysis

Current Shoreline and Water Uses

Three marinas/mooring areas are located on the river (See Figure 11.1). Brown's Boat Yard on the western shore near the mouth, Guilford Yacht Club some 1,000 feet from the mouth on the eastern bank, and Guilford Boat Yard locate on the western bank near the Route 146 bridge.

These facilities have a combined mooring capacity of 200 boats, however more than half of these moorings are currently unuseable due to siltation of the river in the area near the mooring.

Current Upland Use

Upland uses consist mostly of single-family residential development and some commercial/service development. An apple orchard, and a cemetery are also located within the watershed of the West River, and the Guilford Town Center is located east of the upper portions of the river.

Historic and Significant Land Use Changes

Much of the upland development present today was present in 1934, although more of the uplands were used for agriculture. The marshlands along the West River were ditched for mosquitoes prior to 1934. The years 1934-1951 saw little large scale development along the river. Some minor development occurred at the point on Chaffinch Island and east of the river in Guilford center. Boat yards were present on the west side of the river at the river mouth and near Route 146.

In the mid-1950's the Guilford Yacht Club basin was dredged out of the eastern bank of the river. From 1951 to the present, little significant change other than residential/commercial infilling occurred in upland areas.

Significant erosion is evident in the period 1934-1951 (most likely due to the 1938 hurricane). The most dramatic change to the system is evident along the marshy shoreline near the river mouth. This process has continued to the present, resulting in a loss of some 200 feet of shoreline through erosion.

Public Access and Recreational Opportunities

Public access to the West River is available at Chaffinch Island (See Figure 11.1). The privately operated boat yards and Yacht Club offer semi-public access to the river. Water access is available through these facilities, or from the town marina located approximately 1 mile to the east in Guilford Harbor. The West River is used for variety of recreational purposes, including boating, canoeing, fishing, swimming, nature walks and bird watching.

C: Problem Identification

Local Departments and Offices Consulted

Town of Guilford - Board of Selectmen, Shellfish Commission, Water Pollution Control Authority, Town Engineer, Zoning Board of Appeals, Park and Recreation Commission, Town Treasurer, Planning Commission; Guilford Yacht Club; Guilford Boat Owners Association; Browns Boat Yard; Little Harbor Laboratory.

Response from Questionnaires and Local Meetings

Severe erosion and sedimentation problems were identified in the questionnaire, with moderate concerns expressed over water quality degradation. Town representatives felt that these problems were all historical in nature. Siltation and erosion are occurring as a result of natural processes, and pollution is caused by a variety of human sources, including road salts, septic system failures, pesticides, fertilizers, oils, and grease.

Results of Field Survey and Research

The field survey confirmed that the West River is exhibiting severe siltation problems. Although the river was dredged (through private actions) in 1975 and 1976 from its mouth to the Guilford Yacht Club, the river is filled in to the point that currently 2/3 of the slips available at the Guilford Yacht Club are not useable and therefore not rented out. In addition, deep draft boats can enter and leave the river only 1 hour either side of mean high water.

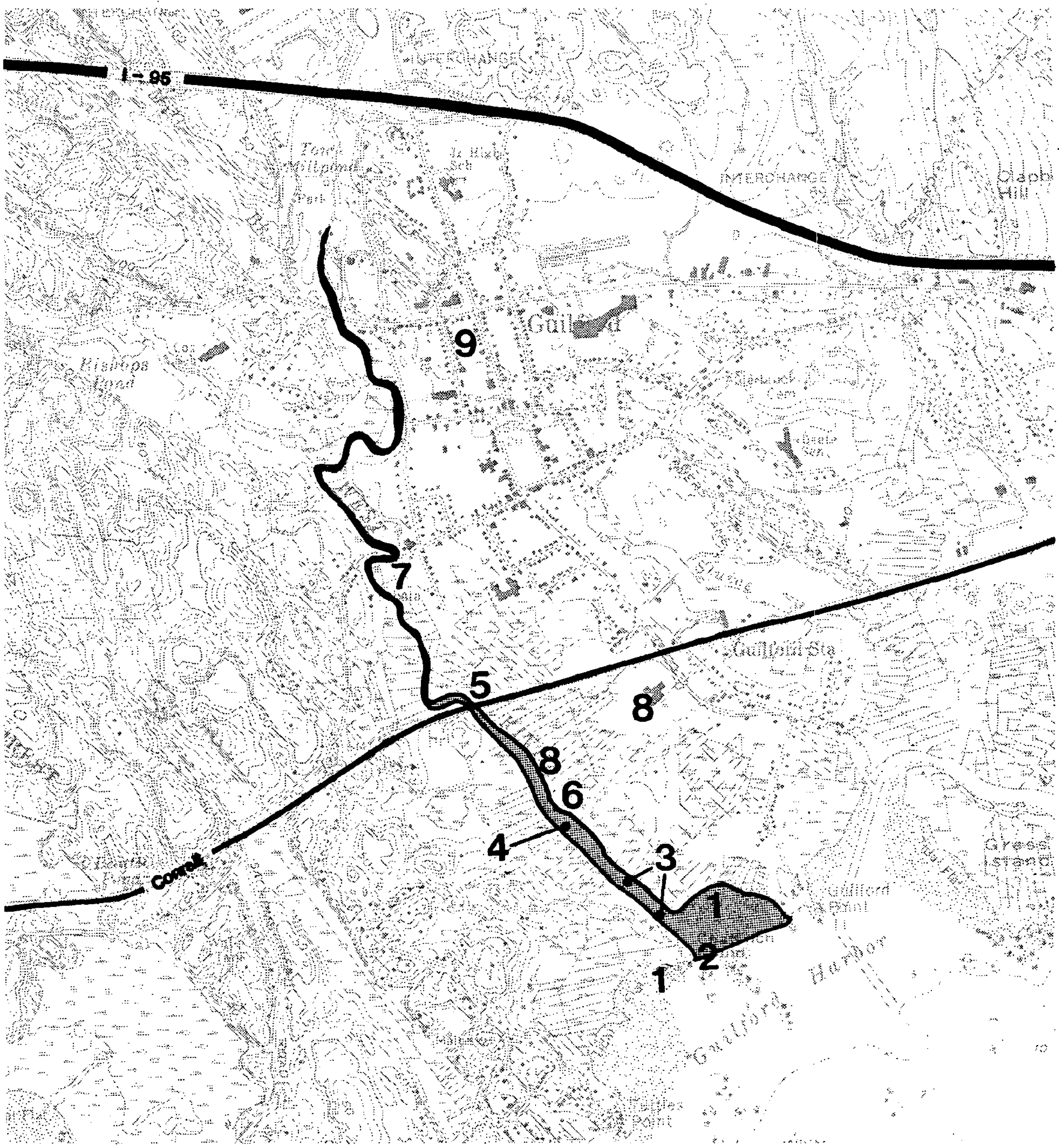
The river has been closed to shellfishing since 1974, and this has resulted in a visible increase in shellfish populations, primarily due to the lack of harvesting. A sand bar has developed just south of the railroad bridge and extends halfway across the river. The bar has been colonized by a large oyster population and is visible at low tide.

D: Problem Analysis

Siltation and Erosion

The open marshlands of Chaffinch Island and Chittenden Beach have been exposed to the eroding forces of wave action for decades (See Figure 11.2). This has resulted in a retreating shoreline with an irregular shape. Historical air photos show a loss of over 200 feet of shoreline in this areas since 1934. Unless efforts are made to artificially stabilize these areas, erosion should continue unabated.

The wave forces that act to erode the marshy shoreline are important in the process of sediment transport. In shallow or shoaling areas, tidal currents usually have a low velocity and thus are not capable of moving large quantities of bottom sediment unless the sediment is first suspended by wave action. Wave action impacts on offshore sediments produces a net movement of sediment that is transported into the near shore shallow areas and the river by tidal currents. Material is brought into the river



Scale: 1" = 2000'

FIG 11.2 WEST RIVER ENVIRONMENTAL PROBLEMS

Problem Areas

1. High erosion area
2. Large rock in channel
3. Heavy siltation in channel
4. Oyster bar
5. Railroad bridge affects tidal flushing
6. Dredge spoils area
7. Suspected wastewater discharge
8. Untreated metal discharge
9. Widespread subsurface disposal problems

Siltation and Erosion (con't)

during flood tides and settles as the tide turns and the ebb currents begin. The flow velocity required to erode this newly deposited material is greater than the ebb tide velocity leading to accumulation of sediment in the channel.

In the case of the West River, the process described above is occurring. To counter this process, many tidal rivers receive contributions of freshwater flow from upstream sources with sufficient velocity to keep the rivers bottom scoured. This is not the case with the West River. The presence of several large rocks near the mouth of the river, and a developing oyster/sand bar located just downstream of the railroad, have acted to further reduce the flushing caused by streamflow, and further increase sedimentation rates. In addition, the abundance of silt loam soils west of the river contribute to the amount of silty material that enters the river systems through surface runoff.

Water Quality Degradation

The waters of the West River are currently classified as SA, but only meet the classification of SB. There are several sources which contribute to the general degradation of water quality, and include septic tank leakage and other non-point pollutants. Most of the single-family homes located within the watershed of the river, particularly areas of dense development on the eastern shore, have septic tanks and leaching systems in soils that are classified by the U.S.D.A. Soil Conservation Service as having severe limitations for such uses. This is not to say that failures of these systems is the sole source of bacteriological contamination to the river, but does represent a serious potential source of contamination.

Other pollutant sources include upland livestock and cultivation activites, commercial facilities, and marine users (there are no pump-out facilities located in the area). In addition, commercial apple orchards in the watershed use pesticides; road salts, oils and grease are contributed in the form of road surface runoff, and fertilizers are used in residential and agricultural lands. All of these non-point pollutant sources combine to impact the rivers' water quality.

LITTLE HARBOR

A: Physical Description

Location

Little Harbor is located on the western end of the Guilford shoreline off of Island Bay (See Figure 11.3). It is located approximately 9.5 miles east of the center of Branford and 3.5 miles west of the center of Guilford. Clark Point forms the eastern shore of the Harbor and Harrison Point forms the western shore. The Thimble Islands are located 0.75 miles southeast of Little Harbor.

Site Orientation and Configuration

The embayment is Y-shaped with the longest dimension measuring approximately 1200 feet. The natural width of the mouth of the harbor is approximately 330 feet. Breakwaters have reduced the entrance width of the harbor to about 150 feet. The two coves within the embayment are symmetrical about the long axis which is oriented N to S (See Figure 11.3).

Tidal Data

Mean tidal range:	5.4 ft.
Spring tidal range:	6.2 ft.
Mean tide level:	2.7 ft.

Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth:	3-8 ft.(MLW)
Channel Depth:	No Channel

Additional Comments: Harbor has not been previously dredged.

Source: NOAA National Ocean Survey Maps

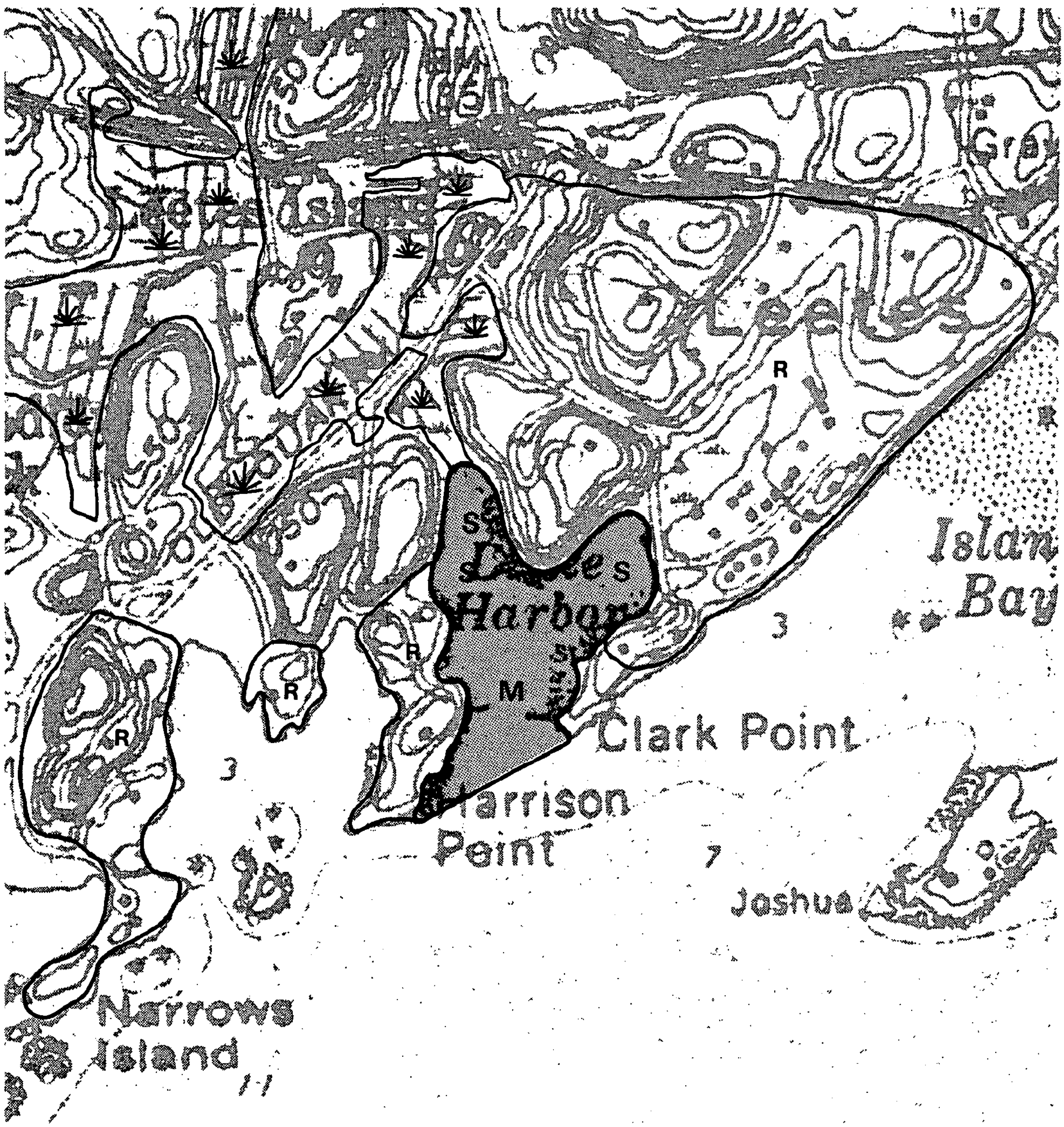
Basin Hydrology

Regional Drainage Basin: Central Connecticut Coastal Basin
Embayment Basin Area: .33 square miles

Tributaries to Embayment:

Name	Flow Rate
Hoadley Creek Wetland via culvert under Quarry Rd	flow flow due to mud and rock obstructions

Other Sources of Freshwater Inflow: Surface runoff, steep slopes around embayment.



Scale: 1" = 666'

FIG 11.3 LITTLE HARBOR ENVIRONMENTAL LAND USE

Legend:

- wetlands
- **A** agriculture
- **R** residential
- **C** commercial/industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Basin Hydrology (con't)

Constrictions to Tidal Flow and Circulation:

Structure	% Constriction*	Distance from Mouth
2 stone breakwaters approximately 200 ft. long each	50-75	at opposite sides of the mouth

Sources: U.S. Geological Survey Connecticut Drainage Basin Gazeteer, 1981 Conn. Dept. of Environmental Protection

Water Quality Conditions

Upstream Water Quality Classification: Hoadley Creek: not classified, North of I-95: A/AA.

Embayment Water Quality Classification: Classification not available.

Direct Discharges: None

Sewer Service Area and Discharge Point: There are no sewers in the Little Harbor area of Guilford. Residences are all on individual septic systems.

Storm Sewer Outfalls: None.

Non-Point Pollution Sources: Septic leachate from upland areas and surface runoff from residential construction activities. These sources have only a minor impact on the Harbor.

Shoreline and Bottom Conditions

Extent of Shoreline Modification: Two stone breakwaters have been built at the mouth of the harbor. Four large stone or wood piers have been built around the harbor to service private residences.

Significant Areas of Erosion: No significant areas of erosion are apparent, shoreline is mostly bedrock outcrop.

Shoaling and Sedimentation Problems: Harbor water appears turbid at high tide even following several days of calm weather. Both northern arms of the harbor have silted into the point that the bottom is exposed during low tide. These areas reportedly had 3-4 feet of depth at mean low water in the past.

Bottom Sediment Characteristics: Bottom sediments are characterized by grey/black very fine silt with a high organic matter content, deposited in a thin layer over a coarser layer of silt, fine sand and shell fragments. Frozen core samples taken in the area indicate the material available at the sediment surface for resuspension is primarily silt and organic matter.

Surrounding Lands

Maximum Basin Elevation:

On slopes adjacent to embayment Leetes Island/Harrison Point	50 feet

Topography: Steep slopes (15-35% with bedrock outcrops are present on the north and west side of the harbor.

General Vegetation Characteristics: The upland areas are forested for the most part, and areas of residential develoment are landscaped. Rock outcropping excludes most vegetation within the harbor. Wetland vegetation covers the area northwest of the harbor (Hoadley Creek wetland) (See Figure 11.3).

Soils:

Name	Characteristics	Slope %	Septic Tank Suitability
Cheshire-Holyoke	complex	3-15	poor
Holyoke-Cheshire	complex	15-35	poor
Holyoke	rock outcrop complex	3-15	very poor
Holyoke	rock outcrop complex	15-35	very poor
Manchester	gravelly sandy loam	3-15	poor
Raypol	silt loam		poor
Walpole	sandy loam		poor
Watchaug	fine sandy loam	3-8	poor
Westbrook	mucky peat		very poor
Wilbraham & Menlo	extremely stony soils		very poor

Shellfish and Finfish Resources

Little Harbor, similar to many embayments of the north shore of Long Island Sound, can support a number of bivalves, snails, finfish and other aquatic organisms.

Species include; blue and ribbed mussels, hard clams, steamers, oysters, jingle shells, starfish, lobster, horseshoe crab, rock and mud crabs, barnacles, shrimp, and spider crabs. A survey of fish present just outside the harbor included; bluefish, striped bass, menhaden, and weakfish.

Shellfish and Finfish Resources (con't)

The species listing above were taken from information developed as part of a reserach project on a floating tire breakwater which was developed by the locally based Little Harbor Laboratory. The benthic organisms listed were recovered from the floating tire breakwater located in shallow water (7-8' MLW).

In a follow up study on the sediment and benthic fauna of the Little Harbor area, it was noted that the amount of resuspended organic material on the sediment surface never permitted the succession of long-lived shellfish species like the fouling species found on the floating tire breakwater. Therefore, occurance of most of these species is limited to inter-tidal areas, and areas where fouling can occur above the bottom sediment layers, rock shoals, and the breakwater.

Wetlands

A small area of wetlands is found north of the northwest arm of the embayment. This wetland area is the result of drainage from Hoaley Creek (under Old Quarry Road) which flows very slowly due to rock and mud obstructions in the road culvert. This wetland area was cut-off from Hoadley Creek prior to 1934.

A small area of saltmarsh located north of the northeast arm of the harbor was filled in sometime between 1934 and 1951. The area now is only a drainage ditch which supports no saltmarsh vegetation.

The embayment has not changed appreciably since 1952, and no further wetland encroachment has occurred.

Environmentally Sensitive Areas

There are no unique or especially sensitive areas or habitat within or near the embayment.

B: Land Use Analysis

Current Shoreline and Water Use

The entire upland area surrounding Little Harbor is in private residential holdings. There are no commercial or industrial land uses in the basin. Several private docks and piers have been constructed along the shoreline for mooring of private boats. The Little Harbor Laboratory is small non-profit reserach lab operated in conjunction with a private residence. The Lab maintain a large power craft and several smaller boats. Recreational vessels in the harbor include both power boats and shallow draft sailboats.

Current Upland Use

The entire upland areas is in private residential ownership. There are undeveloped areas but the dominant land use is low-density, large lot residential development.

Historical and Significant Land Use Changes

The historical changes to wetlands have been described in Section 11. The harbor areas as a whole have seen little land use change since 1934, other than partial clearing for home building. The large stone breakwaters at the mouth were constructed prior to 1934. The harbor has never been dredged and has reportedly been partially silted in since the 1938 hurricane.

Public Access and Recreational Opportunities

There are no public access points to Little Harbor for other than area residents.

C: Problem Identification

Local Departments and Offices Consulted

Town of Guilford: Shellfish Commission, Board of Selectmen, Water Pollution Control Authority, Town Engineer, Zoning Board of Appeals, Park and Recreation Commission, Town Treasurer, Planning Commission; Guilford Yacht Club; Guilford Boat Owners Association; Browns Boat Yard; Little Harbor Laboratory.

Response from Questionnaires and Local Meetings

There was a singular concern raised regarding siltation and sedimentation in Little Harbor. No other issues were raised.

Results of Field Survey and Research

Field work and research verifies that the Harbor is currently experiencing significant sedimentation problems. A floating tire breakwater was constructed in 1977 to increase protection for the harbor. This breakwater failed during several storms and was removed this past summer.

D: Problem Analysis

Two stone groins, (which do not overlap) were constructed at the mouth of the harbor prior to 1934 (See Figure 11.4). These groins are awash at high tide, and only partially protect the harbor from direct wave action. Six to seven foot waves can occur within the harbor during storms.

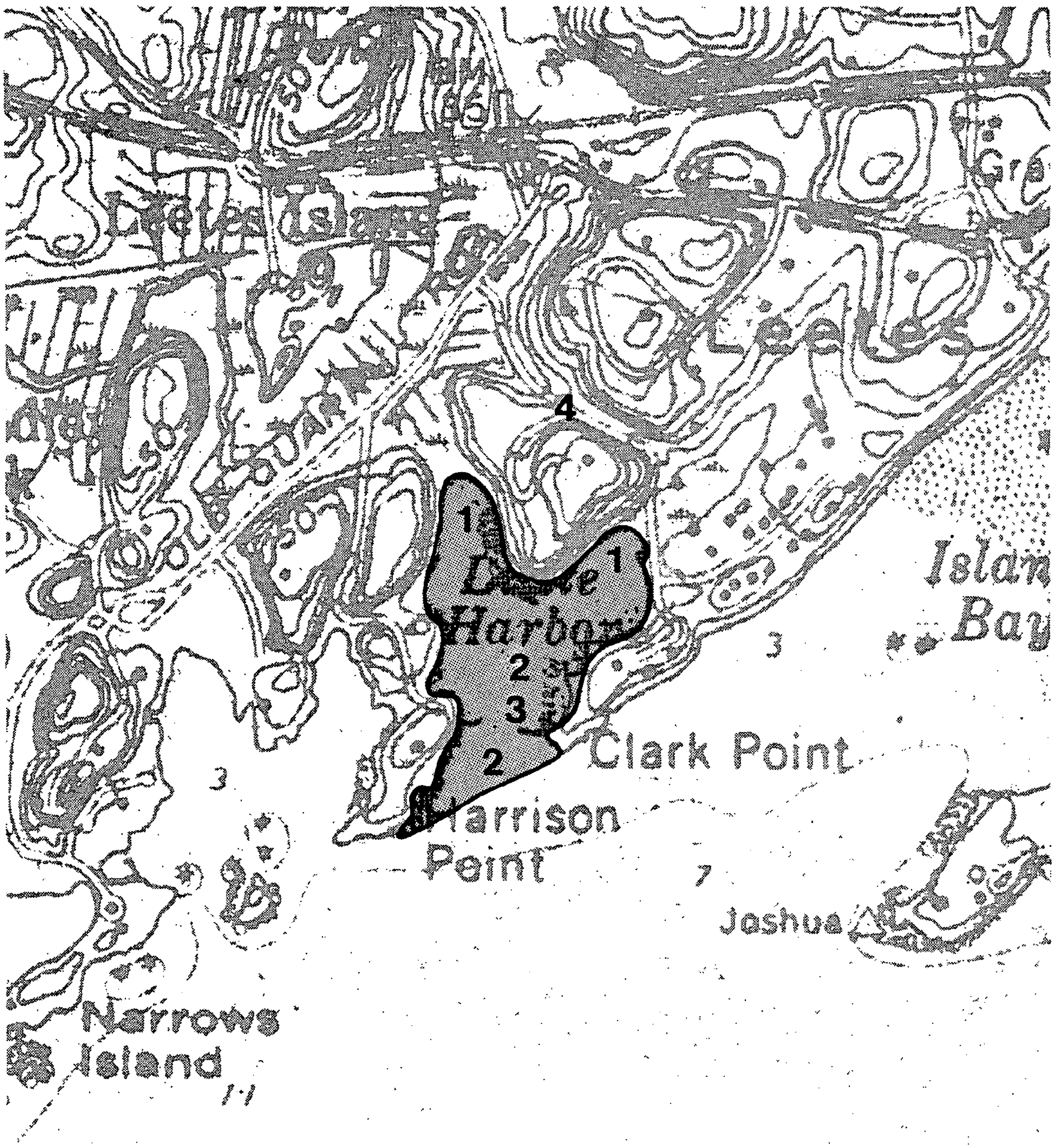
The stone groins reduce the flushing of the harbor and prevent material from washing out during storms. A large volume of sediment was reportedly transported into the harbor during the hurricane of 1938 and has not re-eroded.

The harbor has never been dredged, and the northern end of both arms of the harbor are almost totally exposed during periods of low tide.

The waters in the harbor are turbid, evidently from the presence of extremely fine silt and collected organic matter in the bottom sediments. Delivery of these materials by wave transport leads to rapid deposition behind the groins. Little sediment is being contributd from surface runoff or fresh water inflow.

The rate of harbor filling appears to be most rapid during larger storms (such as the 1934, 1954 hurricanes). The harbor has never been dredged.

The current groin configuration, in addition to reducing tidal flushing, does not provide adequate storm protection for boats and piers inside of the harbor. The harbor is exposed over a 90° sector from SE through SW, the direction of principal fall storms. The mean fetch across Long Island Sound is approximately 18 miles. The floating tire breakwater project was initiated in 1977 but abandoned in 1980 following a series of structural failures during storms. A study on the breakwater concluded that it would not be economically feasible to supply sufficient mooring capacity to hold the breakwater in place, and the wave attenuation to be expected with the adverse storm conditions which prevail at this location would not be great enough to economically protect boats and piers in the harbor. The breakwater was removed this past summer and the harbor is once again exposed to southerly winds and waves.



Scale: 1" = 666'

FIG 11.4 LITTLE HARBOR ENVIRONMENTAL PROBLEMS

Problem Areas

1. Heavy siltation in harbor
2. Poor circulation/flushing
3. Misaligned breakwaters
4. Area of new construction

PROBLEM SUMMARY

WEST RIVER

1.	Erosion of shoreline near mouth	Severe	(a)
2.	Siltation of lower river	Severe	(a)
3.	Bacterial pollution	Moderate	(b)
4.	Channel flow restrictions	Moderate	(a)

LITTLE HARBOR

1.	Siltation in upper portions of harbor	Severe	(a)
2.	Flushing restrictions due to groins	Moderate	(b)
3.	Water quality concerns	Minor	(c)

KEY: (a) Conditions becoming worse (b) No change (c) Conditions improving

CHAPTER 12 BRANFORD EMBAYMENTS

INTRODUCTION

The Town of Branford, part of New Haven County, was named and settled in the 17th century.

Branford is centrally located on the Connecticut coast, and is a member of the South Central Connecticut Regional Planning Agency (SCCRPA). The town has a current population of approximately, 22,200 persons, an increase of about 8% over the 1970 population of 20,444 persons. The town area is 21.5 square miles, and the average population density is 1,027 persons per square mile. This is slightly below the county average of 1,283 persons per square mile. Branford has seen a boom in development in the last 10 years particularly in residential housing units. Over a dozen major dvelopments have been constructed in the last decade, and several new developments are under construction, or in the final planning stage. Many of these developments are located on the coast or in upland areas adjacent to the coastal plain. A good portion of the growth in population is tied to these new developments.

The geology of the Branford Quadrangle is primarily the result of the action of glaciers which crossed the area in a northwest to southeast direction. Glacial till and stratified drift comprise most of the soils in the area, with till being generally thin or absent on many hills and ridges.

A major bedrock fault, known as the Triassic border fault, runs in a southwest-northeast direction immediately west of the town of Branford. At the edge of the Triassic border fault, large trap rock quarries have been developed, mining trap rock for use in road paving, concrete, ballast protection stone, and other uses.

The Branford coast is highly irregular, composed of rock outcroppings and boulders fronted by mud flats at low tide. The Thimble Islands, a grouping of small islands near the shore, are found at the eastern end of the town. The western town line is formed by the East Haven/Farm River.

The major coves and rivers along Branfords coast include; the East Haven/Farm River, Pages Cove, Lamphier Cove, Linsey Cove, Branford Harbor/Branford River and Stony Creek Harbor. The East Haven/Farm River which forms the border with the neighboring Town of East Haven was selected for in-depth analysis. The Branford River Harbor area and Stony Creek Harbor area were not included for further study because they were targets for recent federal navigation projects. Linsey, Pages and Lamphier Coves were deleted from further study when it was confirmed by the Town of Branford that these areas had only minor, or insignificant environmental problems.

EAST HAVEN RIVER

A: Physical Description

Location

The embayment forms the common municipal boundary of Branford and East Haven (see Figure 12.1). The center of East Haven is located approximately 1 mile west of the river, New Haven center is 4 miles to the west, and Branford is 2.5 miles to the east. Kelsey Island is situated at the mouth of the river. Payne Point lies immediately east of the river mouth, Mansfield Point lies immediately to the west (see Figure 12.1). Tweed Airport (East Haven) is 1.5 miles northwest of the river mouth.

Site Orientation and Configuration

The river is roughly linear from the mouth to the intersection of Short Beach Road, and the axis is oriented in a NE to SW direction (see Figure 12.1). One-tenth of a mile north of the Short Beach bridge, the river starts to meander. The river then forks and narrows as it penetrates north between Beacon Hill and the Gillis School area. Kelsey Island divides the mouth of the river into two inlets: the main channel and Farm River (see Figure 12.1). The shores of Kelsey Island are comprised of tidal wetlands.

Tidal Data

Mean tidal range -	5.9 ft.
Spring tidal range -	6.8 ft.
Mean tide level -	2.9 ft.

Source: U.S. Department of Commerce, <u>1980 Tide Tables: East Coast of North and South America</u>

Bathymetry

Range of Depth:	1-15 ft. (MLW)
Channel Depth:	1.5-9 ft.(MLW)

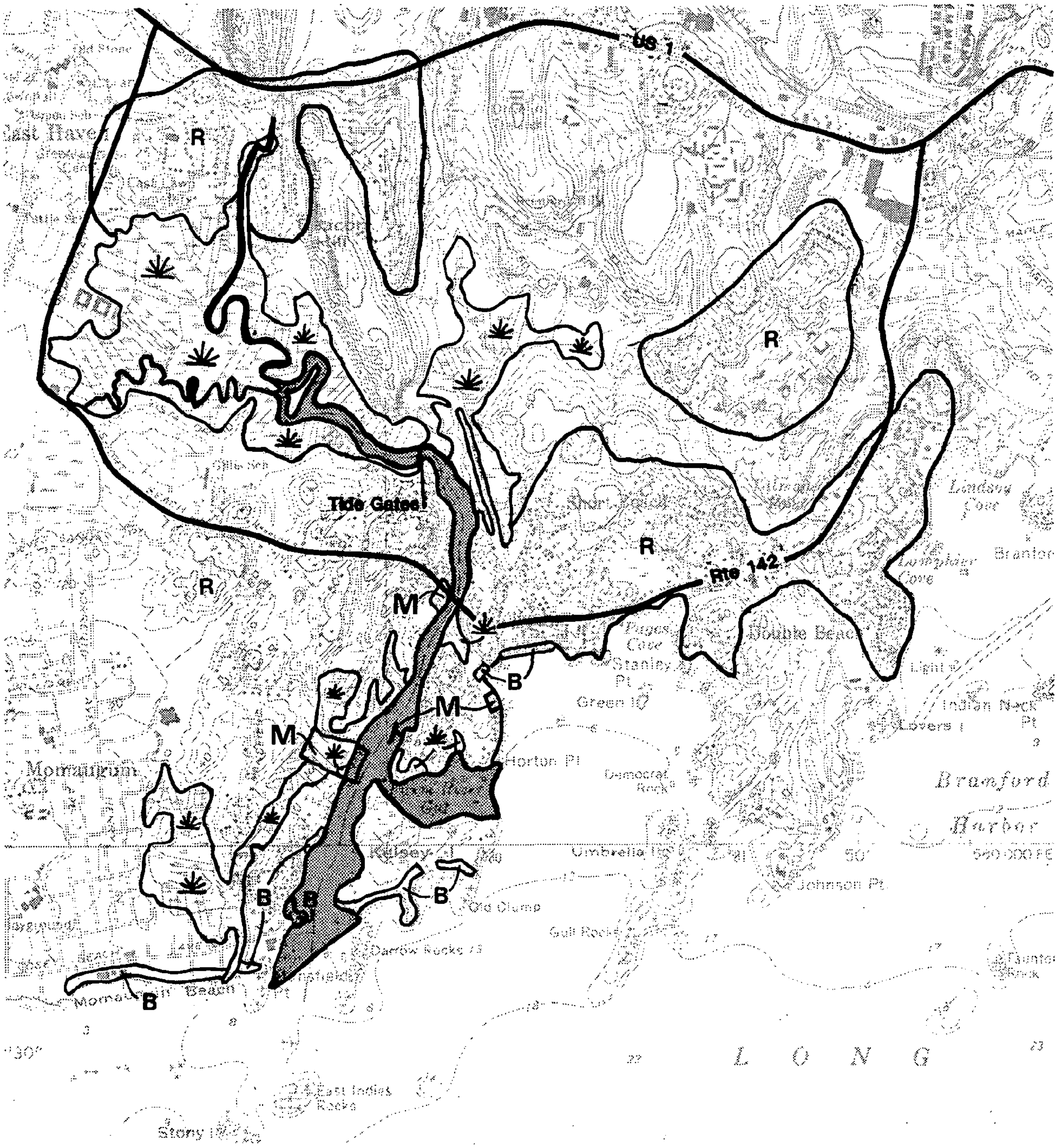
Additional Comments: Channel has not been dredged since 1900.

Source: NOAA National Ocean Survey Maps

Basin Hydrology

Regional Drainage Basin: Central Connecticut Coastal Basin
Embayment Basin Area: 26.6 square miles

Tributaries to Embayment: Farm River
small feeder brooks



Scale: 1" = 2000'

FIG. 12.1 EAST HAVEN RIVER ENVIRONMENTAL LAND USE

Legend:

- wetlands
- **A** agriculture
- **R** residential
- **C** commercial/industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Basin Hydrology (con't)

Other Sources of Freshwater Inflow: Lake Saltonstall (drinking water reservoir) surface runoff from upland.

Constrictions to Tidal Flow and Circulation:

Structure	% Constriction*	Distance from Mouth
Fixed Bridge (Short Beach Rd.)	0-25	5,250 feet
Old Tide Gates (removed)	0-25	7,650 feet

Sources: U.S. Geological Survey Connecticut Drainage Basin Gazeteer, 1981 Conn. Dept. of Environmental Protection

Water Quality Conditions

Upstream Water Quality Classification: B/A upstream of embayment. Lake Saltonstall - AA

Embayment Water Quality Classification: SB/SA

Direct Discharges:

Source	NPDES Permit #	Waste Characteristics
New Haven Water Co.	CT0021881	Freshwater backwash from water treatment plant, 81,000 gal/day

Sewer Service Area and Discharge Point: Most of the upland areas in both East Haven and Branford have been sewered. Discharge is through the sewage treatment plant located on the Branford River.

Storm Sewer Outfalls: None reported.

Significant Non-Point Pollution Sources: Non-sewered residences on unsuitable soils are found in the river's watershed.

Shoreline and Bottom Conditions

Extent of Shoreline Modification: The shoreline of the lower reachs of the river (below Route 146 bridge) has been modified for marina development, mooring areas and residential dock use. Many private docks and piers have been constructed, but little bulkheading or construction of sea walls has occurred. Some 205± slips are available in the 3 marinas/boat yards on the river (see Figure 12.1).

Shoreline and Bottom Conditions (con't)

The upper reaches of the river have seen significant amounts of saltmarsh encroachment for a variety of commercial and residential development projects. Most of the upper river shoreline remains in its natural condition.

Shoaling and Sedimentation Problems: The lower sections of the river have been experiencing gradual filling since 1938. In the last few years, the rate of sedimentation has increased dramatically to the point where the channel near Farm River Gut currently has 4' (MLW) compared to 9' in the past. The greatest problem is near the mouth, where shoaling has reduced the amount of water from 7 feet (in 1938) to 18 inches today.

Bottom Sediment Characteristics: Bottom sediments vary the length of the river and are mostly a mixture of mud/silt, with one layer of fine sandy and shell fragments.

Surrounding Lands

Maximum Basin Elevation:

Location	Height
Beacon Hill (40 north)	120 feet
several hills adjacent to river	50 feet

Topography: The westerly ridge of Beacon hill and the western bank of the river on both sides (N and S) of the highway bridge have slopes in excess of 15%. Steep slopes are also found on the peninsula located on the east bank of the river and south of Short Beach Road (see Figure 12.1).

General Vegetation Characteristics: Extensive saltmarsh wetlands have developed in the estuary, particularly the upper reaches of the river. Upland areas are predominantly mixed-hardwood forest and residential development which ranges from open lawns to dense wooded lots (see Figure 12.1).

Soils:

Name	Characteristics	Slope %	Septic Tank Suitability
Branford	silt loam	3-8	poor
Branford-Holyoke	silt loams	3-15	poor
Cheshire	fine sandy loam	15-25	good
Cheshire-Holyoke	complex	3-15	poor
Deerfield	loamy fine sand	-	poor

Soils:
(con't)

Name	Characteristics	Slope %	Septic Tank Suitability
Holyoke-Cheshire	complex	15-35	poor
Holyoke	rock outcrop complex	3-15	very poor
Ludlow	silt loam	3-8	poor
Manchester	gravelly sandy loam	3-15	poor
Penwood	loamy sand	0-3	poor
Penwood	loamy sand	3-8	poor
Raynham	silt loam	-	poor
Hollis	rock outcrop complex	-	very poor
Rumney	variety silt loam	-	poor
Scarboro	muck	-	very poor
Typic Udorthents	cut and fill	-	variable
Urban Land	-	-	variable
Walpole	sandy loam	-	poor
Wethersfield	loam	3-8	poor
Wethersfield	loam	8-15	poor
Wethersfield	loam	15-25	poor
Wilbraham & Menlo	extremely stony soils	-	very poor
Gravel pit	-	-	variable
Westbrook	mucky peat	-	very poor

Shellfish and Finfish Resources

Available shellfish data indicate an abundance of resources in the East Haven River. In the area running from the tide gates south to the mouth, the river supports significant populations of seed oysters. Populations decrease near the mouth, and are greatest just south of the Route 146 bridge (Short Beach Road). Also present are hard and soft shell clams, especially in the tide flats of Fall River Gut, and many lobster pots are found near the mouth of the river.

Shellfish and Finfish Resources (con't)

The river is closed to shellfishing for direct human consumption, although oysters north of the Route 146 bridge are being harvested and commercially purified prior to sale.

Finfish resources include runs of stripper blues and winter flounder, which are harvested by local recreational fishermen.

Wetlands

Significant saltmarsh development is found along the banks of the river. The upper reaches of the estuary support a large healthy and thriving saltmarsh (see Figure 12.1).

Portions of the upper fringes of the marsh have been invaded by Reed Grass (*Phragmites communis*) and other indicators of marsh disturbance. The presence of Reed Grass degrades the saltmarsh and increases fire hazards.

Environmentally Sensitive Areas

The extensive saltmarsh in the area represents a significant resource for biological productivity and habitat. The marshes provide nesting for an abundance of migratory waterfowl as well as fish spawning grounds and shellfish habitat.

B: Land Use Analysis

Current Shoreline and Water Use

The majority of the river's shoreline is in its natural condition, and includes saltmarsh banks, mud flats, and rock outcrops. Three marinas/boatyards have been developed south of the Route 146 bridge (see Figure 12.1). The largest of these is located on the west shore opposite Farm River Gut. A dozen or so private docks with floats have been built along the shores of the lower river for use by local residents.

The river is used for a variety of water-based recreational activities, including: power boating, canoeing, sailing, swimming and fishing. The Branford Trolley Museum offers scenic rides through the upper marsh area on an old train.

Current Upland Use

Concentrated residential development occurs in upland areas all around the upper and lower river. The neighbrohoods of Short Beach, Casey Beach Avenue (near Mansfield Point), and Short Beach Road (in East Haven) are all densely developed (see Figure 12.1). Significant portions of the upland still remain undeveloped and are composed of wooded slopes with much rock outcropping (see Figure 12.1). The East Haven town center borders the west bank of the upper reaches of the river.

Historical and Significant Land Use Changes

Many of the roads and subdivisions found in the area today were already under initial development in 1934. Between 1934 and 1951, the heaviest residential development occurred in East Haven near the town center and in the Vista Drive (Gillis School) neighborhood. Marina development on the eastern shore near Farm River Gut and on the western bank near Route 146 was present in 1951 (see Figure 12.1).

Gradual residential infilling was the trend from 1951 to the late 1960's. The last decade has seen a rapid growth of large scale development projects within the watershed, particularly apartment and condominium developments that result in large-scale soil disturbances and erosion.

A large marina presently opposite Farm River Gut was developed after 1951. This development involved dredging of significant portions of marshland. Likewise, marshland in portions of the upper reaches of the river were converted to apartment and commercial use.

Public Access and Recreational Opportunities

No public boat ramps or lands adjoin the East Haven River. Public access is available only by water or use of the several private marinas in the area.

C: Problem Identification

Local Departments and Offices Consulted

Town of Branford - Conservation Commission, Shellfish Commission, Wetlands Commissioner, Flood and Erosion Control Board; Marina Operators; Town of East Haven Residents.

Response from Questionnaires and Local Meetings

The response from local interests indicated concern over siltation and sedimentation, and water quality problems. Minor concern for erosion, finfish loss, and tidal circulation problems were also voiced. Local marina operators, and boat owners voiced strong concern over sedimentation problems which have worsened in the past decade due to upstream construction.

Results of Field Survey and Research

The field survey and follow up research clearly confirm siltation and sedimentation problems in the East Haven/Farm River system. In addition water quality problems and flood control issues were identified, but a lack of specific quantitative data (in the case of water quality degradation) hampers complete analysis of the problem.

Long time residents and marina operators in the area indicate that the control depths in the river which were once 6 to 18 feet at mean low water now vary from 18 inches to 9 feet at mean low water. The worst areas of sediment deposit and shoaling have occurred in areas downstream of the Route 146 bridge. The narrow channel at the bridge (due to constriction by the fixed bridge) acts to increase tidal velocities and aids in bottom scouring.

Further downstream in the vicinity of two marinas located near the Farm River Gut, the river has silted-in from where there was once 9 feet (MLW) to where there is currently only 3-4 feet control depth (MLW). The worst area of shoaling has occurred at the mouth of the river, where the day after the 1938 hurricane, the controlling depth was 7 feet (MLW). This same area currently exhibits 18 inches of water at mean low tide. The river has not been dredged in this century. The New Haven Trap Rock Company dredged the river to a minimum depth of 6 feet (MLW) from its mouth to the tide gates located upstream of the Route 146 bridge (which was a draw bridge up until the current fixed bridge was constructed in the 1940's) before 1900.

The fact that the river is a shellfish closure area indicates that water quality problems exist.

D: Problem Analysis

Siltation and Sedimentation

Large scale housing and commercial development projects located in the watershed of the upstream portion of the river, largely as a

Siltation and Sedimentation (con't)

result of poor erosion and control practices, have been allowing significant amounts of fine sand and silt material to enter the East Haven/Farm River system. The extensive marsh development in the estuary acts to filter out much of the soil particles that enter the system through surface runoff. In fact, core samples taken by the Yale University School of Forestry and Environmental Studies document a 3-4 inch layer of sediment deposit on portions of the marsh from a single season. This increase was directly related to sediment laden runoff from an upland condominium development project.

Although the marsh acts as a filter and removes much of this material, a significant portion enters the waters of the river where it is transported and deposited further downstream.

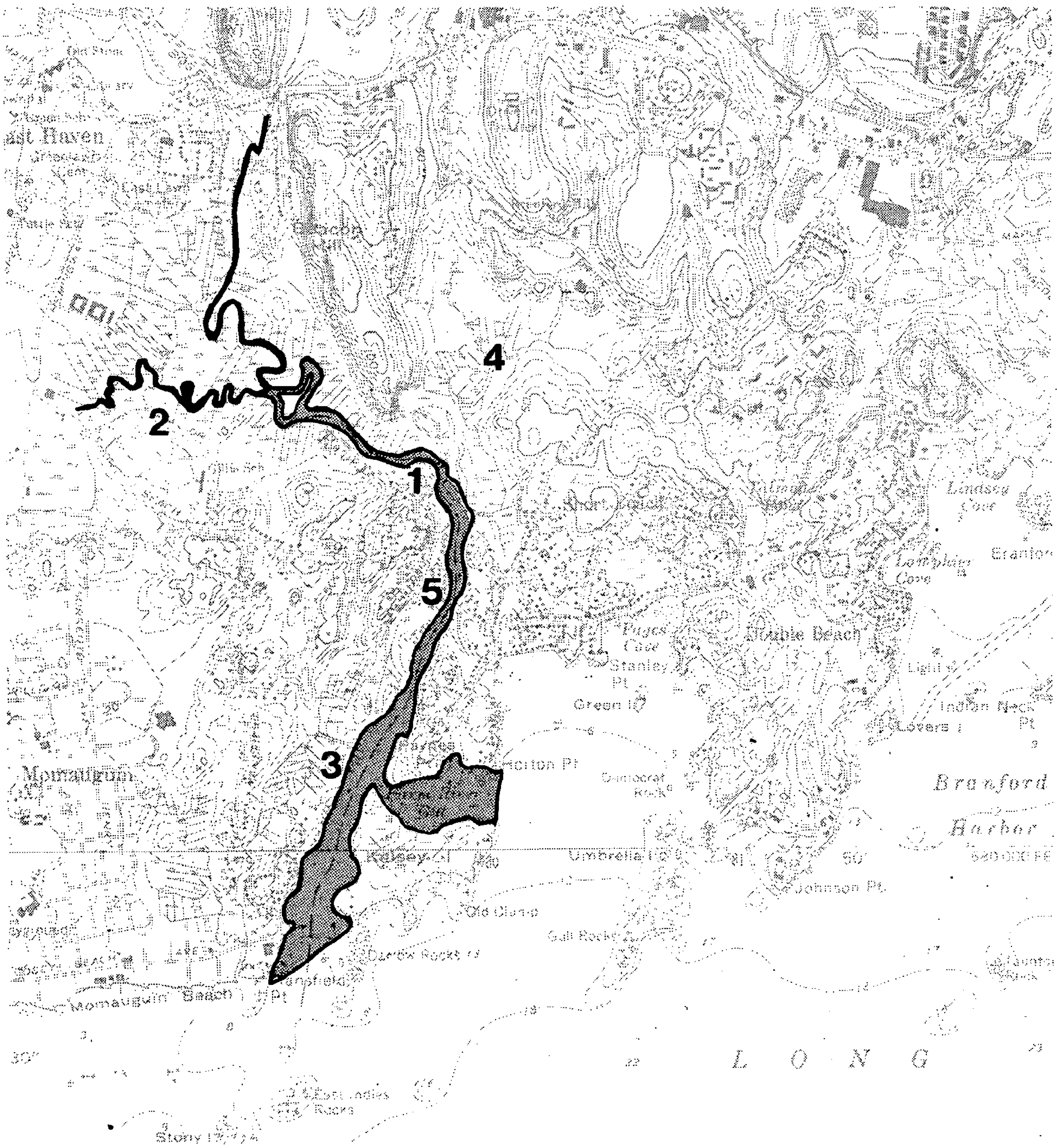
Shoaling and sedimentation has developed to the level that local commercial operations, and recreational boats are being impacted. Users of the river, which historically was navigable in all conditions, now must wait 2-3 hours either side of low tide before entering or leaving the river (see Figure 12.2).

Although it is likely that a moderate amount of sediment transport via wave and tidal action occurs, bulk of the sediment being deposited is clearly linked to upstream activities.

Water Quality Degradation

The East Haven/Farm River system is closed to shellfish harvesting for direct human consumption. Possible sources of bacterial contamination include septic system failures of upland systems, discharges from marine sources (boats), and transport of degraded water from outlying areas (New Haven/Branford Harbors).

Most of the heavily developed upland areas around the river have been sewered. This includes several large scale residential and commercial development projects. There are however, residences along low-lying areas at the rivers edge where gravity sewers were not possible. The soils of these areas are classified by SCS as having severe limitations for septic system use. It is possible, although not confirmed, that septic system leachate from residential systems in these area are responsible for elevated bacterial levels in the river. Other individuals have suggested that the amount of marina development in the river is responsible for shellfish closures. Although contamination through illegal dumping of wastes from marine systems is possible, the actual contaminant contribution from this source is most likely insignificant. The strict enforcement of regulations and availability of holding tank pump-out facilities would reduce this problem potential.



Scale: 1" = 2000'

FIG 12.2 EAST HAVEN RIVER ENVIRONMENTAL PROBLEMS

Problem Areas

1. Tide gates removed
2. Reported highwater/flooding
3. Expanded Marina development
4. Heavy sediment load from upland development
5. Highway bridge restriction

The geographic location of the East Haven River between major sewage treatment plant discharges in New Haven and Branford is the most probably cause of water quality contamination.

Flushing and Circulation

Tide gates were constructed some 7,650 feet up from the rivers mouth sometime in the last century (some reports indicate the year 1812.) These gates were installed to facilitate salt marsh haying by farmers. The upper marsh was actively hayed as late as 1926. The tide gates were destroyed in 1938 and 1954 by hurricanes. Each time the gates were repaired, but subsequent damage occurred resulting in their current state of disrepair.

Since the removal of the tide gates, the tide range is about 3 feet in the upper estuary. This tidal fluctuation has resulted in greatly improved flushing characteristics which aid in marsh development. The environmental quality of the estuary has significantly improved with the removal of the gates. However, residents in homes very close to the marsh have had minor flooding problems in their homes since the removal of the tide gates.

PROBLEM SUMMARY

East Haven River

1.	Siltation and Sedimentation below Route 146 Bridge	Moderate	(a)
2.	Bacterial Pollution	Moderate	(c)
3.	Salt Marsh Loss/Conversion	Moderate	(b)
4.	Circulation Restrictions	Moderate	(c)
5.	Erosion at Mouth	Minor	(b)

KEY: (a) Conditions becoming worse (b) No change (c) Conditions improving

CHAPTER 13 NEW HAVEN EMBAYMENT

INTRODUCTION

The City of New Haven is located in New Haven County and has the largest port in Connecticut. All of the city's 18.4 square miles fall within the Central Connecticut coastal basin. As of 1978, New Haven had the third largest urban population in the state, despite a population decrease of 5.3 percent since 1970 (1970-137,707; 1978-130,400).

The harbor area is quite large and is bordered by East Haven to the east and West Haven to the west. The three major tributaries to the harbor are the Quinnipiac River, the Mill River and the West River. The Quinnipiac River is the largest of the three and drains 166 square miles of land, including Bristol and Plainsville.

New Haven is a highly urbanized environment. Much of the stormwater falls on impervious surfaces, and flows directly to major drainageways by way of the city's extensive network of storm sewers. Land use around the harbor is predominantly industrial, and the complex has been in a general decline since World War II. Most companies along the waterfront used to be water dependent, but that is no longer the case. Extensive rail and road facilities provide or have provided superior access to the region, and the ease of land tranport has fostered a declining interest in channel maintenance. Some areas of the inner harbor (such as the Mill River channel) are now silted into 3 or 4 feet. The authorized minimum depth for a navigable channel is 9 feet.

The railroad used to dominate the New Haven waterfront, but many of the yards have been displaced or cut off from the ocean by interstate highway construction. Consequently, former water-dependent industries which used to transport most of their production by rail now rely on truck transport. This has left some waterfront rail corridors idle.

Highway construction has had a major impact on the harbor and tributaries. The shoreline was moved almost 2000 feet seaward in the area around Long Wharf (from former Waterside Park to City Point) to build Interstate 95. The upper reaches of Mill Cove were filled to improve traffic flow and provide some additional room for industrial expansion. Interstate 91, in crossing the Mill and Quinnipiac Rivers, required additional filling of the floodplains. Improved access also stimulated local development and increased urbanization of surrounding land.

The largest single remaining water-dependent use in the harbor is oil storage. Tanker transport requires minimum depths ranging from 15 feet to 35 feet (MLW). Dredging historically has been conducted approximately once every 2-5 years, but some sediment removal has become controversial due to its severe contamination. This has made the Army Corps of Engineers reluctant to dredge harbor channels unless the action is clearly necessary. Consequently, less active channels such as those of the Mill River, have not been dredged for many years.

Of the three major tributaries to the habor, the Mill River was chosen for investigation, because of its severe pollution problems.

MILL RIVER

A: Physical Description

Location

The embayment lies in the heart of New Haven's industrial district and formerly served as one of the city's major shipping waterways (See Figure 13-1). As part of the Quinnipiac drainage basin, the Mill River is a significant tributary to inner New Haven Harbor. Downtown New Haven is directly west of the embayment, while Fair Haven lies to the east. The Hamden Reservoir dam marks the northern boundary of the study area, while Quinnipiac Park and the Interstate 95 corridor are located at the mouth, its southern limit. Interstate 91 and the Springfield line of Conrail cross the embayment approximately 1 mile north of the mouth. East Rock State Park borders the river north of Interstate 91.

Site Orientation and Configuration

The embayment is roughly linear with its axis oriented north to south (see Figure 13.1). It is approximately 2.9 miles long from the Hamden Reservoir to the mouth. The banks of the river are filled and stabilized south of Interstate 91, but have remained in a more natural state north of the highway. The maximum width of the river is found at the mouth (400 ft.). From there, the river maintains a width of at least 130 feet up to the Grand Avenue bridge, just north of the United Illuminating power plant. North of Grand Avenue, the river maintains a width of at least 80 feet until it approaches the reservoir dam.

Tidal Data

Mean tidal range -	6.0 ft.
Spring tidal range -	6.9 ft.
Mean tide level -	3.0 ft.

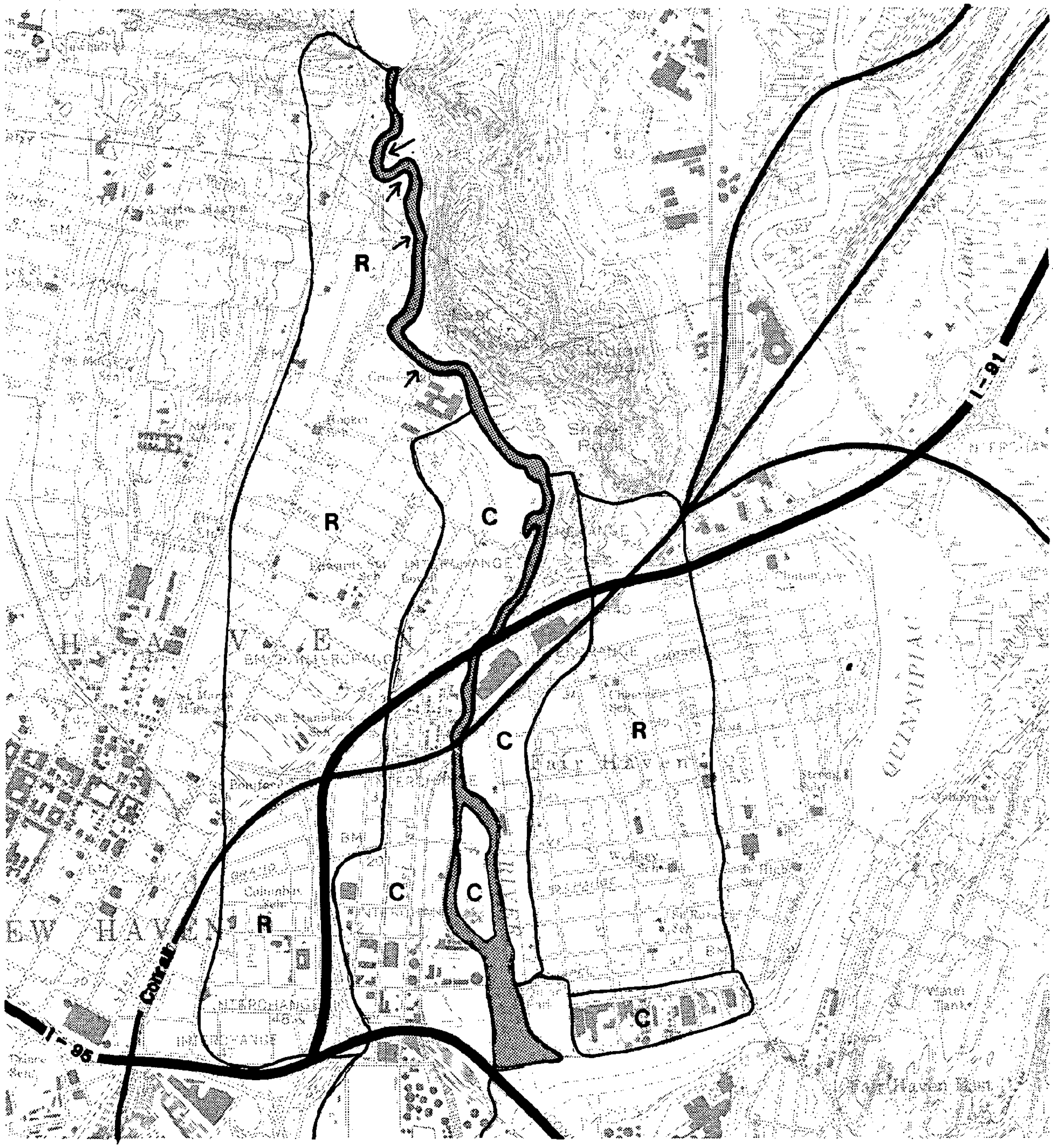
Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth:	3-9 ft. (MLW)
Channel Depth:	9 ft. (MLW)

Additional Comments: The above date was recorded in 1971, and recent field observations indicate that the river is considerably shallower than 9 feet at mean low water.

Source: NOAA National Ocean Survey Maps



Scale: 1" = 2000'

FIG. 13.1 MILL RIVER ENVIRONMENTAL LAND USE

Legend:

- wetlands
- **A** agriculture
- **R** residential
- **C** commercial/industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Basin Hydrology

Regional Drainage Basin: Central Connecticut Coastal Basin

Embayment Basin Area: 38.5 square miles

Tributaries to Embayment: Mill River (upper reaches)

Other Sources of Fresh Water Inflow: A large percentage of river flow during storm events comes from urban runoff.

Constrictions to Tidal Flow and Circulation:

Structure	% Constriction	Distance from Mouth
Chapel Street Bridge	0-25	0.3 miles
Grand Avenue Bridge	0-25	0.7 miles
Conrail R.R. Bridge	0-25	1.0 miles
I-91 Bridge	0-25	1.2 miles

Sources: U.S. Geological Survey, Connecticut Drainage Basin Gazeteer, 1981; Conn. Dept. of Environmental Protection

Water Quality Conditions

Upstream Water Quality Classification: C/B

Embayment Water Quality Classification: SD/SB

Direct Discharges:

Source	NPDES Permit #	Waste Characteristics
Cerro Wire & Cable Co.	CT0000256	-
*Conn. Hard Rubber Co.	CT0002810	Thermal discharge
New Haven Water Co.	CT0000876	Suspended solids, pH variation

Water Quality Conditions (con't)

Direct Discharges:

Source	NPDES Permit #	Waste Characteristics
Simkins Ind. - N.H. Board Div.	CT0003425	Treated paper effluent, high BOD suspended solids, variable pH
United Illum. -English St.	CT0003794	Suspended solids, variable pH, suspended solids thermal discharge
Rockbestos Co.	CT0023302	Variable pH, thermal discharge

* Permit has expired.

Future Status of Discharges: Most companies appear to be phasing out their discharges. Simkins Paper Co. indicated they had phased out their discharges, yet there was discolored effluent flowing from a pipe in front of their factory.

Sewer Service Area: Sewers serve the entire lower drainage basin of the river, except for the waterfront lots below the Grand Avenue bridge and above the I-91 bridge.

Storm Sewer Outfalls: Storm sewers discharge to the Mill River all along the waterfront and are most common along the lower reaches south of the I-91 bridge.

Significant Non-Point Pollution Sources: Organics and heavy metals are probably the two most significant types of pollution. The organics come from domestic wastes, while the metals are primarily caused by oil and gas combustion. Oil, antifreeze and other car products are also another significant component of non-point pollution.

Shoreline and Bottom Conditions

Extent of Shoreline Modification: Almost the entire lower half of the Mill River has been channelized and stabilized with seawalls and bulkheads. Tidal flats along the upper half of the river have been filled for development and playing fields, particularly around the Lovell School (New Haven). Tide gates, which are located under the I-91 bridge, reduce upstream flow of tidal waters.

Many of the bulkheads along the lower reaches of the river are old, and in some cases rotting out or completely disintegrated. The sediment banks behind the decayed stabilization are vulnerable to erosion, particularly during high flow periods.

Surrounding Lands

Maximum Basin Elevation:

Location	Height
East Rock Park	360 ft.
Yale Observatory, Prospect St., New Haven	150 ft.
Ferry St., Fair Haven	30 ft.

Topography: The eastern shore of the Mill River near East Park has very steep slopes.

General Vegetation Characteristics: Most of the Mill River basin is highly urbanized and has little vegetation.

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Adrian and Palms	mucky	-	very poor
Branford	silt loam	0-3	very poor
Branford	silt loam	3-8	very poor
Branford	silt loam	8-15	very poor
Cheshire	fine sandy loam	3-8	very good
Cheshire	fine sandy loam	8-15	very good
Cheshire	fine sandy loam	15-25	very good
Cheshire-Holyoke	complex	3-15	poor
Hinckley and Manchester	gravelly sand loams	15-35	very poor
Holyoke-Cheshire	complex	15-35	very poor
Manchester	gravelly sand loam	3-15	very poor

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Penwood	loamy sand	0-3	very poor
Penwood	loamy sand	3-8	very poor
Rock Outcrop-Hollis	complex	-	very poor
Rumney	fine sandy loam	-	very poor
Typic Udorthents	cut and fill	-	variable
Wethersfield	loam	8-15	poor
Wethersfield	loam	15-25	poor

Bottom Sediment Characteristics: Former paper company waste included high concentrations of sulfur, which are now mixed in high concentrations with the sediment. Anaerobic bacterial action produces hydrogen sulfide gas which bubbles through the sediment and rises to the surface of the river. The H_2S turns the bottom sediment into a light, gasified mass that occasionally breaks off from the bottom and floats to the water surface in large gray chunks. It is not known what other pollutants are present, but it is presumed that the heavy industrial activity of past decades discharged a wide variety of chemical and heavy metal wastes.

Shoaling and Sedimentation Characteristics: Most of the waterfront uses are no longer water-dependent, and thus there is little pressure to dredge the Mill River for navigation. As a result, the lower reaches are particularly shallow. NOAA maps show a 9 foot channel (MLW), but recent field observations indicate the depths are generally no more than five feet. Many areas are less than three feet. An engineer for one of the companies along the waterfront claims that much of the sedimentation problem is linked to the extensive filling of upstream tidal flats. Currently, much less harbor water enters the river basin, and the reduced flow limits the scouring effect of the tides.

Shellfish and Finfish Resources

There are no known shellfish beds in the Mill River. All shellfish beds in New Haven are closed. The status of finfish populations in the river is unknown. Due to the high stress of the severely degraded environment, it is presumed that the species diversity is low and limited to very hardy fish.

Wetlands

Wetlands are limited to Reed Grass (Phragmites communis) fringe marshes north of the Interstate 91 bridge (See Figure 13.1). The system is fresh water, due to the tide gates located underneath the bridge. The vegetation lines the banks and helps stabilize soil and filter debris and organics that would otherwise pollute the embayment.

The Mill River floodplain is quite wide and presumably includes marshes along the shores at least as far inland as Snake Rock. Development of the lower reaches occurred at least 100 years ago, and large areas of marsh and intertidal flats were present north of the Conrail bridge before World War II. Tide gates under the I-91 bridge block saline waters from penetrating further upland, and have essentially converted that part of the estuarine system to a freshwater one.

At presents most of the marshy floodplain has been filled to reclaim land for roads and industrial expansion. Though the lower reaches are extensively stabilized, segments of the upper reaches are in a natural state and may be bulkheaded or diked in the future. The area of wetlands within East Rock State Park should be protected from further filling and development.

Environmentally Sensitive Areas

Location - East Rock Park contains the only vegetated floodplain and natural habitat in the Mill River basin below Whitney Lake. The park's vegetated floodplain provides habitat, flood protection, and a natural filter effect for detritus and nutrient loading. The steep slopes and exposed ledge provide habitat for birds and some mammals.

The Mill River did contain at least several species of rare plants which inhabited the intertidal flats. It is not known whether these species are still found in the area today.

B: Land Use Analysis

Current Shoreline and Water Use

The shoreline of the lower reaches is industrial, but very few companies are still water-dependent. A small commercial fishing operation stores oyster shells on the eastern shore across from the United Illuminating power plant.

The upper reaches of the Mill River fall within East Rock Park and include wildlife habitat on the east bank and recreational fields and sport facilities on the west bank.

Current Upland Use

Land use of the lower reaches is almost entirely industrial on the west side of the river, and a mixture of industrial and residential use on the east side. Quinnipiac Park, a large community recreation facility, is located at the mouth of the river. Most of East Rock Park is located on the east side of the upper reaches of the river, while the west side includes several schools and a mixture of industry and residential neighborhoods.

Historical and Significant Land Use Changes

The most significant changes in land use since 1930 have been the construction of Interstates 91 and 95, a decline in water-dependent uses along the lower reaches, and filling of additional floodplain north of Interstate 95. Placement of self-regulating tide gates under the I-91 bridge converted the upstream aquatic system from estuarine to fresh.

The United Illuminating power plant is now used to supplement the state's electricity needs only during peak power demand, and thus discharges thermal effluent only periodically.

Public Access and Recreational Opportunities

Visual access to the river is provided from the Grand Avenue Bridge.

The floodplain of East Rock Park was designed primarily for recreation, and includes trails along the east bank for naturalists. A large recreation area with basketball courts, a track and playing fields is located on the west bank.

C: Problem Identification

Local Departments and Offices Consulted

New Haven Office of Downtown and Harbor Development.

Local Industry Field Visits

United Illuminating, Simpkins Paper Company, Rockbestos Company

Response from Questionnaires and Local Meetings

According to city officials, the embayment experiences erosion, siltation, and both point and non-point pollution. The erosion is mostly of the industrially developed shoreline where old bulkheads have decayed and left the river bank exposed. Some of the sediment is believed to settle in the river next to the source of erosion. Other siltation appears to be caused by natural fluvial transport, particularly from the floodplain near East Rock Park, where there is a large sediment reservoir.

An engineer of Simkins Paper Company believes the siltation problem became significantly worse after back bay flats were filled for park and upland development. When this happened, there was a considerable decrease in the volume of tidal flow moving through the lower reaches. With lower flow velocities, there was less opportunity for the resuspension of silted bottom sediment.

Results of Field Survey and Research

The field investigation confirmed the polluted and severely silted condition of the Mill River below the Grand Avenue Bridge. Close observation from the river bank revealed that the water body is actually effervescent. Anaerobic bottom sediments continually release hydrogen sulfide gas which bubbles to the surface. Extensive sediment gas production also makes the bottom soft and buoyant. Occasionally, glutinous gray chunks of the material float to the surface.

A Simkins Paper Company official indicated they had phased out their industrial discharge, yet a look at their outfall revealed a discharge of turbid, gray process water. Aerial photographs from a previous fly-by during 1981 also showed this same discharge in a large gray plume.

The United Illuminating power plant is located across from Simkins Paper Company. The plant used to run on coal, and the old storage areas still exist on-site. Currently, because the plant runs on oil and is expensive to operate, the facility provides supplementary electricity to the power grid during peak demand periods. The company is forced to dredge parts of the Mill River channel periodically to keep the cooling water intake pipes free of sediment and bottom debris.

Other uses of waterfront property between the Grand Avenue and Chapel Street bridges include a rubber tire scrap operation, New Haven Gas Companv's storage tank, oyster shell storage, and a cement company. North of the bridge, the east bank is underutilized with a few storage buildings and empty lots. The west bank is more intensively developed with a variety of industrial companies, such as Connecticut Hard Rubber and a scrap materials recycling center.

Results of Field Survey and Research

In general, the lower reaches of the Mill River are underutilized and provide opportunities for adaptive reuses of waterfront property. Only one water-dependent industry remains today. Four industries still discharge wastes into the river (see Sub-section A-8 for details), and the river water quality is still turbid and very polluted. Tidal constriction from bridges and the subsequent filling of back bay wetlands have turned the embayment into a sluggish water body which tends to localize and concentrate pollutants.

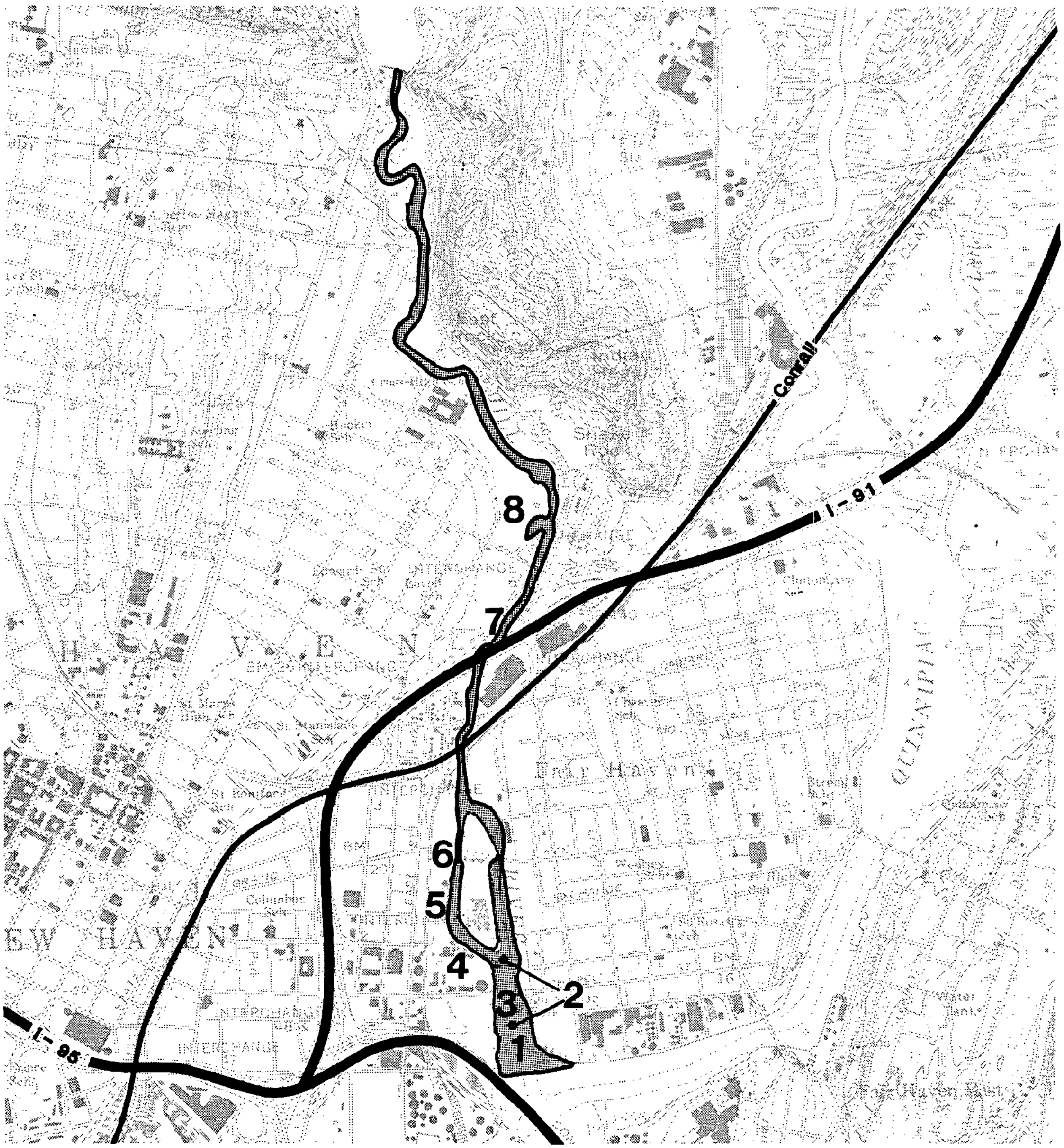
The natural shoreline of East Rock Park is vegetated primarily with Reed Grass (Phragmites communis). The creek bed is shallow and meanders within a relatively wide floodplain. Some former marsh areas have been filled for recreational fields on both sides of the river. The shorelines of filled land are now well vegetated with Reed Grass and other wetlands species. Several large diameter storm sewer pipes drain the high water table of the filled land and discharge storm water collected from surrounding lands into the river.

D: Problem Analysis

Siltation and Tidal Flow Constriction

The Mill River once meandered through a wide floodplain of tidal marshes and mud flats. Subsequent development over the past 150 years transformed this productive estuary into one of the largest industrial centers of the state. The industrial land was formed through a gradual filling of marsh and flats, and through stabilization of the shoreline with stone walls and wooden and steel bulkheads. Today, upland encroachment of the floodplain constricts tidal flow and reduces both water column mixing and circulation.

The lower reaches were the first areas to be filled, due to ease of access and close proximity to the New Haven rail lines. This constriction likely had the greatest impact on sedimentation, as the encroachment slowed tidal exchanges and increased sediment deposition. Despite this development, large volumes of Long Island Sound water still penetrated the inner marshes on a flood tide. During the ebb phase, outgoing currents helped to scour the channel bottom and free it from sediment. When the inner marshes were eventually filled to provide recreational space and additional industrial sites, tidal flow through the lower reaches dropped significantly. Several industries near the mouth claim that this, in turn, reduced the scouring effect and increased the sedimentation rates of the channel.



Scale: 1" = 2000'

FIG. 13.2 MILL RIVER ENVIRONMENTAL PROBLEMS

Problem Areas

1. Area closed to shellfishing
2. Anoxic bottom conditions
3. Highly contaminated bottom sediment
4. Stormwater runoff from industrial lots
5. Decaying bulkheads
6. Bridge constricts tidal flow
7. Tidegates
8. Filled in floodplain

Siltation and Tidal Flow Constriction (con't)

Historically, as long as water-dependent uses demanded regular dredging of the channels, the Army Corps was compelled to maintain minimum depths of 9-12 feet. Since World War II, however, much of the Mill River industry has either left the area or converted to trucking for raw materials, parts, and products distribution. Consequently, the demand for dredging has declined and the river has silted to depths of less than 5 feet (MLW) below the Grand Avenue Bridge. Many of the industrial pollutants have become fixed to fine suspended sediment particles and have settled to the bottom of the channel. The contaminated quality of the sediment makes disposal more difficult and tends to further discourage the Army Corps from dredging the channel in the future.

In the future, the major source of sediment will continue to be the silty upper reaches of the Mill River. Periodic peak flow conditions flush the reservoir of sediment to the lower reaches. Here, storm surge slows drainage velocities, creating favorable conditions for the settling of the material. The two other less significant sediment sources include erosion of deteriorated river banks and siltation of tidally transported material from New Haven Harbor and Long Island Sound.

Water Quality Degradation and Eutrophication

Mill River water quality is rated B as it leaves Whitney Lake (Hamden), but by the time it reaches New Haven Harbor it has been degraded to SD. Below Whitney Lake, the first source of pollution is the New Haven Water Company's filter backwash from its water purification process at Whitney Lake. This source of intermittent pollution, combined with storm sewer discharges above I-91, degrades water quality to Class C. Below Interstate 91, the industrial discharges of Cerro Wire and Cable Company, Connecticut Hard Rubber Company, Simkins Industries and United Illuminating degrade the water quality to SD, Connecticut's lowest classification. This classification means that one or more of the following embayments uses are severely inhibited or precluded: water recreation, fish spawning, industrial cooling, and wildlife habitat. Storm sewer drainage and re-suspension of polluted sediments add to the degraded conditions of the embayment. It should be noted that the United Illuminating plant discharges thermal effluent to the river only occassionally now, because its use is limited to periods of peak energy demand.

Water Quality Degradation and Eutrophication (con't)

The sediment of the lower basin appears to be heavily contaminated with pollutants from current and past industry. The typically high biological oxygen demand (BOD) levels of paper waste (Simkin Industries) depletes the water column of dissolved oxygen and creates anaerobic conditions in the sediment. The sulfurous paper wastes create an environment favorable for the production of hydrogen sulfide gas (H_2S). Warm tidal water during summer months accelerates the process and creates a constantly bubbling water surface. Gas production also makes the sediment very soft, and periodically chunks float to the surface.

In summary, the majority of pollutants that continue to be discharged to the Mill River are suspended solids, high BOD organics, acids, and cooling water.

Heavy metals, polychlorinated biphenyls and other highly stable contaminants are generally absent in the discharge, and therefore have no long term effects on the embayment. If any are present, they are more likely to have been discharged by former industries. Little information was available on this matter.

PROBLEM SUMMARY

Mill River

1.	Tidal Flow Constriction	Moderate	(b)
2.	Sedimentation	Severe	(b)
3.	Water Quality Degradation	Severe	(b)
4.	Eutrophication	Severe	(b)

KEY: (a) Conditions becoming worse (b) No change (c) Conditions improving

CHAPTER 14 MILFORD EMBAYMENTS

INTRODUCTION

The City of Milford is located in New Haven County and is situated between West Haven and Stratford on Long Island Sound. The city has an area of 22.3 square miles, all of which drain to the Central Connecticut coastal basin. During 1970 to 1978, the city grew 1.6 percent (1970-50,858; 1978-51,700). This figure was considerably less than the New Haven county average of 4.1 percent, which in itself was the lowest growth rate of the four counties bordering on Long Island Sound. The housing unit growth rate was 10.5 percent, suggesting that construction impacts in the coastal community may be more significant than the population growth rate indicates.

Compared to other coastal Connecticut communities, Milford has a fairly regular shoreline. Aside from the embayments of Gulf Pond, Milford Harbor, and the mouth of the Housatonic River, most of the shoreline is comprised of beaches. Several tidal creeks, such as Gulf Pen Meadow Creek and Great Creek, drain wetlands that are protected by barrier beaches. Much of the beach sand in the community originated from large deposits left during the Ice Age. For example, the southeastern part of Milford around Milford Lawns, Morningside and Bayview is actually a formation of five large drainlines. Bryan Hill and Merwin Hill are two classic examples of drainline geology. Drainlines typically are composed of a mixture of polished stone, sand, and gravel. It is likely that prior to changes in sea level and the action of coastal currents, there were one or two other drainlines in the offshore zone. The sand from these eroded drainlines and other sand deposits have since formed the beaches of Milford.

Historically, development was most active along the Wepawaug River because of its deep natural channels (See Figure 14.3). The upper reaches above U.S. 1 were dammed in several places to provide water power for the community's first mills. Most of the overland traffic moved by way of the Boston Post Road, which dates back to the eighteenth century. The first Post Road bridge built over the Wepawaug was constructed in 1802 under the Jefferson Administration as part of the Milford-New Haven Turnpike.

Milford has been known as an industrial community, and since the early 1940's has diversified its economy with increased commercial and retail businesses. As of 1977, approximately one-third of the total non-agricultural employment force was employed in manufacturing. This compares with approximately 24% for West Haven and 62% for Stratford.

Considerable residential growth has occurred since the 1950's. Infilling has been quite extensive in the southeastern part of the city and between Gulf Pond and Milford Harbor. As the local economy has expanded, the city is becoming increasingly popular for community executives. Despite the recent growth, a large area of Milford has been sewered for more than thirty years. Treatment plants are located on both the harbor and Gulf Pond, and discharge directly into the surface water. The Milford Harbor facility is very old, and the city anticipates replacing it during the next five years. In addition, the Gulf Pond treatment facility may be enlarged to handle wastes from an expanded service area.

In the initial stages of this investigation, the three embayments considered for study included Beards Creek, Gulf Pond and the Wepawaug River. Beards Creek was ultimately dropped from the groups because it is a relatively small water body that has long-term historical problems relating to pollution and sedimentation. Gulf Pond and the Wepawaug River are much larger and more complex estuarine systems which have encountered significantly greater impacts over the past twenty years. It is likely that increased developmental pressures along the shoreline and increased recreational demands will create a number of negative environmental impacts.

GULF POND

A: Physical Description

Location

The embayment is located approximately 1 mile east of the center of Milford (See Figure 14.1). The mouth of the pond flows into Milford Harbor across from Burns Point. The neighborhoods of Knobb Hill, Bayview and Bryan Hill occupy the east bank, while an unnamed residential section borders on the west bank. New Haven is located 9 miles east of Gulf Pond.

Site Orientation and Configuration

The pond is divided by Buckingham Avenue into two water bodies. For the purpose of this report, they will be referred to as the inner and outer ponds. The outer pond is irregular in shape and crossed at the mouth by the Gulf Street bridge. The dimensions of the outer pond are 1400 feet wide (at its widest point) and 3200 feet long (longest dimension). The inner pond is narrower and altogether smaller. It is 800 feet at its widest point and 2800 feet long. Indian River drains into the head of Gulf Pond at the crossing of U.S. 1 and the Conrail line.

Tidal Data

Mean tidal range -	6.6 ft.
Spring tidal range -	7.6 ft.
Mean tide level -	3.3 ft.

Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth:	Not Available
Channel Depth:	Not Available

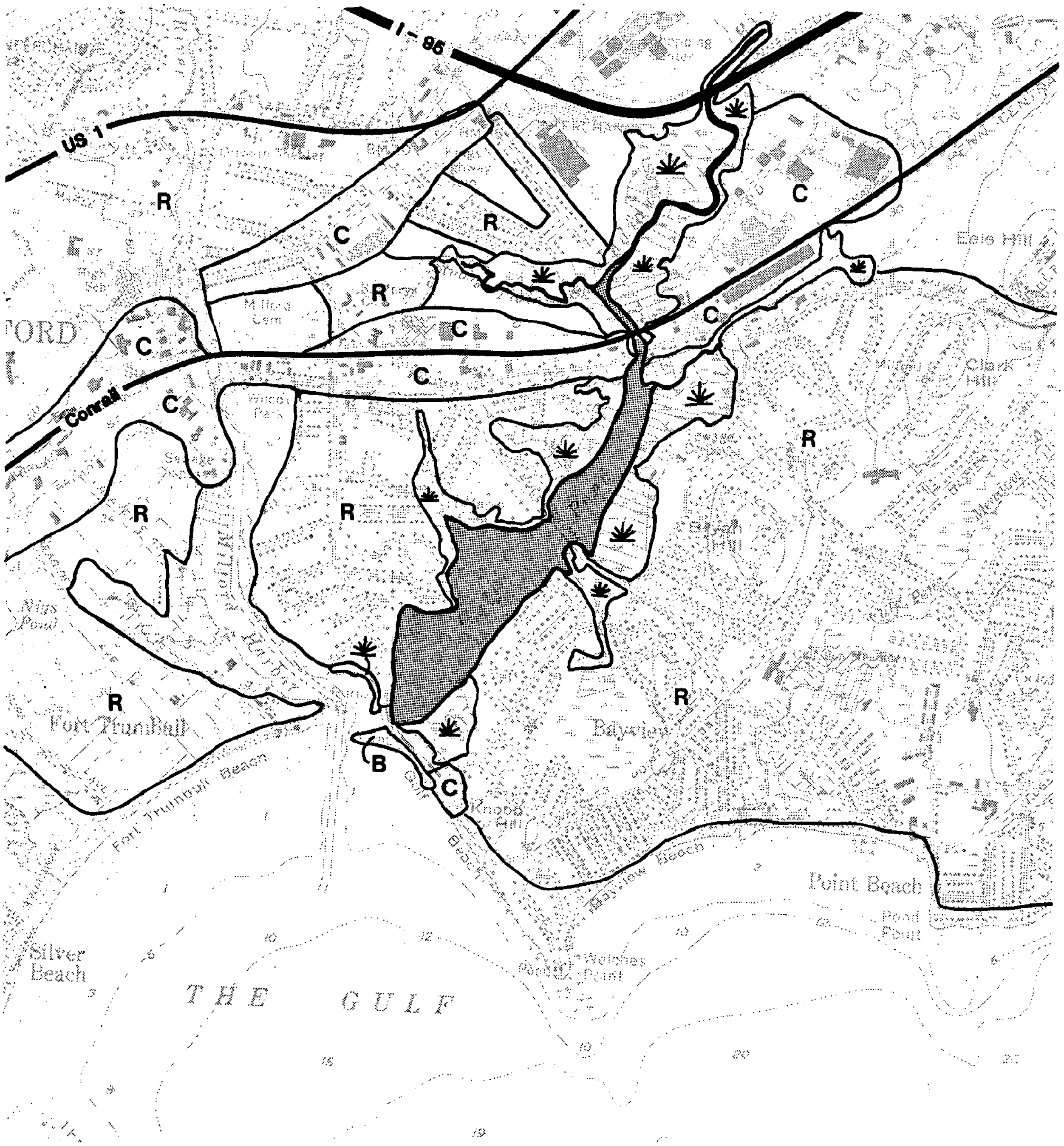
Additional Comments: Though NOAA shows no recorded depths for the embayment, field observations indicate the depth probably ranges from 1 to 5 feet at mean low water.

Source: NOAA National Ocean Survey Maps

Basin Hydrology

Regional Drainage Basin: Central Connecticut Coastal Basin

Embayment Basin Area: 12.1 square miles



Scale: 1" = 2000'

FIG 14.1 GULF POND ENVIRONMENTAL LAND USE

Legend:

- wetlands
- **A** agriculture
- **R** residential
- **C** commercial/industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Tributaries to Embayment: Indian River
Stubby Plain Brook
3 unnamed brooks

Additional Significant Sources of Fresh Water Inflow: Stormwater runoff is minimal and limited to surface drainage from New Haven Avenue strip development and some residential development bordering the marshes of Gulf Pond.

Constrictions to Tidal Flow and Circulation:

Structure	% Constriction	Distance from Mouth
Welches Point Road Bridge	75-100	At mouth
Buckingham Ave. Bridge	75-100	0.7 miles
New Haven Avenue Bridge	50-75	1.1 miles
Conrail Railroad Bridge	75-100	1.2 miles
I-95 Bridge	0-25	2.0 miles

Sources: U.S. Geological Survey, Connecticut Drainage Basin Gazeteer, 1981; Conn. Dept. of Environmental Protection

Water Quality Conditions

Upstream Water Quality Classification: B

Embayment Water Quality Classification: SB

Direct Discharges:

Source	NPDES Permit #	Waste Characteristics
Alinabal, Inc.	CT0023922	
Brunswick Corp.	CT0000647	Treated industrial waste-iron, chromium nickel, suspended solids, thermal discharge
Milford-Gulf Pond STP	CT0100765	High BOD, suspended solids, pH variability, chloride

Water Quality Conditions (con't)

Direct Discharges:

Source	NPDES Permit #	Waste Characteristics
Schick Safety Razor	CT0003395	Treated industrial discharge-copper, gold, iron, nickel, zinc, cyanide, suspended solids, thermal discharge pH variability
Burndy Corp.	CT0001538	Industrial discharge aluminum cadmium, copper, nickel, tin, cyanide, suspended solids, thermal discharge

Future Status of Discharges: Milford rejected a plan in 1978 to expand the city sewer system, consolidate the sewer treatment districts and expand the treatment capacity at the Gulf Pond Waste Treatment Facilty. Dissolved oxygen levels commonly go below the state standard of 5.0 ppm, so the city must find a strategy to reduce the biological oxygen demand of the waste load.

Sewer Service Area and Discharge Point: The houses along the shorefront of Gulf Pond are served by an old sewer system which treats the waste at a waterfront site on the east side of the pond south of U.S. 1. The plant discharges the treated waste directly to Gulf Pond (See Figure 14.2).

Storm Sewer Outfalls: The sewer outfall of the Gulf Pond plant is located on the east side of the pond between the Buckingham Avenue and the New Haven Avenue bridges (See Figure 14.2).

Shoreline and Bottom Conditions

Extent of Shoreline Modification: Most of the shoreline remains as natural tidal wetlands. Only a small stretch of shoreline has been stabilized on either side of the three highway bridges and one railroad bridge that cross the embayment. Some commercial development near the U.S. 1 bridge has encroached into wetlands, but the intrusion is relatively minor.

Significant Areas of Erosion - Erosion within the embayment is not severe and is caused by the natural processes of drainage, tidal currents and wind generated currents.

Shoreline and Bottom Conditions (con't)

Shoaling and Sedimentation Problems: Gulf Pond is not well suited for navigation because of the low bridges across the embayment and the shallow and silty bottom conditions. The pond has a wide floodplain, and sediment deposits have formed tidal flats. Tidal flow has maintained a channel through the flats, and permits some flushing of the embayment during each tidal cycle. The embayment is used very little for boating, so there has been litte demand for dredging.

Bottom Sediment Characteristics: Field observations indicate that the bottom is a mixture of sand and silt. Relative percentages of the two components depend on the magnitude of tidal and wind energy affecting any given site. Generally, the bottom sediment becomes increasingly silty upstream. The same pattern is true as one moves away from the channel center toward the shore.

Surrounding Lands

Maximum Basin Elevation:

Location	Height
Bryan Hill (east side, inner pond)	138 ft.
Bayview (near Welches Point Rd.)	60 ft.

Topography: The uplands surrounding the embayment south of the Conrail line are essentially flat on the western shore and gently rolling hills (drainline formations) on the eastern side. The uplands become more hilly further north in the Indian River Basin.

General Vegetation Characteristics: The eastern shore area (Bayview and Bryan Hill) is moderately developed and is interspersed with large mature trees and some grassy fields. The western shore has a similar pattern of vegetation.

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Adrian and Palms	mucky	-	very poor
Agawam	fine sandy loam	0-3	very poor
Agawam	fine sandy loam	3-8	very poor
Beaches	-	-	very poor

Surrounding Lands (con't)

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Carlisle	muck	-	very poor
Charlton	fine sandy loam	3-8	very good
Charlton	fine sandy loam	8-15	very good
Charlton	fine sandy loam	15-25	very good
Charlton-Hollis	fine sandy loams	3-15	poor
Haven	silt loam	0-3	very poor
Haven	silt loam	3-8	very poor
Hinckley	gravelly sandy loam	3-15	very poor
Leicester	fine sandy loam	-	very poor
Sutton	fine sandy loam	3-8	poor
Typic Udorthents	cut and fill	-	variable
Walpole	sandy loam	-	very poor
Westbrook	mucky peat	-	very poor

Shellfish and Finfish Resources

There are large clam populations in the mud flats of the embayment. All waters of Gulf Pond, however, are closed to shellfishing.

Gulf Pond serves as an anadromous fish pathway for spawning fish seeking the Indian River. In addition, many juvenile fish rely on the Gulf Pond marshes for habitat.

Wetlands

Wetlands completely surround Gulf Pond from the Welches Point Road bridge to the New Haven Avenue bridge (See Figure 14.2). Wetland vegetation is also found in the floodplain of the Indian River.

The Gulf Pond marshes form a protective vegetated buffer between the water's edge and adjacent uplands, and range from 25-1200 feet in width. The marshes provide habitat, a food source, soil suitability, buffering of storm wave action, and serve as a natural biological filter for excess nutrients, detritus, and eroded sediment.

Historically, most of the pond shoreline has not been filled or stabilized, and the wetlands still remain in their natural state. Most wetland filling over the past 20 years has been limited to the wetland interface, where homeowners or developers may have filled small areas to create lot dimensions that satisfied zoning requirements. Some additional filling has also occurred at bridge abutments and along the causeways of roads crossing the embayment.

Thus far, the wetlands have survived the pressures of new suburban residential development and infilling on both sides of the embayment. Continued active enforcement of both tidal and inland wetland regulations should protect the wetlands in the future.

Environmentally Sensitive Areas

The Gulf Pond and Indian River tidal marshes provide resting and feeding sites sites for shore birds, food and refuge for other wildlife, and a natural buffer for the embayment water body. In addition, the mud flats which are exposed at low tide are a productive feeding area for shore birds and should be considered a complementary component of the wetland wildlife habitat.

B: Land Use Analysis

Current Shoreline and Water Use

The shoreline remains in a natural state and is bordered by marsh ranging in width from 25 to 1200 feet. A few docks border on the embayment near the mouth, but the pond is essentially unused for boating.

The major uses of the embayment include disposal of treated sewage waste, fishing, passive recreation and conservation. The embayment is seldom used for swimming because of high coliform bacteria levels (especially during the summer).

The Indian River is also well vegetated along its banks and is used for disposal of industrial wastes (see Sub-section A-4), passive recreation, and conservation.

Current Upland Use

The upland use around Gulf Pond is almost exclusively residential, except for the recreational use of Gulf Beach located on the seaward side of Welches Point Road (See Figure 14.1).

Current Upland Use (con't)

The uplands adjacent to the Indian River between the Conrail and I-95 bridges are used for industry. A shopping center and several other commercial buildings border on the river's floodplain north of the I-95 bridge.

Historical and Significant Land Use Changes

1934 aerial photos show that the uplands surrounding Gulf Pond used to be primarily agricultural land. Some crops actually bordered directly on tidal wetlands along the lower reaches of the pond. By 1951, the choice farm sites on the eastern and western sides of the pond were being developed for housing. Large scale housing tract developments were built along the eastern shore areas of Knob Hill, Bryan Hill and the nearby shoreline of the outer cove. Housing development tended to be of smaller scale on the western bank and included infilling of less developed neighborhoods.

By 1970, nearly all local farmland had been developed for housing. The rest was abandoned and allowed to grow over with trees and shrubs. The remaining significant areas of undeveloped land were freshwater and tidal wetlands that had high water table conditions and poor soils.

Public Access and Recreation Opportunities

Gulf Beach, a public recreation area, is located near the mouth of Gulf Pond. The Welches Point Road bridge, located next to the beach, is a popular fishing spot. There are good views of the pond from the beach and bridge, as well as from the Buckingham Avenue and New Haven Avenue bridges. There are no public boat ramps or docking facilities on Gulf Pond.

C: Problem Identification

Local Departments and Offices Consulted

Milford Engineering Bureau and Milford Harbor Commission.

Response from Questionnaires and Local Meetings

Milford officials believe there is a severe natural siltation problem that has existed for at least 20 to 30 years. The consensus also is that the problem will become even more severe in the future. Pollution and eutrophication are regarded as moderate problems that are principally caused by the 2.4 million gallon per day (mgd) sewage treatment plant located on the eastern shore of the inner pond (See Figure 14.2). The plant was originally built in 1959 and has a peak flow design of 7.2 mgd. One pollution impact of the plant cited was the embayment's low dissolved oxygen levels in the summer, presumably caused by the heavy BOD loading of the sewage effluent. City officials believe that eutrophication will also become more severe in the future. Although the presence of industry along the Indian River was mentioned during communication with the city, no mention was made of any polluting effluent or impacts of outfalls on the embayment environment.

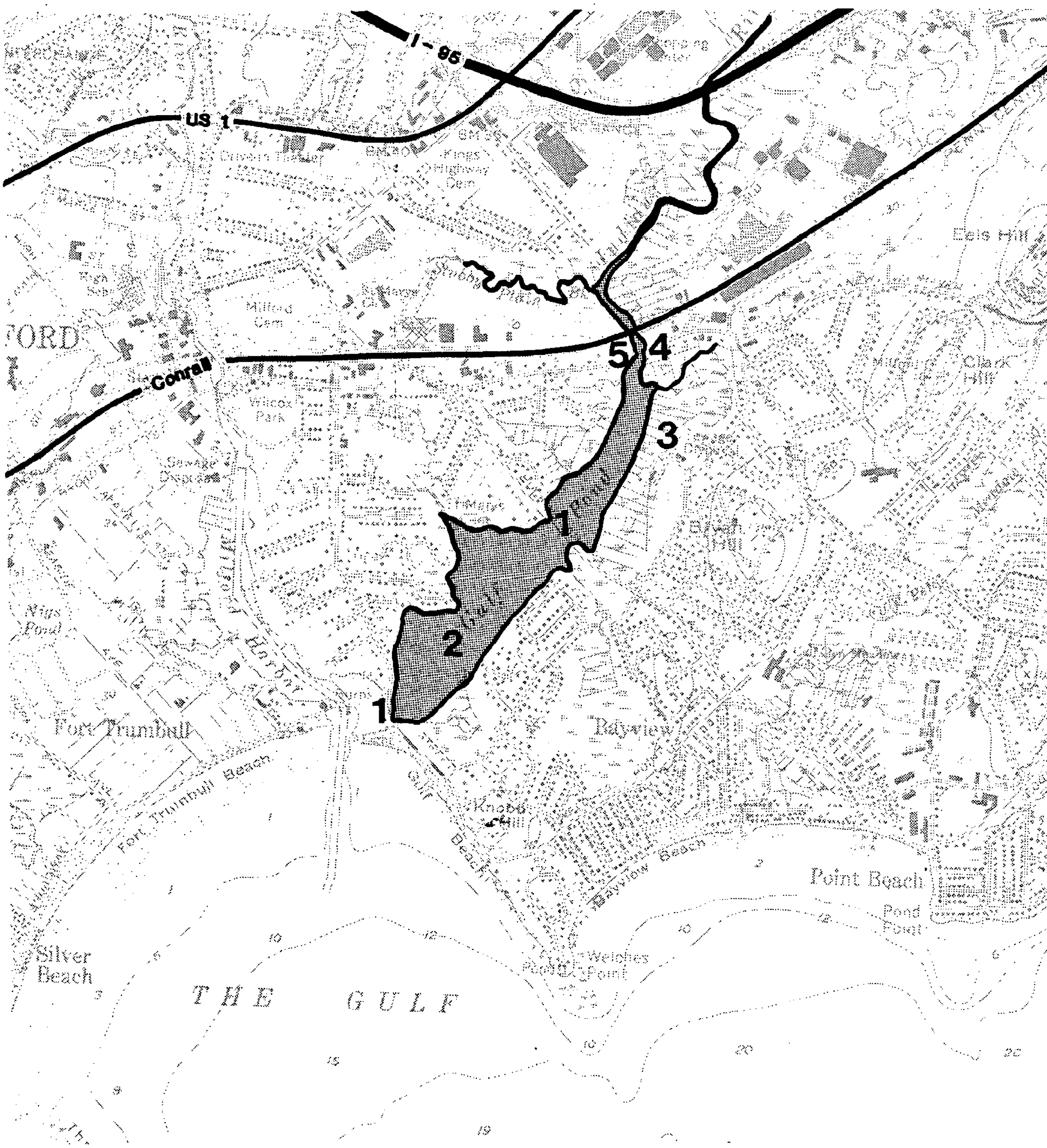
The only erosion noted by the city concerned Gulf Beach, which is located outside of the embayment. Saltmarsh loss is believed to be minor, if at all, and city officials do not expect that trend to change in the future. The condition of the marshes is believed to be good, and the marshes are moderately productive.

Results of Field Survey and Research

A survey of the embayment confirmed the shallow silted condition of both the inner and outer pond areas. The marshes along the shoreline show vigorous growth and appear to be expanding into some areas of shallow subtidal and intertidal mud flats. A large number of shore birds were observed feeding on fish in shallow tidal areas and working mud flats just north of the Buckingham Avenue causeway and bridge.

No boating on the embayment was observed during the survey, but fishing appeared to be quite popular from the Welches Point Road bridge.

The embayment tidal flushing and circulation is very constricted due to the Welches Point Avenue bridge and the Buckingham Avenue bridge. Though it is difficult to estimate how wide the natural mouth of the pond was prior to construction of the bridge, it probably was at least 4 to 5 times as wide. Gulf Beach used to be an unstable barrier spit that shifted in response to storms and changes in sand flow. In addition, tidal currents shifted sand at the mouth and kept the inlet open sufficiently to permit generous mixing of the embayment. The two bridges no longer permit this natural adjustment of inlet width. Consequently, the outer pond area, which is constricted by one bridge, is poorly flushed, while the inner pond, constricted by two bridges, is very poorly flushed.



Scale: 1" = 2000'

FIG 14.2 GULF POND ENVIRONMENTAL PROBLEMS

<u>Problem Areas</u>

1. Bridge constricts tidal flow
2. Closed to shellfishing
3. Sewer ourfall
4. Stormwater runoff from streets and parking lots
5. Railroad bridge constricts tidal flow

Results of Field Survey and Research (con't)

The sewage treatment plant and outfall located on the east side of the inner pond probably has the most significant local impact on the embayment water quality with some additional degradation from surface runoff. Eroded drainage ditches were noticed in several locations along New Haven Avenue, and outfall pipes and drainage eroded banks were found along the Buckingham Avenue causeway.

D: Problem Analysis

Tidal Constriction and Sedimentation

Constriction from the bridges is severe and has created favorable conditions for settling of eroded and suspended silt. The result is accelerated sedimentation rates causing increasingly shallow depths in the embayment. The sediment gradient ranges from fine silt to sand moving from the head of the embayment to its mouth. This indicates that the Indian River basin is a source of the fine, silty material. Sand typically comes from the barrier spit enclosing the outer pond and from the nearshore waters just outside the pond inlet.

As a result of the sedimentation, the wetland shoreline has encroached on intertidal flats and shallow subtidal waters. Comparison of 1934 and 1980 aerial photos document the extent of this process over a more than 40 year period. Wind-generated waves and tidal currents normally keep wetland encroachment in check, but the bridges and causeway have significantly reduced wave fetch. In addition, as pioneer wetland vegetation takes hold, it forms a sediment trap and accelerates the process. Wetlands will probably continue to expand into the tidal areas until they reach a balance with existing erosional forces.

Water Pollution and Eutrophication

There are several major types of pollution affecting Gulf Pond water quality. The most significant in terms of volume is wastewater treatment disposal, with an average discharge of 2.4 mgd and a peak design flow of 7.2 mgd. The facility effluent limitation for monthly average BOD concentrations is 30 mg/l, which represents a minimum of 85% removal efficiency. The suspended solid output standard of the facility is also 30 mg/l. Both of these pollutants represent a significant loading on the embayment. The oxygen rich waters of Long Island Sound are separated from the embayment waters by two narrow bridges that serve to localize and magnify the effects of the sewage effluent. The nitrogen loading is of less concern than the BOD loading, because the extensive marshes and natural dynamics of the estuary tend to absorb and minimize the impact of surplus nutrients.

Water Pollution and Eutrophication (con't)

Depressed dissolved oxygen levels in Gulf Pond have been identified as a problem for at least ten years. The phenomenon is believed to be related to the high BOD of the sewage treatment plant effluent, yet a 1977 wastewater facility plan indicates that there is a discrepancy between the D.O. estimates generated by a model of the effluent impacts and the D.O. levels actually observed in the embayment. This suggests that there may be another significant source or sources of oxygen demand in the system, but no subsequent reports have investigated these potential sources.

Dissolved oxygen levels in Gulf Pond tend to be particularly low in summer, which is natural given the warmer water temperature and higher rates of respiration. Dissolved oxygen measurements taken in May, August, and September of 1976 showed violations of state D.O. standards for the latter two months. The lowest level measured was 2.5 mg/l, sampled at Gulf Street. Levels that low have a significant negative effect on the vitality of the aquatic ecosystem.

The second major type of water pollution in the basin is industrial effluent discharged by companies located along the Indian River. According to Connecticut DEP records, four companies still discharge industrial effluent under NPDES permits. The effluents contain heavy metals (e.g. Fe, Cr, Ni, Cd, Cu and Sn), cooling water, suspended solids, and low levels of toxic chemicals (e.g. cyanide). Under federal mandate, the states ultimate objective is to have these industries phase out their discharges, pretreat their wastes and tie in to the municipal wastewater system.

Aside from the current short-term water pollution impacts of the industrial effluent, there is also the issue of long term impacts on the physical and biological system. Heavy metals commonly attach to sediment and concentrate on the bottom. The metals become increasingly concentrated over time, to the point where the bottom sedimentary material can become quite toxic. This has particularly significant impacts on benthic invertebrates and bottom feeding fish. Toxic sediment can also complicate dredging projects, as the activity can release the metals, causing unusually high levels in the water. Toxic sediments also require additional precautions during disposal of the dredge spoil.

Water Pollution and Eutrophication

The third major type of pollution is stormwater runoff, which carries surface pollutants into the embayment and may cause erosion of exposed soil. Storm sewer outfalls with direct discharge to Gulf Pond were visible along Buckingham Avenue and New Haven Avenue. Some of the runoff appeared to be entering the embayment through eroded gullies. Surface runoff is probably less of a problem than it might be in a more developed embayment, because the wetlands shorelines filter the runoff and keep eroded material from entering the water body. In addition, the vegetation also absorbs much of the nutrients in the runoff to minimize the potential for eutrophication.

The pollution concerns within Gulf Pond can be summarized as a combination of industrial and municipal wastes that significantly impact the D.O. levels and the chemical quality of bottom sediments.

WEPAWAUG RIVER

A: Physical Description

Location

The river flows through the old part of Milford and has several old mill buildings located along the banks. The study area for this embayment is limited to the lower reaches of the river below the Jefferson Bridge (See Figure 14.3). The study area ends at the beginning of the publicly maintained navigational channel, just north of the sewage disposal plant. Thus, it does not include Milford Harbor. Wilcox Park is located on the eastern bank of the river.

Site Orientation and Configuration

The middle reaches of the river (above the dredged navigational channel) are narrow and relatively straight and oriented in a north to south direction. The width of the river ranges from approximately 50 to 100 feet. The Conrail line intersects the embayment approximately 0.9 miles upstream from the mouth of the harbor.

Tidal Data

Mean tidal range -	6.6 ft.
Spring tidal range -	7.6 ft.
Mean tide level -	3.3 ft.

Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth:	Unknown
Channel Depth:	4.5 ft. (MLW) in harbor; unknown in study area

Additional Comments: NOAA maps show no recorded depths dredged harbor channel, but field observations indicate there is approximately 1 to 6 feet of water at mean low water.

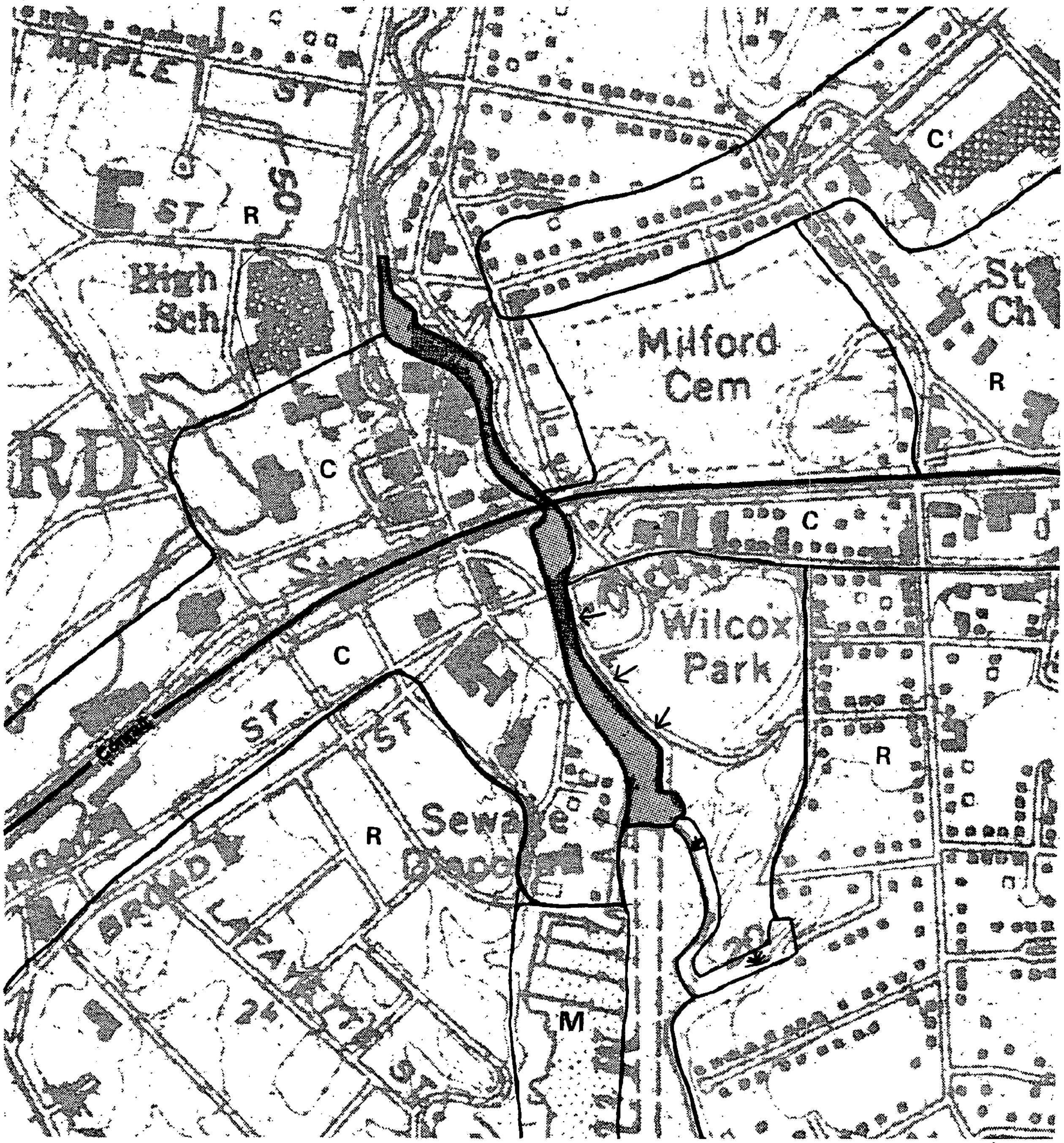
Source: NOAA National Ocean Survey Maps

Basin Hydrology

Regional Drainage Basin: Central Connecticut Coastal Basin

Embayment Basin Area: 20.0 sq. mi. (at mouth of Milford Harbor)

Tributaries to Embayment: 1 small unnamed creek (enters downstream of study area)



Scale: 1" = 666'

FIG 14.3 WEPAWAUG RIVER ENVIRONMENTAL LAND USE

Legend:

- wetlands
- **A** agriculture
- **R** residential
- **C** commercial/industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Basin Hydrology (con't)

Additional Significant Sources of Fresh Water Inflow: The urbanized drainage basin generates stormwater runoff which represents a significant percentage of stream flow during storm events. Sources include storm drains, road drainage ditches, and street ends.

Constrictions to Natural Flow and Circulation:

Structure	% Constriction	Distance from Mouth
New Haven Avenue Bridge	0-25	0.8 miles
Conrail Railroad Bridge	0-25	0.9 miles
Cherry Street Bridge	0-25	1.2 miles
Small Stone Dam	75-100	1.3 miles

6 other bridges within 1 mile above the dam

Sources: U.S. Geological Survey, Connecticut Drainage Basin Gazeteer, 1981; Conn. Dept. of Environmental Protection

Water Quality Conditions

Upstream Water Quality Classification: SB

Embayment Water Quality Classification: SB

Direct Discharges:

Source	NPDES Permit #	Waste Characteristics
U.S. Milford Laboratory	CT0090182	
Milford Harbor -STP	CT0100757	BOD loading, suspended solids, variable pH, chlorides, turbidity, volatile organics

Source	NPDES Permit #	Waste Characteristics
Milford- Town Meadows TP	CT0100731	BOD loading, suspended solids, chlorine, bacterial contamination, variable pH, limited thermal discharge

Future Status of Discharges: The city rejected a plan in 1978 to discontinue the Milford Harbor plant and pump sewage collected from houses within the Wepawaug River basin to an expanded Beaver Brook plant. The existing plant is over 40 years old, and its future use is uncertain.

Sewer Service Area and Discharge Point: A relatively small 0.5 mgd treatment plant, with a peak design flow of 1.0 mgd, is located on the west side of the river along Lafayette Street (See Figure 14.3). The plant provides secondary treatment of wastes collected from development within the Wepawaug River Basin and discharges the effluent directly to the river.

Storm Sewer Outfalls: Development of the Wepawaug River basin dates back to the 17th century. Due to the historic nature of development, there are many old, unrecorded drain pipes and storm sewers that discharge to the river. There is a newer storm sewer outfall located on the east bank next to the Milford Launch Ramp.

Shoreline and Bottom Characteristics

Shoreline Conditions: Most of the shoreline of the Wepawaug River is filled, stabilized or altered in some way. The river runs through the center of town and has a long history of development, particularly as a source of waterpower for mills. The river is dammed in several places, and some of the shoreline is stabilized with old stone walls. The Cherry Street bridge (called the Jefferson Bridge) was built in 1802 as part of the Milford-New Haven Turnpike.

Significant Areas of Erosion: None was observed, except for a relatively small area of erosion at the public boat launching ramp (southern end of study area).

Shoaling and Sedimentation Problems: A channel is maintained in Milford Harbor up to the Milford Launching Ramp. Shallow depths combined with low bridges make navigation above that point difficult.

Bottom Sediment Conditions: The river north of the Cherry Street bridge consists of a series of dammed millponds interspersed with segments of rocky streambeds and free flowing water. Due to their age and retention characteristics, the millponds are filled with sediment. The river is tidal south of the Cherry Street bridge. At that point, the riverbed deepens, the water surface is flat, and flow is sluggish. These conditions are favorable for sedimentation, and the bottom material is comprised mostly of silt.

Surrounding Lands

Maximum Basin Elevation:

Location	Height
Naugatuck Ave. (west Shore)	100 ft.
Orange Avenue (east shore)	120 ft.

Topography: The Wepawaug drainage basin consists primarily of gently rolling hills. There is a short section of the steep banks on the east side of the river between Cherry Street and the Conrail line.

General Vegetation Characteristics: The river basin is highly urbanized and has little natural vegetation. Trees and shrubbery are limited to residential areas and parks.

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Adrian and Palms	mucky		very poor
Agawam	fine sandy loams	0-3	very poor
Carlisle	muck		very poor
Charlton	fine sandy loam	3-8	very good
Charlton	fine sandy loam	8-15	very good
Haven	silt loam	0-3	very poor
Haven	silt loam	8-15	very good
Hinckley	gravelly sandy loam	3-15	very poor
Typic Udorthents	cut and fill	-	variable

Shellfish and Finfish Resources

No significant clam or oyster beds are reported to exist in the embayment; however, shellfish may exist in small numbers scattered within the embayment. All waters within the embayment and Milford Harbor are closed to shellfishing.

The harbor and river provide habitat to many of the fish common to Long Island Sound. Several of the creeks that flow into the harbor on the west bank are particularly valuable nursery grounds for juvenile fish.

Wetlands

The only tidal wetlands within the embayment study area are a few fringes of Salt marsh (Spartina alterniflora) and Reed Grass (Phragmites communis) next to a boat launching ramp at Wilcox Park (See Figure 14.3). In the upper half of the embayment located north of the New Haven Avenue bridge, the river becomes fresh, as indicated by the presence of lily pads and other freshwater vegetation.

It is presumed that prior to development of the Wepawaug River, the natural shoreline was fringed with productive tidal marshes. Today, the shoreline is stabilized and filled for a number of land uses. The only remnants of a vegetated shoreline are the sparse fringes of marsh along the southern end of Wilcox Park. The remaining marshes, through adequate regulation, should increase in size over time.

Environmentally Sensitive Areas

Though the tidal creek marshes of Milford Harbor are outside the embayment study area, they do serve as important habitat for birds, fish and other estuarine organisms. There is one large creek crossed by Roger's Avenue on the west bank of the river. Some new housing construction is encroaching on the wetlands of the creek and may impact the marsh.

B: Land Use Analysis

Current Shoreline and Water Use

Much of the development along the river is historic and includes a few old mill buildings, several renovated commercial buildings, and residential homes. A city park, which is described below, forms most of the eastern shore of the embayment study area. No channel is maintained north of the city park boat ramps, so boating north of that point is limited to small shallow draft vessels. Low bridges also impede navigation.

Current Upland Use

The uplands contain a mix of commercial, former industrial, and residential use. Development along Cherry Street and New Haven Street is mostly commercial, as these streets lead directly to the heart of the business district.

Historical and Significant Land Use Changes

Development of the Wepawaug River basin is very old, as indicated by the 1803 Cherry Street bridge (also known as the Jefferson Bridge). More recent change since the 1930's includes infilling of residential neighborhoods, the abandonment of old mill buildings, and commercial growth. Most of the commercial development since the early 1950's has occurred away from the center of the city with the introduction of Interstate 95 and large shopping malls. This new development has dramatically increased the areal coverage of paved and other impervious surfaces, with an attendant increase in stormwater runoff.

Several of the retention structures of the millponds have deteriorated, causing changes in flow rates and pond water levels.

The most dramatic changes in land use have occurred along the upper reaches of the Wepawaug River (just north of the study area). As late as the early 1950's, most of this land was used for farming. Aerial photos from 1970 and 1980 show a large-scale development of these lands. It is quite likely that agriculture contributed large volumes of eroded soil to the river, which were then transported to the millponds and ultimately to Milford Harbor. Large-scale construction of new residential neighborhoods also contributed eroded soil which in turn added to the sediment loads in the river.

Public Access and Recreation

Wilcox Park, which starts just north of Cherry Street and stretches south along the waterfront to the Milford boat launching ramp, provides both boating access and a view of the embayment. Three quarters of the riverfront park consists of sidewalks and green space for strolling, and the remainder is a large parking lot and an asphalt boat ramp. Use of the ramp is restricted to individuals with permits. Tennis courts and playing fields are also found in the park.

C: Problem Identification

Local Departments and Offices Consulted

Engineering Bureau, Milford Dept. of Public Works, and Milford Harbor Commission.

Response from Questionnaires and Local Meetings

The city officials indicated that the river experiences a wide range of problems including shoreline erosion, siltation, and point and non-point source pollution. Siltation is believed to be a serious problem, while erosion and water pollution are considered moderate problems. Though there is a consensus that these three problems seem to have become more severe over the past years, some city officials believe that the siltation and erosion problem will become worse, while others don't foresee much change.

Part of the siltation and erosion problems is believed to be natural, but the balance of the problems appears to be caused by upstream land use activities. One proposition for reducing erosion is to adopt pond maintenance and erosion control standards. There also was a general agreement that the city's erosion problems in turn caused or aggravated the lower river and harbor siltation problems.

Water pollution is believed to come from both the local sewage treatment plant and from upstream sources of storm water runoff. Though city officials indicated that the 1977 Wastewater Facilities Plan, which proposed phasing out the harbor plant, was rejected by the residents, they did hope to see the plant phased out within five years.

One of the perceived impacts of pollution is a decline in species diversity in the embayment. The Harbor Commission noted that fish loss has been a severe problem over the past 10 years, and cited the loss of blue crabs and fiddler crabs as two examples. Another pollution impact is believed to be eutrophication, which, according to city officials, has developed only over the past five years. It is unlikely that the sewage treatment plant is the exclusive source of this recent problem, as the plant dates back to 1937 and was upgraded in 1951. The Commission also indicated that it does not anticipate the eutrophication problem to become more severe in the future.

Results of Field Survey and Research

The site visit did not reveal obvious signs of erosion, sedimentation, water pollution or eutrophication. However, a visual study of the embayment did provide some insight about potential causes of some of the problems outlined by the city.

Results of Field Survey and Research (con't)

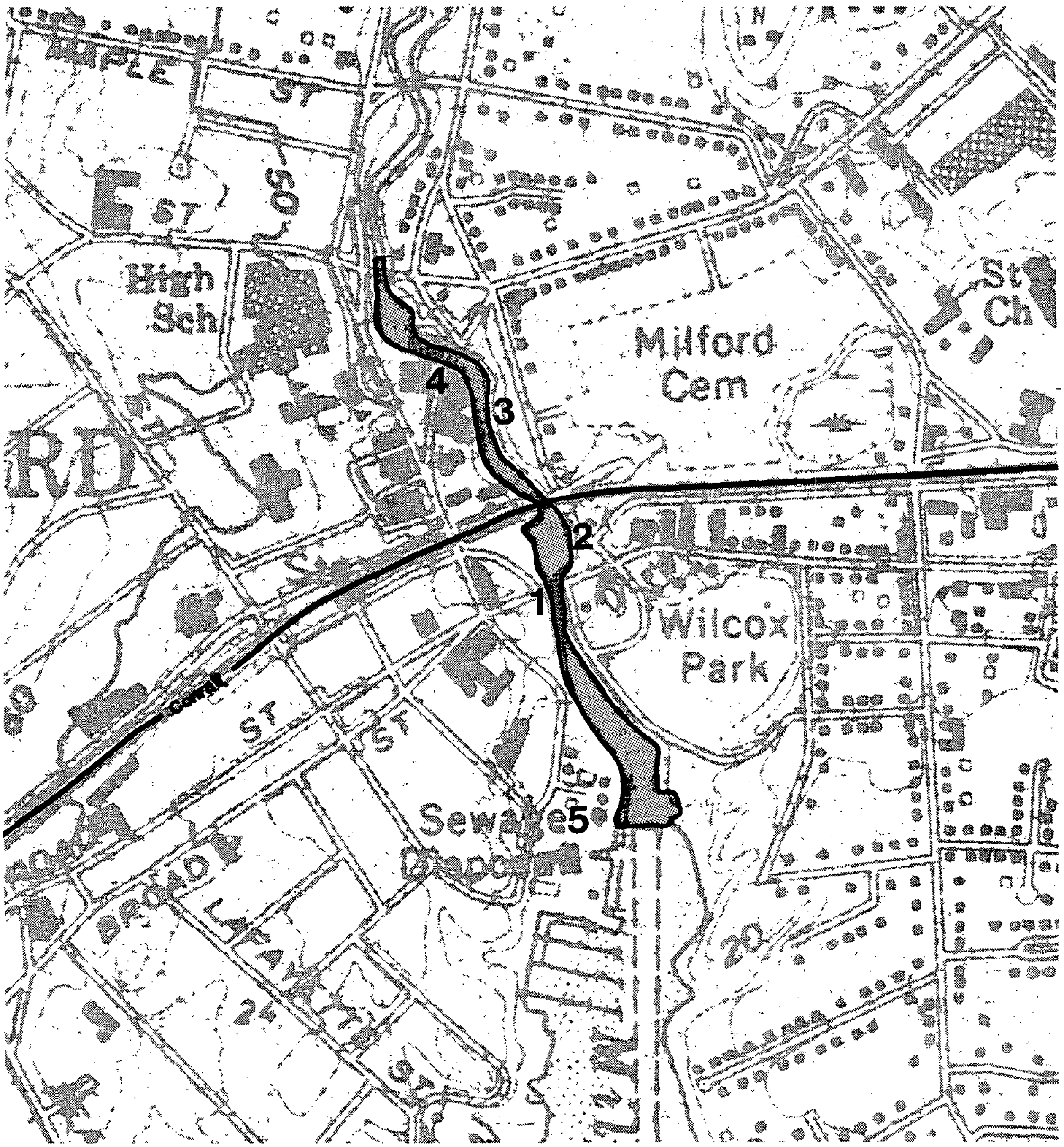
The section of the embayment most subject to potential eutrophication is between the Cherry Street and New Haven Avenue bridges (See Figure 14.4). The bridges on both ends constrict stream flow, limit tidal mixing and make the segment the most sluggish body of water in the area. In contrast to the upper reaches of the stream, where water is oxygenated by agitation at millpond spillways and waterfalls, the pool has little mixing and very little wind-generated turbulence. Organic loading from stream bank erosion and allochthonous material, compounded by limited biological or physical oxygenation, reduces dissolved oxygen to low levels.

Normally, mixing with Long Island Sound waters restores depressed dissolved oxygen levels, but the New Haven Avenue Bridge is a significant constriction to flow exchange. The presence of freshwater aquatic plants in the water body is a good indicator of the extent of the constriction and limited mixing between waters of the harbor and the Sound. The problem with the upper estuarine segment is that it is both the most distant tidal segment from the harbor mouth, and the first body of water to be impacted by BOD loading from upstream sources.

In addition to the tidal constriction, the common low energy conditions of the embayment provide ideal conditions for deposition of suspended sediment. This deposition leads to shallower depths, warmer water, and lower D.O. levels.

The segment of the embayment south of the New Haven Avenue bridge has no major constrictions separating it from Long Island Sound. Though it is closer to the sewer plant outfall, dissolved oxygen loss is replenished through tidal mixing. Sampling data included in the 1977 Wastewater Facilities Plan show the benefit of tidal mixing. Flood tide D.O. levels are consistently higher than ebb tide levels. It is also of interest to note that the D.O. levels near the outfall of the Milford Harbor plant are lower near the bottom than at the top. This suggests either the presence of salt water or a deposit of organic material on the bottom that depresses normal oxygen levels.

Most of the erosion problems mentioned by the city consisted of soil loss from uplands within the river drainage basin. It is difficult to visually assess the cumulative impacts of this type of non-point source; however, housing growth figures for units can provide an index with which to judge the magnitude of the problem. During 1970 to 1978, over 1600 new homes (10% increase) were built in the city. This represents a potentially significant source of soil erosion, and deposition in local millponds.



Scale: 1" = 666'

FIG 14.4 WEPAWAUG RIVER ENVIRONMENTAL PROBLEMS

Problem Areas

1. Bridge constricts tidal flow
2. Altered and filled shoreline
3. Stormwater runoff from streets and parking lots
4. Dam limits tidal influence of river
5. Sewage treatment outfall

D: Problem Analysis

Erosion and Siltation

Historically, there appears to be a relationship between upland erosion in the Wepawaug River basin and siltation of the embayment. As discussed in Subsection C-3, agriculture was the predominant land use of the upstream area of the basin as late as the 1940's. Cropland erosion likely contributed heavy sediment loads to the river, which were then transported during storm flow conditions through a series of millponds to the study area. The low velocity flow and flocculation common to the upper tidal limits of the river provide optimal conditions for siltation.

Over the past 30 years, most of the upstream farmland has been developed for housing. The construction exposed building lots to soil erosion, which occurred on a large scale during the fast growth period of the 1960's and 1970's. Eroded soil was then transported and deposited in the study area. Today, housing construction in the middle reaches of the Wepawaug River has slowed considerably as density has approached the zoning limits. Some of the housing growth, however, has shifted to the undeveloped lands along the upper reaches of the river.

A second potential source of sediment is the outer harbor and Long Island Sound. The amount of sediment input into the embayment is a function of tidal velocities and amounts of fresh water discharge from upstream. During low flow periods with high wave action, more material would tend to be carried into the embayment and deposited. Conversely, higher discharges and lower tidal velocities will act to scour the embayment and transport the material into the Sound.

Observed sedimentation patterns at the mouth of the harbor, however, suggest that the net transport of sediment is into the Sound. The history of dredging of the harbor reinforces this observation.

According to a 1979 Army Corps Reconnaissance Report, an annual average of 6,300 cubic yards of sediment have been dredged from the lower reaches.

The last dredging took place in 1967, and the 14 year time lapse is the longest period without dredging since 1947. This indicates that there is a large accumulated volume of alluvial silt in the harbor basin which may be subject to periodic resuspension and transport.

Water Pollution and Eutrophication

Pollution of the embayment water by direct discharge (effluent from pipes) is limited to a 0.5 mgd discharge of sewage treatment plant and fish tank wastes from the National Marine Fisheries lab just south of the sewer plant. (This finding presumes that all Wepawaug River direct discharges subject to NPDES regulation have been identified by the state). Two other potentially significant sources are storm sewer outfalls and direct stormwater drainage.

According to limited water quality analysis conducted for the 1977 Wastewater Facilities Plan, the bacteria levels for the embayment fall within SB water quality standards (suitable for fishing and swimming), but violate state dissolved oxygen standards. The violations usually occur during the summer months when warm water causes high biological and chemical oxygen demand. Levels during the flood tide were consistently higher than the ebb tide, indicating that the dissolved oxygen-rich waters from Long Island Sound help boost the depressed DO levels through tidal mixing.

Organisms such as small crabs and other crustaceans are less mobile than fish, and are more vulnerable to the impacts of low dissolved oxygen (D.O.) levels. Sessile benthos, which are also vulnerable, have slower metabolisms than crabs and can tolerate lower D.O. conditions. Low D.O. levels (a symptom of eutrophication) may account for the loss of blue and fiddler crabs cited by the Harbor Commission.

As indicated in Subsection C-3, sedimentation from soil erosion will continue to be a problem if construction projects do not adequately control soil erosion and regulate drainage. Soils rich in organics tend to have a significant impact on embayment BOD levels, also.

PROBLEM SUMMARY

Gulf Pond

1.	Total Constriction	Major	(b)
2.	Sedimentation	Minor	(a)
3.	Water Pollution and Eutrophication	Moderate	(b)

Wepawaug River

1.	Erosion	Moderate	(c)
2.	Siltation	Moderate	(b)
3.	Water Pollution and Eutrophication	Moderate	(b)

KEY: (a) Conditions becoming worse (b) No change (c) Conditions improving

CHAPTER 15 STRATFORD EMBAYMENT

INTRODUCTION

The Town of Stratford is located in Fairfield County and is bordered to the east by the City of Milford and to the west by the City of Bridgeport. The town covers an area of 17.3 square miles and falls within the Western Connecticut Coastal Basin. During 1970 to 1978, the population increased 2.0 percent (1970-49,775; 1978-50,800), which is less than half of the overall state growth for that same period. This growth rate is also one of the lowest in Fairfield County, which increased 5.3 percent. The population density is 2,936.4 persons per square mile, as compared to Bridgeport's urban density of 9,333.3 persons per square mile.

The shoreline of Stratford is similar to Milford in that it is composed mostly of sand, swept by longshore currents. One major difference is that the Stratford coast is dominated by twentieth century industrial and commercial development, as well as some older residential development. Much of Stratford's low-lying coastal land was formerly wetlands, created in part by the alluvial processes of the Housatonic River and in part by littoral processes. The Wheeler Wildlife Management Area, (also known as Nells Island), though a relatively young marsh, provides some insight as to what part of the large Stratford marsh used to look like. Over the past 100 years, the residential community of Lordship, Bridgeport Municipal Airport, and several large industries have been built on former wetlands.

Much of the impetus for industrial growth in Stratford came from expansion of Bridgeport's industrial center, which moved into the area to take advantage of inexpensive, level lots for modern, low-profile industrial buildings. The growth and close proximity of the airport, which serves the entire Bridgeport metropolitan area, has also made the industrial land even more attractive.

Unlike many other coastal communities, the center of Stratford is not built on the water. The center is located inland, where homes could be built on higher ground. Overland road access to Long Island Sound was established, and the coastal marshes were used mostly for pasture and other limited forms of agriculture.

Today, development extends inland and growth has been stimulated by the construction of Interstate 95. The town is also served by the Conrail line and U.S. 1 (Boston Post Road).

The riverfront along the Housatonic is considerably more developed than in the 1940's. However, as in the case of Milford, the wide, marshy floodplain along the river has posed an obstacle to construction. Several large industrial facilities, such as the Sikorsky aircraft plant, have been built on the edge of the Housatonic River floodplain.

With respect to residential development, Lordship and a part of Pleasure Beach are the only two communities located directly on Long Island Sound. Pleasure Beach is located on the barrier spit that encloses Lewis Gut (See Figure 15.3), and is too isolated and distant for sewerage. Lordship is served by sewers, as are residential neighbrohoods north and east of Frash Pond. Water quality along the coast is dominated by the drainage from the Housatonic River and the industrial effluent of Bridgeport Harbor.

Five embayments in Stratford were considered for this investigation. Lewis Gut, Marine Basin and Frash Pond were selected for further study. The selection was based on a growing local concern about the impact of development on the integrity of coastal resources in these embayments.

MARINE BASIN

A: Physical Description

Location

The basin is located at the mouth of the Housatonic River just north of the Lordship section of Stratford (See Figure 15.1). The western end of the embayment is only 600 feet west of the Bridgeport Municipal Airport. The center of Stratford is approximately 3 miles north of the basin, and Bridgeport is 4.5 miles to the west . Bridgeport Municipal Airport lies only 600 feet west of the edge of the basin. Main Street and Short Beach Road run between the basin and the airport. Short Beach lies immediately south of the mouth of the basin, and Sniffens Point lies directly north.

Site Orientation and Configuration

Marine Basin is a small body of shallow water, with its long axis oriented in an east to west direction. The oval-shape embayment is approximately 1800 feet long and 300 feet wide (See Figure 15.1). The shoreline is somewhat irregular, with sand spits and wetlands extending out into the basin near the mouth.

Tidal Data

Mean tidal range -	5.5 ft.
Spring tidal range -	6.3 ft.
Mean tide level -	2.7 ft.

Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth:	Unknown
Channel Depth:	Unknown

Additional Comments: Basin depth is presumed to range from 1 to 10 feet at mean low water (MLW). The channel is dredged with public funds.

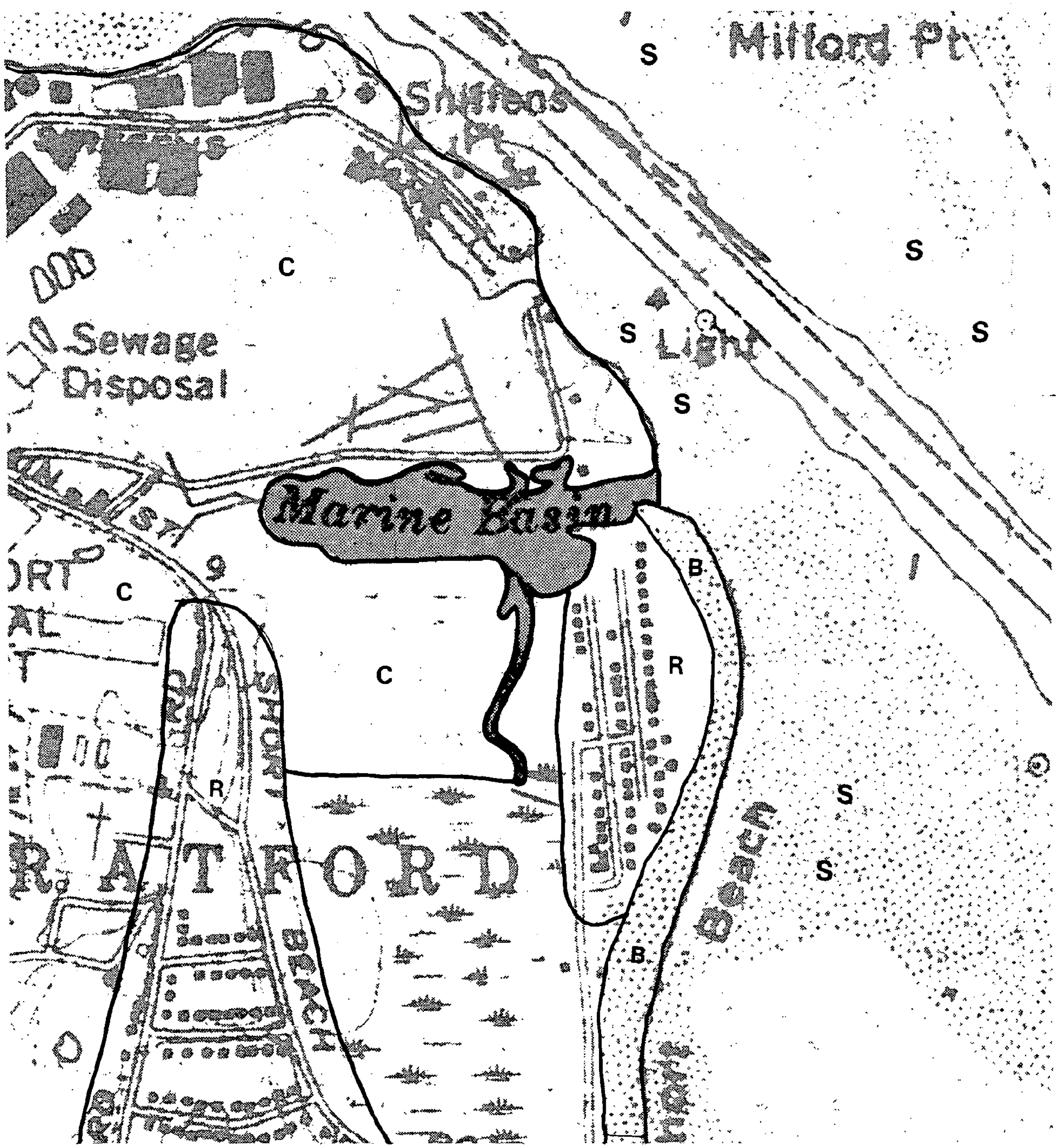
Source: NOAA National Ocean Survey Maps

Basin Hydrology

Regional Drainage Basin: Housatonic River
Embayment Basin Area: Data not available

Tributaries to Embayment: 2 unnamed brooks

Other Sources of Freshwater Inflow: minimal surface runoff from surrounding uplands.



Scale: 1" = 666'

FIG 15.1 MARINE BASIN ENVIRONMENTAL LAND USE

Legend:

- wetlands
- **A** agriculture
- **R** residential
- **C** commercial/industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Basin Hydrology (con't)

Constrictions to Tidal Flow and Circulation: No man-made constrictions. A sand bar at the mouth and offshore shoals create a natural constriction.

Sources: U.S. Geological Survey, Connecticut Drainage Basin Gazeteer, 1981; Conn. Dept. of Environmental Protection

Water Quality Conditions

Upstream Water Quality Classification: Unclassified

Embayment Water Quality Classification: SCc/SBc

Direct Discharges:

Source	NPDES Permit #	Waste Characteristics
AVCO, Lycoming - USAF	CT0002984	Metal finishing wastes (company makes aircraft parts)

Future Status of Discharges: Scheduled phase-out information on AVCo discharge was not available at the time of our request.

Sewer Service Area and Discharge Point: AVCO Lycoming, an aircraft parts manufacturer, discharges pretreated wastes to lagoons which drain via a channelized tidal creek to Marine Basin.

Storm Sewer Outfalls: A long, open canal runs from the AVCO settling ponds to Marine Basin, but also serves as a drainageway for stormwater runoff.

Significant Non-Point Pollution Sources: The drainage channel (described above) is bordered by a landfill. Some of the fill material is exposed along the face of the canal banks. Some contaminated drainage is presumed to leak from this landfill into Marine Basin.

Shoreline and Bottom Sediment Conditions

Extent of Shoreline Modification: The land surrounding the Marine Basin has been extensively filled, except for a fringe marsh of Saltmarsh Cord-grass (*Spartina alterniflora*) mixed with tall stands of Reed Grass (*Phragmites communis*). The head of the basin has been stabilized with rip rap. A small creek enters the embayment through a culvert in the riprapped bank. Large piles of fill and debris encroach on the remaining fringe marsh.

Shoreline and Bottom Sediment Conditions (con't)

Significant Areas of Erosion: The mouth of the basin is comprised of shifting sands which are quite unstable. Historic photos from 1970, 1980, and 1981 show considerable back and forth movement of this sediment.

Shoaling and Sedimentation: The sand at the mouth of the basin continually shifts and acts to form a shoal within the inlet channel, making navigation difficult. These shoals form both inside and outside of the mouth. Sedimentation has occurred in the basin and is visible at low tide in the form of tidal flats.

Bottom Sediment Characteristics: The sediment at the head of the basin is very silty due to limited wave, wind, and tidal action. The sediment at the mouth is disturbed by waves from the Housatonic and tidal currents, and is mostly sand. The relative percentage of silt increases as one moves toward the head of the basin.

Surrounding Lands

Maximum Basin Elevation:

Location	Height
Short Beach Road	10 ft.

Topography: The area is relatively flat with a gradual rise at the landfill. There are moderate slopes along the south shore of the basin created by the elevation difference between the shoreline and the landfill.

General Vegetation Characteristics: The area is sparsely vegetated, and is mostly tidal marsh, land fill, and low lying shrub-covered areas.

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Agawam	fine sandy loam	0-3	very poor
Agawam	fine sandy loam	3-8	very poor
Beaches	-	-	very poor

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Hinckley	gravelly sandy loam	3-15	very poor
Typic Udorthents	cut and fill		variable
Walpole	sandy loam		very poor
Westbrook	mucky peat		very poor
Landfill		-	-

Shellfish and Finfish Resources

All of the shellfish beds delineated by the Stratford Shellfish Commission are located outside Marine Basin. Due to the close proximity of substantial seed stocks, it is probable that shellfish also inhabit Marine Basin. The sandy substrate is very similar to the substrate of the shellfish beds within the river. In addition, the Marine Basin silt content varies along the bottom and favors the developmnt of various shellfhish species. All Marine Basin waters are closed to shellfishing.

The 1978 Sikorsky Airport Master Plan (prepared for the City of Bridgeport) includes an environmental assessment which provides a good review of the coastal resources, including fish species of the Stratford shore area. The fish species list is apparently representative of most of Long Island Sound. No unusual species or lack of common species was noted in the assessment.

Wetlands

A narrow fringe marsh borders on the north and south sides of the embayment and along the channelized tidal creek that drains into the western end of the basin. (See Figure 15.1) The fringe marsh is comprised of approximately a five to ten foot wide strip of Saltmarsh Cord-grass (Spartina alternaflora) at the water's edge, and is bordered by a ten to fifty foot wide strip of Reed Grass (Phragmites communis).

The area around Marine Basin used to be comprised of expansive wetlands as part of the Housatonic River Basin. Subsequent filing by Bridgeport has converted the area to uplands. In addition, according to a 1977 Reconnaissance Report by the Army Corps of Engineers, land immediately south of the basin was used for dredge spoil disposal in 1976. Property in the same general area has also been used as a landfill, however, it has since been closed.

Wetlands (con't)

The wetlands adjacent to the western channelized tidal creek have been filled to approximately two to five feet from the water's edge of the channel.

Currently, bulldozers constantly move dirt and fill on the land adjacent to the wetlands. It is quite possible that some of the material will be moved into additional wetland areas. Some of the landfilled debris has already been bulldozed and dumped at the water's edge of the channelized creek. The same could happpen to other nearby wetlands.

Environmentally Sensitive Habitat

The Great Meadows marsh is regarded as one of the most valuable tidal marsh habitats in Connecticut, and is located approximatley 0.6 miles from the basin.

B: Land Use Analysis

Current Shoreline and Water Use

Past landfilling activity, upland soil erosion and industrial effluent have significantly degraded the shoreline. Old rubber tires, cinder blocks, and metal pipes lay in the mud flats at the western end of the embayment. The Marine basin is currently used for stormwater runoff and industrial waste disposal.

Current Upland Use

The land south of the basin was formerly used as a landfill, but is now closed (See Figure 15.1). A small part of this land is currently used to store large diameter sewer pipe. The Army Corps used adjacent property as a dredge spoil site in 1976. A modest recreational center consisting of several tennis and paddle ball courts is also south of the basin. Bridgeport Municipal Airport is located to the west of Main Street. The north edge of the residential community of Lordship extends to within 1500 feet of the basin. To the north is AVCO Lycoming engine parts plant. In addition, over three-quarters of the land around Marine Basin is zoned for light industry. The Housatonic Marina, located inside Sniffen Point, is approximately 1000 feet north of the basin. The rest of the upland is either filled, unused land or sparsely vegetated open space.

Historical and Significant Land Use Changes

As early as 1934, aerial photos show that the water's edge of the basin was either stabilized with bulkheads or dredged to form a linear shoreline. A road to the linear portion of the water's edge from adjacent homes suggests use of the basin for boating.

Historical and Significant Land Use Changes (con't)

The land surrounding the basin to the east of Main Street was mostly wetlands. The tidal creek that currently exists between the old landfill and short beach (see Figure 15.1) used to be about twice as long and drained most of the wetland area bordered by Main Street south of the basin. The now channelized tidal creek was formerly a meandering creek as late as 1951. Land further south on the other side of Main Street was used for agriculture in 1931, but by 1951 had been developed for tract housing. In 1934, Lordship's streets were almost completely laid out, but had very few houses. Extensive new construction and infilling had occurred by 1951.

In the area now referred to as Short Beach Park, there used to be a colony of summer cottages. Aerial photographs from 1951 show the community structures still intact. Today the only structures on the property include several pavillions, some old concession buildings, barbecue fireplaces and the tennis and paddle ball courts described earlier.

Today, the Short Beach site is 93 acres and includes Marine Basin within its boundaries. A waterfront park master plan, developed in 1969 but never implemented, proposed a large-scale recreation complex with a marina, ballfields, 18 hole golf course, driving range, football stadium, ice rink, pool, community buildings, beach, and picnic area. Thus far, only the tennis and paddle ball courts have been built. Construction of the marina and golf course would have required dredging wetlands on the south shore of the basin and filling wetlands and a subtidal portion of the north half of the embayment for the golf course. The master plan also involved relocating Main Street from which there would be a new park entrance.

Public Access and Recreational Opportunities

The recreational facilities proposed for Short Beach Park in 1969 are described in the subsection above. Currently, the park includes tennis and paddle ball courts, several pavillions and several old concession stands. A report written in the 1970's indicates that the park facilities have been underutilized and some structures have been vandalized.

The boating facilities evident in the 1934 aerial photos are no longer intact, and have decayed to the point that there are no visible signs of their previous existence. Though there are good views of the basin, there are no boatramps, docks, or public facilities along the embayment's shoreline.

C: Problem Identification

Local Departments and Offices Consulted

Shellfish Commission
Conservation Commission

Response from Questionnaires and Local Meetings

There was a consensus among town officials that pollution and shellfish loss were major man-made problems. Individual town representatives also cited siltation, circulation, and eutrophication as additional major problems. The pollution problems originate from both upstream sources, such as the drianage from AVCO's settling ponds, and the local leaching of contaminated drainage from the contiguous landfill. Suggested solutions to the pollution problem are to have AVCO discharge to the municipal sewer system, monitor the pollution and drainage from northeast tidal creeks, and consider dredging the basin. It is hoped that the dredging would remove contaminated silt from the embayment system and improve tidal flushing and circulation. The desire of the Commission, given the necessary resources, is to restore the basin to what it claims was once a "thriving" shellfish area, even in the silted western end. Under existing conditions, attempts to seed the embayment have failed.

Generally, the problems of Marine Basin are believed to have existed for at least 30 years, during which time they have either become more severe or have not changed. The perceived trend concerning pollution is not unanimous, with some officials claiming that the situation has deteriorated, while others claim it has improved. There was uncertainty about future trends, but in a few cases the feeling was that current conditions would either stay the same or, in one case (siltation), the condition would improve.

Local officials know of no local studies conducted on Marine Basin.

Results of Field Survey and Research

The field survey confirmed that Marine Basin is significantly impacted by industrial and municipal activities and is visibly degraded. Most of the marshes surrounding the basin have been filled or covered with hydraulically pumped dredged spoils. Some of this soil and dredged spoil has eroded from the surrounding uplands into the basin, creating highly silty conditions in the western and of the embayment and silty sand conditions toward the mouth.

Results of Field Survey and Research (con't)

Several bulldozers were observed at work on the site moving soil cover and earthen piles at the landfill. Wetlands along the channelized creek that drains into the west end of the basin appeared to be partially buried by some of the new unconsolidated material. Some of the debris had recently been pushed on top of the wetlands up to the water's edge of the channel. Some of the solid waste debris had tumbled into the creek water.

The Reed Grass (Phragmites communis) along the southern shore had grown vigorously, and some of the seed grass was over 12 feet tall. A continuous fringe of Salt-marsh Cord-grass (Spartina alternaflora) was located seaward, and appeared to be expanding into some of the intertidal flat areas.

The silty intertidal sediment at the west end of the basin was almost black and very mucky. Rubber tires, concrete blocks, pipes and other debris had been discarded on the mud flats.

The drainage flowing through the channelized creek at the west end looked somewhat degraded.

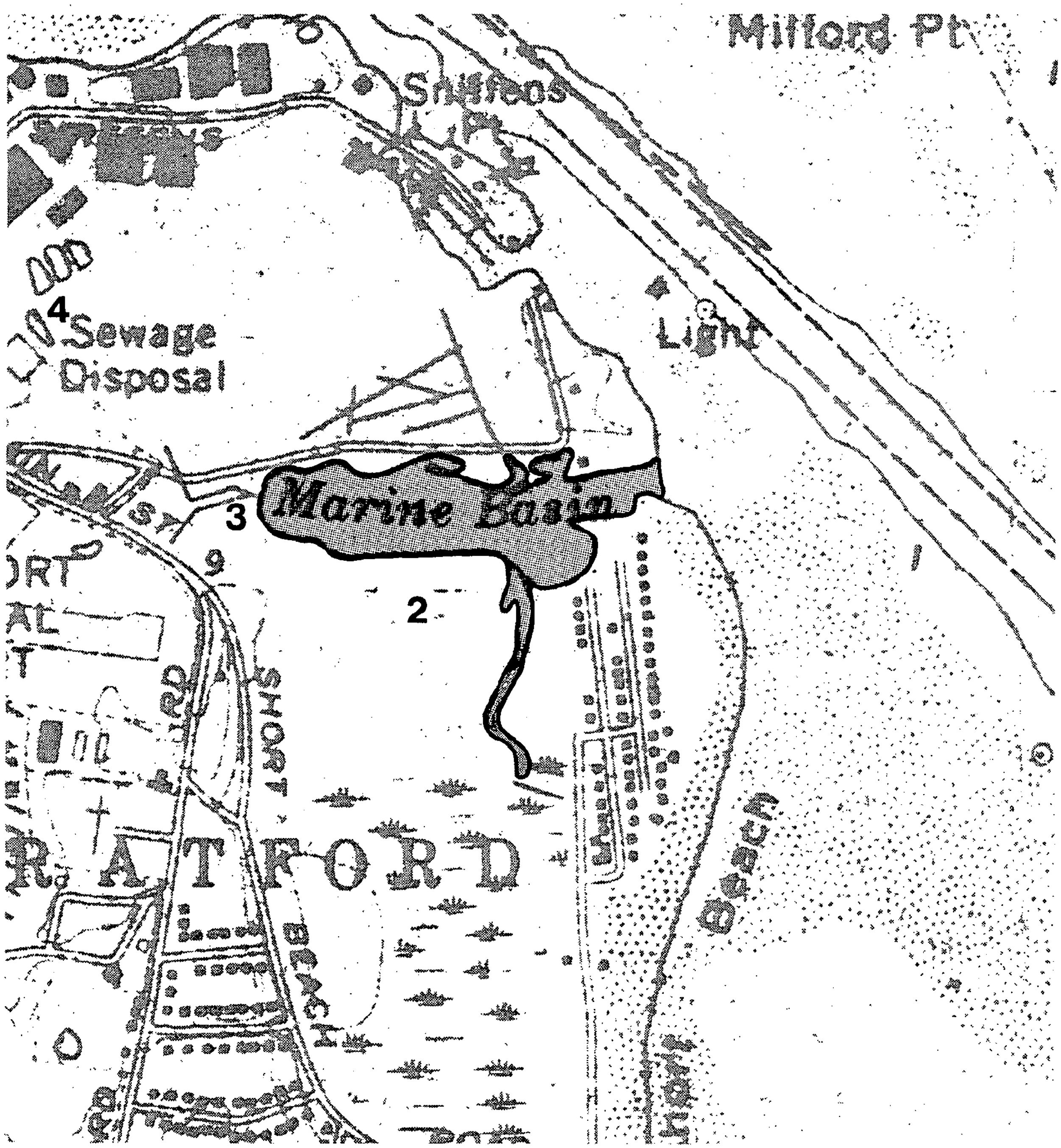
Drainage from the channel ultimately flows through a culvert under an access road that winds around the end of the basin. This constricts flow from the channel and leads to stagnant water conditions. The bulldozed solid waste dumped in the channel probably contributed some leached pollutants.

Though the landfill is no longer actively used, movement of soil cover by bulldozers had exposed some of the formerly buried material. A part of the closed landfill was being used to store sewer pipes.

D: Problem Analysis

Siltation and Eutrophication

The siltation of the basin is most severe in the western end and becomes less severe toward the mouth (See Figure 15.2). Two factors explain the gradient. First, tidal flow and circulation, though constricted by natural shoaling at the mouth, is more active in the eastern end of the basin. Particles are resuspended there and either flushed to the Housatonic River on an ebb tide or transported and deposited in the quieter environment of the west end. Second, the landfilled area most subject to erosion is located near the west end. As noted in Section C, part of the landfill at the western end of the basin extends right to the water's edge. This is a clear opportunity for erosion of silt into the embayment.



Scale: 1" = 666'

FIG 15.2 MARINE BASIN ENVIRONMENTAL PROBLEMS

<u>Problem Areas</u>

1. Closed to shellfishing
2. Potential for landfill to leach into basin
3. Fill and debris encroaching on wetlands
4. Industrial discharge to lagoons that drain into basin

Siltation and Eutrophication (con't)

The dark mucky silt has an odor typical of reducing (oxygen depleted) sediment conditions.

Such conditions create low dissolved oxygen (D.O.) conditions in overlying waters. Since Long Island Sound waters are presumed to be a source of replenishment of D.O., the basin areas closest to the mouth benefit from tidal flushing. The inner areas of the basin benefit the least. The combination of reduced opportunity for the west end to mix with D.O.-rich waters, coupled with the higher BOD levels associated with the silt of the west end, probably create a D.O. gradient from the head of the embayment to the mouth. Consequently, eutrophic conditions are most likely to be found at the west end of the embayment. This may explain why seed stock has not been successful in re-establishing clam beds, particularly in the basin's western end.

Pollution

There are three significant sources of pollution in Marine Basin. First, AVCO Lycoming, under NPDES permit, discharges metal finishing wastes to on-site holding ponds which then flow into the basin. Though little is known about the chemical constituents of the AVCO waste stream, metal finishing effluent commonly contains heavy metals and acids. Cyanide is also commonly found in the waste stream.

Any of the heavy metal pollutants that reaches the marine basin will likely bind to the clay and fine particles of the silt in the west end. These are then deposited and become components of the bottom sediment. Shellfish exhibit varying degrees of tolerance to heavy metals found in this type of embayment, but it is well documented that the organisms are inclined to concentrate the metals in their tissues through their filter feeding mechanism. Shore birds and fish that feed on the shellfish then have the opportunity to ingest heavy concentrations of the metals, and the contaminant spreads thoughout the ecosystem.

The second significant source of water pollution is stormwater runoff from the surrounding basin land and the channelized tidal creek. The filled land tends to have high, fine fractions that impede infiltration and encourage overland runoff. The result can be erosion of topsoil, leading to siltation of the embayment and BOD loading from fill with a significant organic content. The blackish silt at the west end of the basin seems to indicate that loading is being caused by some source. It is difficult to tell whether overland flow erosion or drainage from the canal is the major contributor of organics to the embayment.

The third significant source is landfill leachate. According to the 1969 Short Beach Master Plan, the adjacent landfill was 40 acres, and was phased out around 1960.

Pollution
(con't)

The landfill is underlain with a five to twenty foot thick layer of silt and marsh peat. The fill layer ranges from five to fifteen feet in thickness. Soil cover now seals the landfill material, though some disturbed areas have been exposed. The water table of the landfill is quite high, and several areas have pools of standing water. In addition, some of the fill cover is thin and rests on saturated, mucky soils which drain to the basin. The remnants of a tidal creek drain land along the eastern side of the landfill, and the creek water is a potential source of contaminated leachate. It should be pointed out, however, that in other landfills on wetlands, the former wetland peat and mucky soils have demonstrated a great capacity to absorb and tie-up contaminants. If this capacity exists at the Marine Basin landfill, the magnitude of the leachated contamination problem would be diminished.

LEWIS GUT

A: Physical Description

Location

The embayment is located east of the mouth of Bridgeport Harbor (See Figure 15.3). It is bordered by Long Beach to the south, Lordship to the east, and Bridgeport Municipal Airport and an industrial park to the north. The Gut is 4.2 miles from the center of Bridgeport and 3.5 miles south of the Stratford central business district. Lordship Boulevard is the major highway providing access to the shoreline of Lewis Gut.

Site Orientation and Configuration

Lewis Gut is comprised of a major east-west channel leading into an embayment surrounded by a dendritic network of tidal creeks and wetlands. The Gut channel is approximately 1.3 miles long, and the tidal creeks cover approximately 475 acres. The southern side of the Gut is enclosed by a 2.6 mile long barrier spit. The end of the spit is part of Brigeport and is connected to the mainland by bridge.

Tidal Data

Mean tidal range -	6.7 ft.
Spring tidal range -	7.7 ft.
Mean tide level -	3.4 ft.

Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth:	1-8 ft.
Channel Depth:	6-8 ft. near mouth

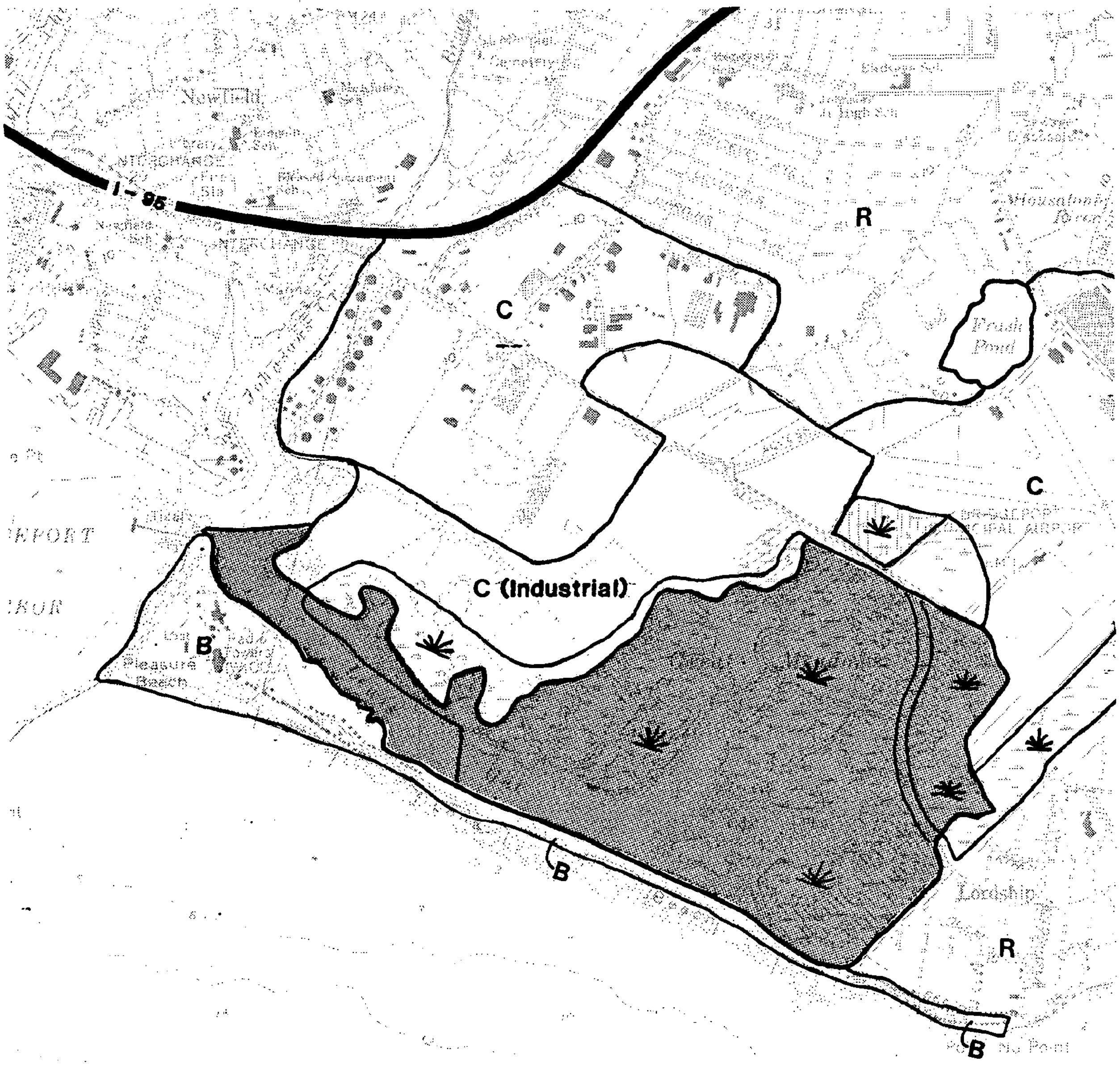
Additional Comments: None.

Source: NOAA National Ocean Survey Maps

Basin Hydrology

Regional Drainage Basin: Western Connecticut Coastal Basin
Embayment Basin Area: 4.0 square miles
Tributaries to Embayment: 4 channelized tidal creeks

Additional Significant Sources of Fresh Water Inflow: Stormwater drains to Lewis Gut from the airport runways and industrial buildings and parking lots along the Access Road and Main Street.



Scale: 1" = 2000'

FIG. 15.3 LEWIS GUT ENVIRONMENTAL LAND USE

Legend:

- wetlands
- **A** agriculture
- **R** residential
- **C** commercial/ industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Water Quality Conditions

Constrictions to Natural Flow and Circulation:

Structure	% Constriction	Distance from Mouth
Long Beach Blvd. (tidal gate)	75-100	1.5 miles
Lordship Blvd. (tidal gate)	75-100	1.9 miles
Lordship Blvd. (tidal gate)	75-100	2.1 miles
Lordship Blvd. (tidal gate)	75-100	2.1 miles

Sources: U.S. Geological Survey, Connecticut Drainage Basin Gazeteer, 1981; Conn. Dept. of Environmental Protection

Upstream Water Quality Classification: Not yet reclassified
Embayment Water Quality Classification: Not yet reclassified

Direct Discharges:

Source	NPDES Permit #	Waste Characteristics
Bridgeport Fittings, Inc.	CT0021890	Cadmium, chromium, copper, iron, zinc, cyanide, acids, suspended solids, and thermal effluent
Buckley Bros.	CT000230	Oil storage, occasional spills
Sun Oil Co. of PA	CT0023434	Oil storage, occasional spills
Sun Oil Co. Terminal	CT0021016	-
Boros Metal Finishing	CT0021288	out of business
Bridgeport Rolling Mills	CT0002674	industrial wastes
Chemical Plating Co.	CT0004031	Cadmium, chromium, copper, iron, nickel, tin, zinc, chemical oxygen demand, cyanide, suspended solids, variable pH, thermal discharge

Future Status of Discharges: Many of the NPDES permits have not been updated in recent years. For example, the Chemical Plating Company's permit expired October 21, 1971, and no new permit was found in the DEP files. Consequently, it is difficult at this point to indicate the future status of the direct discharges listed above.

Sewer Service Area and Discharge Point: Areas north of the Gut and in Lordship are sewered. The collected waste is treated at a plant north of Frash Pond and is discharged to the Housatonic River.

Storm Sewer Outfalls: There are no storm sewer outfalls recorded in the area, though it is suspectted that several exist to drain both street runoff and stormwater runoff from buildings and parking lots.

Significant Non-Point Pollution Sources: Several channelized tidal creeks drain into Lewis Gut and receive stormwater runoff from the Bridgeport Airport and parking lots of surrounding industries.

Shoreline and Bottom Sediment Conditions

Extent of Shoreline Modification: The expansive tidal wetlands surrounding the embayment have been extensively filled, paved and built on along the perimeter of the marsh. Bridgeport Airport and access roads border the northeast side of the basin. Several large industrial lots border to the northwest, the community of Pleasure Beach borders to the southwest, and Lordship borders the southeast side of the basin. A 1000-2000 foot wide drained wetland separates industrial development from the marshes along the northeast shore, but industry is now attempting to develop the wetlands. According to town officials, Great Meadows Marsh had over 1800 acres of wetlands in 1900. Today, it has only 600 acres.

Significant Areas of Erosion: Long Beach, which forms the southern shore of Lewis Gut, is an unstable barrier island spit. An inlet which used to be located in the middle of the spit from approximately 1938 to 1960 created an island out of Long Beach and provided direct tidal access to Lewis Gut. Several groins now trap sand as it follows the littoral drift from east to west (See Figure 15.3), and the tidal exchange of the Gut is significantly lower.

Shoaling and Sedimentation: The dikes surrounding dredge spoil deposition sites in Lewis Gut have broken open and released large amounts of sediment to the system. Historical observations seem to indicate that this sediment has mostly remained within the Gut and has caused some areas of the embayment to shoal. Though the main channel may still be navigated by shallow craft, the inner embayment area is difficult to penetrate. Turbid tidal waters entering the quiet environment of the basin also continue to deposit suspended sediment. Tidal creeks may also contribute some sediment.

Bottom Sediment Characteristics: The Lewis Gut system is very large and complex, but several general sediment patterns prevail. The bottom sediment in the vicnity of the marshes along the northern shore is very fine and silty, while the sediment near Long Beach is coarse and sandy. A similar gradient exists from the eastern end to the mouth, grading from silt to sand. The inner reaches of the Gut are protected from wind, experience less tidal energy, and allow settling of suspended sediment. The mouth and southern edge of the Gut are subjected to somewhat greater tide and wave action, so the sediment tends to exhibit a higher sand fraction.

Surrounding Lands

Maximum Basin Elevation:

Location	Height
Lordship Blvd. (also known as Great Meadows Road)	less than 10 ft.

Topography: There are no areas of steep slopes adjacent to the embayment.

General Vegetation Characteristics: The area is covered mostly with tidal wetland vegetation, some low lying scrub, and a few trees located near Long Beach Boulevard. Oak Bluff Avenue, which borders the eastern end of Lewis Gut, is lined with trees.

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Agawam	fine sandy loam	0-3	very poor
Agawam	fine sandy loam	3-8	very poor
Beaches	-	-	-

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Hollis Rock Outcropping	complex	3-15	very poor
Limerick	silt loam		very poor
Merrimac	sandy loam	3-8	very poor
Raypol	silt loam	-	very poor
Scarboro	muck	-	very poor
Tisbury	silt loam	0-3	very poor
Typic Udorthents	cut and fill	-	variable
Walpole	sandy loam	-	very poor
Westbrook	mucky peat	-	very poor
Westbrook	mucky peat, low silt	-	very poor
landfill	-	-	-

Shellfish and Finfish Resources

Historically, Lewis Gut has been a major shellfish producing area. Clams and oysters were most common, and beds served as an important source for seed stocks. Higher volumes of surface runoff, industrial discharges and uncontained dredge spoil disposal, however, have reduced the overall productivity. Oysters have been particularly affected, and are no longer plentiful in the embayment.

Another major impact on the Gut has been a significant change in the tidal circulation patterns. According to town officials, the 1938 storm carved a large inlet through the middle of Long Beach, thus establishing direct tidal access to Long Island Sound (See Figure 15.3). The new inlet established a complementary relationship between shellfish seed stock in the Gut and shellfish beds off Long Beach. In addition, tidal exchange bypassed the degraded conditions of Bridgeport Harbor and provided more thorough mixing. The inlet closed in 1960, and the U.S. Army Corps of Engineers has since constructed a series of groins to stabilize Long Beach. There has been some interest in reopening the former inlet, but it has not been pursued very far, so the beds continue to suffer from low flushing rates and supplemental pollutants.

Shellfish and Finfish Resources (con't)

All of the waters of Lewis Gut are closed to shellfishing.

The Gut is used as an anadromous fish pathway. Shad and herring typically run up the drainage canal to Frash Pond. On some occasions, the tidal gate along Lordship Boulevard is closed during the spawning season, causing large populations to back up in the tidal creek. The Shellfish Commission indicates that the fish runs have declined considerably over recent years.

Wetlands

Wetlands surround the entire area of Lewis Gut (See Figure 15.3). Drainage canals provide limited tidal exchange to wetlands on the north side of Lordship Boulevard.

Approximately 475 acres of tidal marsh and intertidal flats are linked to the waters of the Gut by a dendritic network of tidal creeks. The wetland system is one of the most valuable tidal marshes of the entire Connecticut coast. Major functions include breeding habitat for birds and fish, shelter for juvenile organisms, food, and a buffer zone protecting the water quality of the Gut. The wetland buffer filters soil and detritus from stormwater runoff, and fixes pollutants in the mucky peat. The buffer serves as an important sink for excess nutrients. In addition, the intertidal character of the marsh with tidal pools and a large edge-to-water ratio create a unique setting for waterflow and birds. One of the other significant features of the marsh is the restoration of natural drainage patterns. Such marshes serve as important scientific control areas with which scientific staff can evaluate the effects of mosquito ditching. Consequently, it is important that the town seek to preserve these unditched wetlands for future analysis and enjoyment.

Prior to the development of the Stratford coast, most of the town south of a transect from Frash Pond to the head of Johnson's Creek was wetlands. Wetlands immediately surrounding the Lewis Gut water body provide some insight as to what the vast areas of wetlands used to look like. Historic U.S. survey maps (circa 1830) show Great Meadows marsh covering an area approximately three times its current area. The three major developments that have consumed most of this former wetland are the community of Lordship, Bridgeport Municipal Airport and the industrial park that runs along the western end of Lordship Boulevard.

1934 aerial photos show Lordship as mostly a layout of streets with only a few homes. The filled land is linked to the mainland by Lordship Boulevard and is surrounded on all sides by wetlands and water. In 1934 the airport was still a modest grass field and Lordship Boulevard fed directly into the end of Prospect Drive. The industrial park was not yet constructed, though some of the land had been filled in the process of building the boulevards.

Wetlands
(con't)

The major controversy associated with Lewis Gut and the Great Meadows Marsh over the past 15 years has concerned the expansion of the industrial park. A long dike was constructed around wetlands in the northwest corner of the Gut and back-filled with dredge spoils. Subsequently, only part of the land was used for industrial structures, leaving a wide buffer strip around the perimeter between the buildings and the marsh. Some of the filled marsh became suitable for upland vegetation and a large stand of trees grew near the mouth of Johnson's Creek.

Today the original dikes have deteriorated in places, and some areas of formerly filled land look increasingly similar to wetlands. The 1978 Sikorsky Memorial Airport Master Plan does not refer to this area as upland, but instead describes it as an area "no longer considered as marsh". The future use of the perimeter buffer zone has become a heated issue. The property owners believe that they are entitled to develop what the state no longer considers wetlands, and conservationists fear that loss of the buffer zone will signficantly impact the marsh. In addition, the large stand of trees at the mouth of the Gut has now become an important nesting area for the Black Crowned Night Heron and is regarded as unique habitat in the region. The issue over future use is further complicated because the federal definition of wetlands under the Clean Water Act regulations is different from Connecticut's definition. In order to develop the land for industrial use, it must be filled, and the Army Corps of Engineers may reject applications to fill, based on the substantial public concern about the protection of wetlands.

Current Trends: The Stratford Industrial Park wetlands case has been in court repeatedly over the past 15 years, and is again in litigation now. This leaves the projected future impacts to contiguous wetlands uncertain. Generally, the state protected wetlands south of Lordship Boulevard will remain intact in the future. Most new wetland filling, if it occurs, will take place north of Lordship Boulevard.

Still at issue is the recent degradation of water quality in Lewis Gut and the consistent decline in productivity.

Environmentally
Sensitive Areas

The Great Meadows marsh is regarded as one of the more valuable tidal marsh habitats in Connecticut. Its value is further enhanced by its unditched characteristics in many parts of the marsh.

The marsh is over 400 acres in area and is an important habitat for a variety of shorebirds and waterfowl. The marsh is also a very productive ecosystem for the region.

B: Land Use Analysis

Current Shoreline and Water Use

The Gut provides for a mix of uses including recreation, conservation, industrial waste disposal and limited boating. The area is noted for its diversity of waterfowl and highly productive wetlands. Shellfishing used to be a lucrative business in the area, but the waters have been closed by the state and productivity has declined due to pollution.

At present, several companies in the industrial park along Lordship Boulevard discharge their wastes ultimately to Lewis Gut. Wastes are first pumped to on-site settling ponds. The drainage then runs into several tidal creeks at the edge of the marsh, where tidal action and circulation flush the effluent through the Gut and into Long Island Sound.

Good views of the marsh are available along Lordship Boulevard and at Long Beach Park. No boat ramp exists at the park, but it is possible to launch a canoe or small rowboat into the Gut. Most navigation is limited to shallow draft vessels because of shallow depths throughout the embayment. Deeper draft vessels can navigate through some parts of the Gut, particularly during high tide, but since bottom sediment frequently shifts within the embayment, deep draft vessels rarely use the area.

Current Upland Use

The three large-scale upland uses surrounding Lewis Gut are the residential community of Lordship to the east, Bridgeport Municipal Airport to the southwest and the Stratford Industrial Park to the north. Lordship Boulevard (Route 113) intersects the northern portion of Great Meadows Marsh, and is one of two major access roads to the airport and Lordship (See Figure 15.3).

Long Beach Park, which encloses Lewis Gut to the south, is the major recreational area bordering on the embayment. The small residential area of Pleasure Beach, part of which falls within the Town of Stratford, is at the end of the Long Beach spit (See Figure 15.3). The rest of the area is part of Bridgeport and is connected to the City by a bridge over the mouth of the Gut.

Historical and Significant Land Use Changes

Since wetland development constitutes almost all of the land use change surrounding Lewis Gut, refer to Subsection A-10, "Wetlands" for a summary of this past activity.

Historical and Significant Land Use Changes (con't)

The two changes not addressed in the earlier section are the extension of Bridgeport Municipal Airport Runway 6, and the creation of Long Beach Park. The runway planning and construction, which occurred after World War II, required relocating the eastern end of Lordship Boulevard and filling large areas of wetlands. To maintain adequate access to Lordship, a solid fill causeway was constructed to curve around the end of the new runway and connect into Stratford Road. This required additional filling of wetlands and construction of two small bridges to maintain tidal exchange with marshes on the north (inland) side of the road.

Long Beach Park, which forms the south side of Lewis Gut, was created by the closure of the old inlet in 1960. Prior to closure, the property was split by the channel, and Pleasure Beach was an island.

Public Access and Recreation Opportunities

As discussed in the previous subsection, Long Beach Park serves as coastal open space for viewing the Sound and Lewis Gut, for fishing and swimming, and for launching small boats by hand (no ramp is available). Access to the park is at the junction of Oak Bluff Avenue, and is unregulated. A parking lot is located at the end of the entrance drive. Cars and off-road vehicles are prevented from continuing down the beach by large granite stones.

Good views of Lewis Gut are also available from Lordship Boulevard.

C: Problem Identification

Local Departments and Offices Consulted

Stratford Shellfish Commission
Stratford Conservation Commission

Response from Questionnaires and Local Meetings

Town officials voiced a consensus that poor circulation in Lewis Gut and fish loss are major problems. Individually, officials also cited siltation, pollution, erosion and salt marsh loss as other major concerns. The history of these problems dates back at least twenty years, and the problems have become progressively worse. Without exception, the consensus is that these problems will become even more severe in the future.

Response from Questionnaires and Local Meetings (con't)

Two factors were repeatedly mentioned as the primary cause of decline in environmental quality: 1) the closing of the former Long Beach Inlet, and 2) the continual encroachment and growing impact of surrounding industry and other development. Impacts that were mentioned included loss of shellfish stocks and diminished fish runs.

The general perception is that the overall productivity of the embayment has declined. The solution, according to local officials, is to reopen the old inlet and to halt continued encroachment, development, and filling of wetlands. Officials believe that natural longshore currents have successfully eroded the barrier spit to a current width of 200 feet, significantly less than it used to be. Stabilization of the system has required spacing seven groins at regular intervals down the beach. They are only marginally effective and proponents of a reestablished inlet insist that less money should be spent on erosion control. They believe erosional forces should be permitted to break through the spit naturally and reestablish what they are convinced is a natural channel for tidal exchange.

Though there was repeated concern expressed about pollution in the embayment, no specific solutions were offered. Examples of pollution included fuel spills from Sun Oil and Exxon, discharges from industries and boats, and the impacts of tidal exchange with the degraded water of Bridgeport Harbor.

There was divided opinion about the status of wetlands, as some officials believe that filling has ceased for the time being while others are convinced that some filling is still occurring. The large size of the wetland area of Great Meadow Marsh makes it difficult to have a comprehensive understanding of the status of the resource.

Results of Field Survey and Research

A field survey of the embayment confirmed the large-scale filling of wetlands that has occurred around Great Meadows Marsh. The diked wetlands in the northwest corner of the marsh, although filled, are still quite wet and support wetland vegetation similar to vegetation outside the dike. Sections of the dike were also noticeably deterioriated, and in some cases, were no longer containing landfill.

Results of Field Survey and Research (con't)

Despite a documented decline in productivity of the embayment, it is still an impressive habitat. This observation is amplified in the Sikorsky Airport Master Plan (1978):

> Although large acreages of the original 2400 acre marsh have been converted to industrial, airport, residential and highway use, the remaining wetlands are a viable and valuable unit of coastal ecology and recreational space.[1]

Field observations revealed a wide diversity of waterfowl, many juvenile fish, a large population of fiddler crabs, and brief glimpses of diamond back terrapins. The observation period had been preceeded by exceptionally dry weather, and this condition probably accounted for the relatively clear water found in the Gut.

Although the center of the embayment has open water areas, the tidal current is still quite perceptible. A mean tidal range of 6.7 feet for the area translates into significant velocities flow.

An inspection of the tide gates along Lordship and Long Beach Boulevards revealed that they are inadequately maintained and provide insufficient tidal exchange to wetlands north (inland) of the road. The mechanisms of the gates are designed to regulate or completely block flow to marshes on the inland side of the road. Even if the gates are open, twin 36 inch pipes permit only a percentage of the tidal exchanges that existed prior to construction of the road. One of the problems caused by the tide gates is the obvious impediment to spawning anadronomous fish. Herring have been seen struggling on several occasions trying to penetrate through the gates to the upstream sources of fresh water.

1 Teer, Dobbins, and Transplan Incorporated, Igor I. Sikorsky Memorial Airport Master Plan, prepared for City of Bridgeport, Connecticut, 1978

Results of Field Survey and Research (con't)

Clifford Templeton, as part of his statewide tidal gate survey[1] in 1972, reviewed the three pairs of flood gates along Lordship Boulevard and the pair of

flood gates owned by Rykar Corporation off Long Beach Boulevard. The report documents that, under normal operating conditions, the incoming tide forces the metal flap gate closed, and the accumulation of surface water on the inland side forces the gates open at ebb tide. The mechanism is common to all four pairs of gates. In all four cases the result was negligible salt water flushing of the inland side marshes and a predominant growth of Reed grass (Phragmites communis). The airport master plan further elaborates on this relationship in the context of studying the floral condition on the edge of the airport's Runway 6:

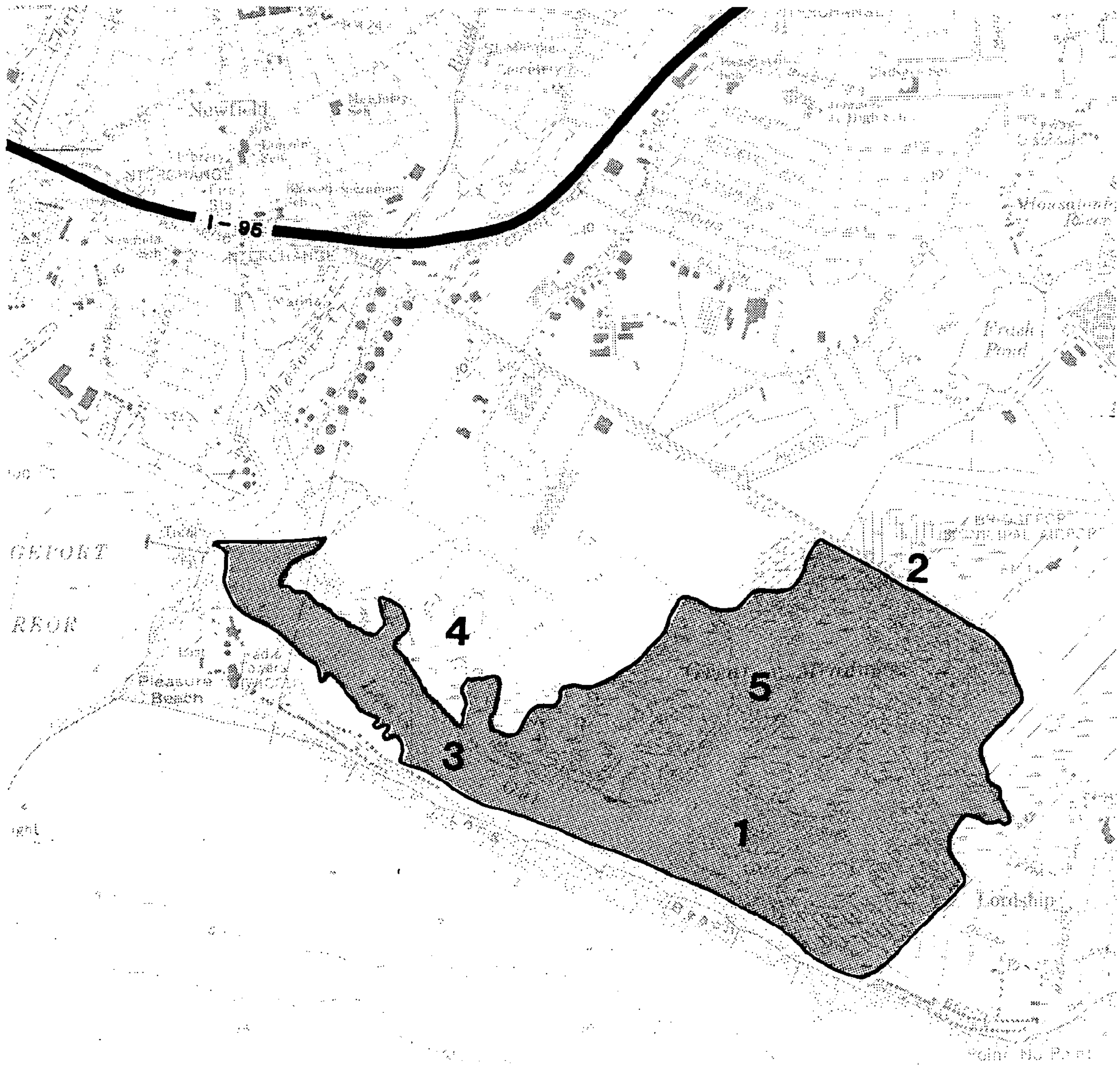
> The dominance of Phragmites is due to disturbance preventing the natural influx of tidal waters. This area would be capable of supporting many of the plants listed in Public Act 695 if the tidal flow were increased by construction of a bridge or culverts of sufficient size to allow "normal" tidal flow to and from Lewis Gut.

D: Problem Analysis

Poor Circulation and Pollution

From 1938 to 1960, a wide inlet cut through the Long Beach sand spit direct tidal exchange between Long Island Sound and Lewis Gut. Direct exchange assured restoration of minimum DO levels, reduction of pollutant concentrations by mixing and dilution, and a contribution of clean sand to the system. In addition, the inlet established a direct link with the habitat of the Stratford near-shore area of Long Island Sound. For example, shellfish beds are believed to have thrived off Long Beach, primarily due to the close proximity and large seed stocks in the Gut. This is critical, as the first stage of the oyster or clam life cycle is planktonic and the ebb tide current provides an ideal means to naturally establish shellfish beds in the town's nearshore waters. It is uncertain how critical direct access to the Gut is to fish, but it is presumed that it potentially improved access to spawning grounds and feeding areas.

1 Source: Clifford Templeton, Tide Gates and Other Tidal Restrictions in the State of Connecticut, Dept. of Environmental Protection, 1972.



Scale: 1" = 2000'

FIG. 15.4 LEWIS GUT
ENVIRONMENTAL PROBLEMS

Problem Areas

1. Erosion of old dredge spoil dikes
2. Stormwater runoff drains into tidal creeks
3. Closed to shellfishing
4. Development encroaches on wetland buffer
5. Unditched marshes or areas returning to former natural drainage pattern - protect from new ditching

Poor Circulation and Pollution (con't)

When the inlet was closed in 1960, tidal exchange with the Sound was channeled through Bridgeport Harbor. Historically, the harbor has been an industrial center and used for the discharge of industrial wastes. Consequently, not only have there been chronic water pollution problems, but, according to the Army Corps analyses, many of the effluent contaminants are now found in the harbor bottom sediment. During tidal exchanges, contaminated sediments and degraded harbor water mix with Long Island Sound water and flow into Lewis Gut. Little research has attempted to quantify the impacts; however, it is quite likely that they are significant.

Degraded conditions of the harbor also affect the movement of organisms between the estuary and nearshore/offshore waters. The planktonic stage of shellfish are highly sensitive to pollution and are reluctant to settle on degraded bottom surfaces. This probably explains the decline of Stratford's offshore shellfish beds. Although they are probably less significant, anadromous fish spawning through a degraded pathway adds stress and might increase mortality.

Of additional concern is the contamination of Lewis Gut by industry around the Great Meadows Marsh. Fuel oil spills from Johnsons Creek and metal plating wastes are two of the most common forms of pollution. The metal wastes have long term impacts, because they typically become fixed to suspended sediment and settle to the bottom. Subsequent dredging and resuspension recirculates the contaminants, and they are commonly assimilated into the ecosystem. Currently, industrial development around the Gut has slowed, as litigation and the economy have constrained growth. However, the potential growth impetus remains and the above constraints may be lifted in the future.

Examples of these plating companies around Lewis Gut include Bridgeport Fittings, Chemical Plating Company (head of Johnsons Creek), and Boros Metal. The specific characteristics of the plating wastes of Chemical Plating Company are described in Subsection A-6, but generally they include a wide range of heavy metals, acids, and thermal effluent. Effluent limits are established through the NPDES permit process. Regulation has also helped discourage direct discharges. Updated DEP records show that Bridgeport Fittings no longer discharges to Lewis Gut and Boros Metal no longer uses that site. Still, the long-term effects of heavy metal discharge remain as contaminated sediment from the area is transported into the Gut.

Wetland Loss and Productivity Decline

The two primary factors contributing to wetland loss are filling and severe reduction in tidal circulation. Most filled areas have been created either entirely or substantially through diking and dredge spoil disposal. For example, the industrial/manufacturing area in the northwest part of the Great Meadows was formerly wetlands, and was diked and filled many years ago. Currently, as described in Subsection A-10, sections of the dike are deteriorating and some of the filled areas support wetland vegetation.

Two other areas of former large-scale wetland filling are Bridgeport Municipal Airport and Lordship. Most of this filling activity originally occurred in the 1920's and 1930's. Spoil disposal has also occurred in other parts of Lewis Gut. One of the islands of the Gut is actually the remnant of former diking and dredge spoil disposal. Though these present potential negative impacts to the Gut, there are some potential benefits. Development of upland habitat surrounding Great Meadows Marsh has stimulated the growth of wildlife and appears to be continuing.

Dredge spoil disposal can create some of the upland habitat that has been lost. One of the most important nesting areas in the marsh is a former dredge spoil site. There are trade-offs, however, as the dredge spoils displace valuable wetlands, intertidal, and sub-tidal habitat.

The most common technique used to regulate tidal exchange in parts of Great Meadows Marsh are tide gates. Three pairs of 36-inch gates are found along Lordship Boulevard and one pair of 48-inch gates are located off Long Beach Boulevard. The gates are designed to prevent penetration of saline waters on an incoming tide and to permit drainage of the marsh during the outgoing tide. This seriously impacts the productivity of the marsh and favors the domination of Phragmites communis, as explained in Subsection C-3. One way to reverse this decline, according to the 1978 airport master plans, is to remove or redesign the gates to permit free exchange in both directions.

FRASH POND

A: Physical Description

Location

Frash Pond is located on the northern edge of the Bridgeport Municipal Airport along the airport access road (See Figure 15.5). It is connected to Lewis Gut to the south, via a 3000 foot long drainage canal. 800 feet northeast of the pond is the Housatonic River shoreline. Stratford's Main Street runs along the northern edge of the embayment, between it and the Housatonic River.

Site Orientation and Form

The pond is oval-shaped with dimensions of 1400 feet by 1000 feet. The long axis is oriented from NE to SW. The shoreline is regular, with most of the pond visible from any shoreline vantage point. The drainage canal is comprised of three linear segments, with the longest segment measuring 2400 feet.

Tidal Data

Mean tidal range - 6.7 ft.
Spring tidal range - 7.7 ft.
Mean tide level - 3.4 ft.

Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth: unknown
Channel Depth: None
Additional Comments: 2750 ft. drainage canal connects Frash Pond to Lewis Gut. Pond is believed to be up to 80 feet deep.

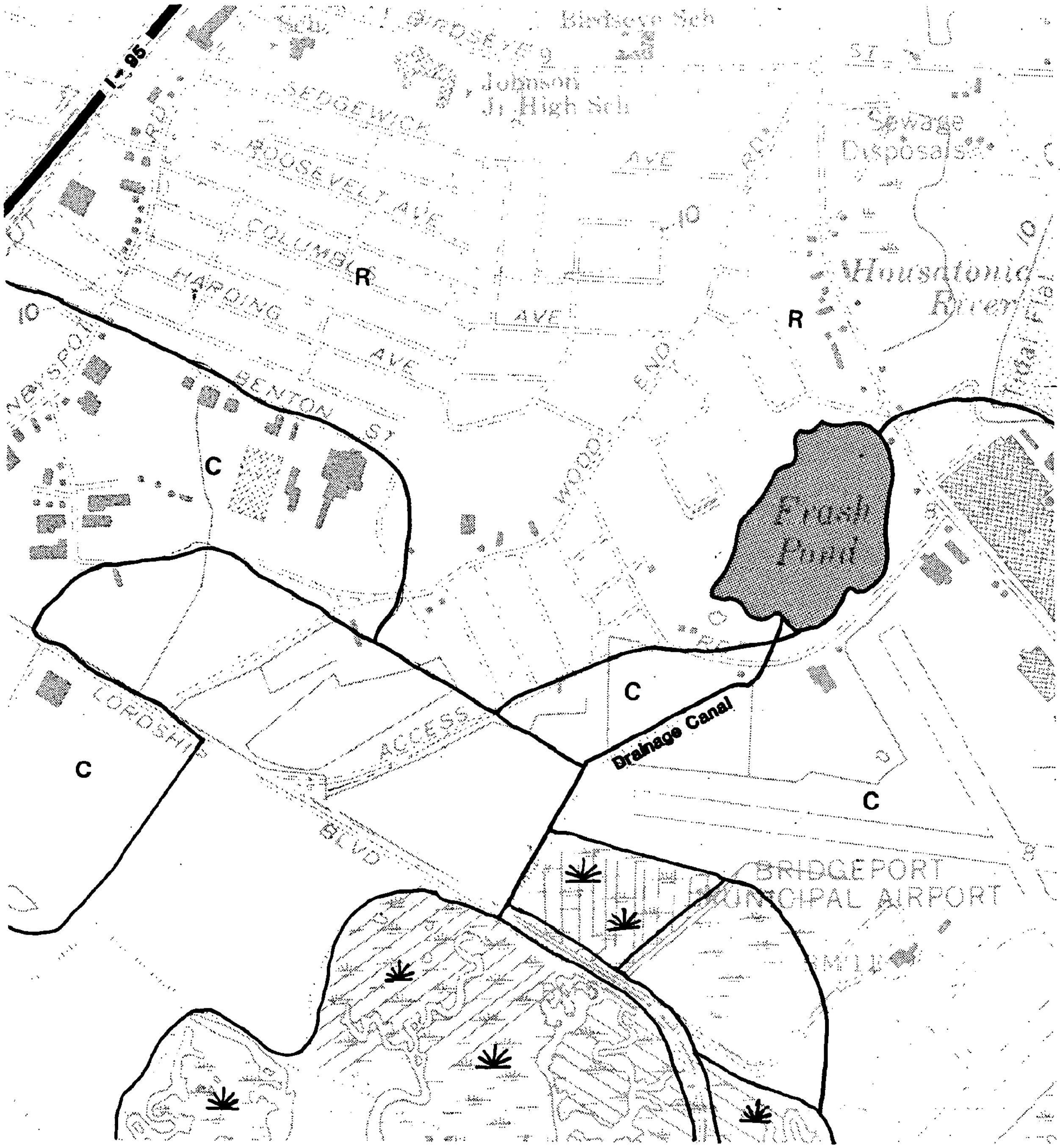
Source: NOAA National Ocean Survey Maps

Basin Hydrology

Regional Drainage Basin: Western Connecticut Coastal Basin
Embayment Basin Area: Not delineated; considered part of Great Meadows basin

Tributaries to Embayment: None

Other Sources of Fresh Water Inflow: Stormwater runoff from surounding commercial and industrial buildings and parking lots. Some runoff may come from residential development bordering the north shore.



Scale: 1" = 1000'

FIG 15.5 FRASH POND ENVIRONMENTAL LAND USE

Legend:

- wetlands
- **A** agriculture
- **R** residential
- **C** commercial/industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Basin Hydrology (con't)

Constrictions to Natural Flow and Circulation:

Structure	% Constriction	Distance from Mouth
Channelized drainage canal	--	-
Route 113 tidal gates (2)	75-100	2750 feet

Sources: U.S. Geological Survey, Connecticut Drainage Basin Gazeteer, 1981; Conn. Dept. of Environmental Protection.

Water Quality Conditions

Upstream Water Quality Classification: Not yet reclassified

Embayment Water Quality Classification: Not yet reclassified

Direct Discharges: None

Future Status of Discharges: Not applicable

Sewer Service Area and Discharge Point: Three quarters of the area surrounding Frash Pond is sewered. The other quarter consists of the airport access road and runway space.

Storm Sewer Outfalls: None

Significant Non-Point Pollution Sources: The parking lot and storage yard of A and B Enterprise Company borders directly on the northeast shoreline of Frash Pond. Stormwater runoff drains from the lot into the pond. In addition, the runoff eroded large dirt piles right on the water's edge.

Shoreline and Bottom Conditions

Extent of Shoreline Modification: Most of the shoreline of Frash Pond consists of a fringe marsh, except for the northwest part (next to A & B Enterprise Co.), which is filled to the water's edge. A multi-family housing development on the west side of the pond has a large lawn which extends to within 10 to 15 feet of the embayment. The southwest section of the embayment is gradually filling in and becoming grown over with *Phragmites*.

Shoreline and
Bottom Conditions
(con't)

Exposed soil areas, both on the construction company site mentioned above and on surrounding idle land, appear to be eroding into the pond during rainstorms.

Significant Areas of Erosion: Soil erosion from stormwater runoff and from shore erosion of exposed fill piles sits on the edges of the pond. The area of the pond surrounding the entrance of the drainage channel is very shallow and extends at least twenty feet into the pond.

Shoaling and Sedimentation: The channel leading from Lewis Gut to the embayment is not navigable because of tidal gates and low bridges. Small boats conceivably could be launched from the shoreline of the embayment, but the town indicates that this rarely happens.

Bottom Sediment Characteristics: The shoreline and bottom sediment near the drainage canal is composed of fine sand. On the other side of the pond, the sediment is more silty. The quality of the bottom sediment in the middle of the pond is unknown.

Surrounding Lands

Maximum Basin Elevations:

Location	Height
Wood End Rd.	Less than 10 feet

Topography - The area surrounding Frash Pond is part of the coastal plain and is level.

General Vegetation Characteristics: The uplands surrounding the embayment are well developed on the east side but include stands of trees between the *Phragmites* marsh and Access Road. On the west side is a large-scale multi-family housing development separated from the embayment by grass lawns. Trees and marsh and part of the Access Road lie south of the embayment (See Figure 15.5).

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Agawam	fine sandy loam	0-3	very poor
Limerick	silt loam	-	very poor
Merrimack	sandy loam	3-8	very poor

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Raypol	silt loam	-	very poor
Scarboro	muck	-	very poor
Tisbury	silt loam	-	very poor
Typic Udorthents	cut and fill	-	variable
Westbrook	mucky peat	-	very poor
Landfill	-	-	

Shellfish and Finfish Resources

There are no known shellfish beds in Frash Pond, though shall fragments are found along the shoreline. All coastal waters in Stratford are closed to shellfishing. The Stratford Shellfish Commission indicated that shad and herring run from Lewis Gut to Frash Pond in March or April.

Wetlands

Three-quarters of the embayment shoreline is vegetated with Phragmites (See Figure 15.5). The southern part of the pond is shallow, and becoming increasingly overgrown. The fringe of Phragmites around the pond ranges from 5 to 25 feet wide. The vegetation serves mostly to stabilize the shoreline, filter runoff as it drains through the marsh to the embayment, and absorb nutrients.

Aerial photos from 1934 show the configuration of the shoreline essentially the same as it is today, except for some filling of the southern end of the embayment with vegetation. When Runway II was built, the channel to Frash Pond had to be realigned westward to avoid the strip. This also required filling a large area of wetlands.

At present, encroachment of development and fill into wetland areas appears to be limited to the waterfront of A & B Enterprise. Large piles of dirt and gravel are stored right at the water's edge, and appear to be eroding into the embayment. It is presumed that the area under the storage lot used to be a wetland.

Environmentally Sensitive Areas

The Great Meadows marsh is regarded as one of the most valuable tidal marsh habitats in Connecticut, and is located approximately 0.6 miles from the basin. A state rate marsh grass once grew in the vicinity of Frash Pond.

B: Land Use Analysis

Current Shoreline and Water Use

The shore of the embayment is lined with tidal marshes. Use is limited to passive recreation, since no one swims or boats in the embayment. Town officials, however, indicated that the residents used to swim in the pond.

Current Upland Use

Frash Pond is surrounded by commercial, industrial and residential uses. Bridgeport Municipal Airport Runways 11 and 16 lie south and southeast of the pond, respectively. Access Road is to the east and A & B Enterprise Company, a construction and building materials company, lies to the northeast. A large multi-family housing complex and a single family tract development are located west of the pond.

Historical and Significant Land Use Chabges

Prior to the 1930's, the land surrounding Frash Pond was primarily used for agriculture and some housing along the southwest shore. In the late 1930's the airport was constructed, generating new business and economic activity in the area. By 1950, the small Sikorsky aircraft plant (across Main Street from Frash Pond) had expanded into a large manufacturing complex. By then, Access Road to the east had been built and the pond canal had been moved west to circumvent Runway 11. The runway construction also involved filling large areas of wetlands.

Also, by 1950 a large housing development had been built west of Frash Pond, and additional residential infilling had occurred in the surrounding area. During the period from 1950 to 1980, additional industrial growth occurred along Main Street in the vicinity of the airport. A & B Enterprise Company, at the intersection of Access Road and Main Street, was built during the 1960's.

Public Access and Recreational Opportunities

Frash Pond is used primarily for passive recreation (as discussed above in Subsection B-1). No roads provide access exclusively to Frash Pond; however, access may be gained through the parking lot of A & B Enterprises off Main Street. A foot path also leads to the southern end of the pond from Access Road.

C: Problem Identification

Local Departments and Offices Consulted

Stratford Conservation Commission
Stratford Shellfish Commission

Response from Questionnaires and Local Meetings

Stratford officials indicated that they know very little about the pond. Apparently there has been continued questioning about even basic data such as its depth, now through to be about 50 feet. Officials believe that water quality has deteriorated somewhat over the past twenty years, as people used to swim in the embayment. They also conceded, however, that industrial development in the area and increased dumping of debris, such as tires, may be another reason for the decline in use.

The Stratford Shellfish Commission indicated that fish runs of herring and shad used to occur in substantial size, but have declined considerably over the years. No specific explanation was offered about the decline, except that it was a reflection of the gradual decline in productivity of Lewis Gut.

Officials also noted that the southern end of the pond was silting in and gradually being overgrown with tall reed grass.

Results of Field Survey and Research

A survey of the site confirmed the silting in of the southern end of the pond and encroaching growth of wetland vegetation. The shallows of the pond appear to extend out about 20 to 25 feet from shore, beyond which the water body becomes appreciably deeper.

Results of Field Survey and Research (con't)

As mentioned in Section A, three-quarters of the pond is fringed with wetland vegetation, while the north shore along Main Street and behind A & B Enterprise Company is filled to the water's edge. Large dirt and gravel piles are placed in the company's back lot, right along the shoreline. Some of the material appeared to be eroding into the pond. In addition, there were no barriers or stabilization to keep the piles from sliding into the water.

The quality of the water in the channel leading to Frash Pond appeared somewhat degraded, though juvenile fish were observed swimming in it. The pond appeared very clear and the bottom was visible up to 2.0 feet from shore.

Clam shells were noted along the sandy shore of the pond. It is uncertain whether the shells washed in from the deeper areas of the pond or whether they were left there by animals, such as raccoons or seagulls.

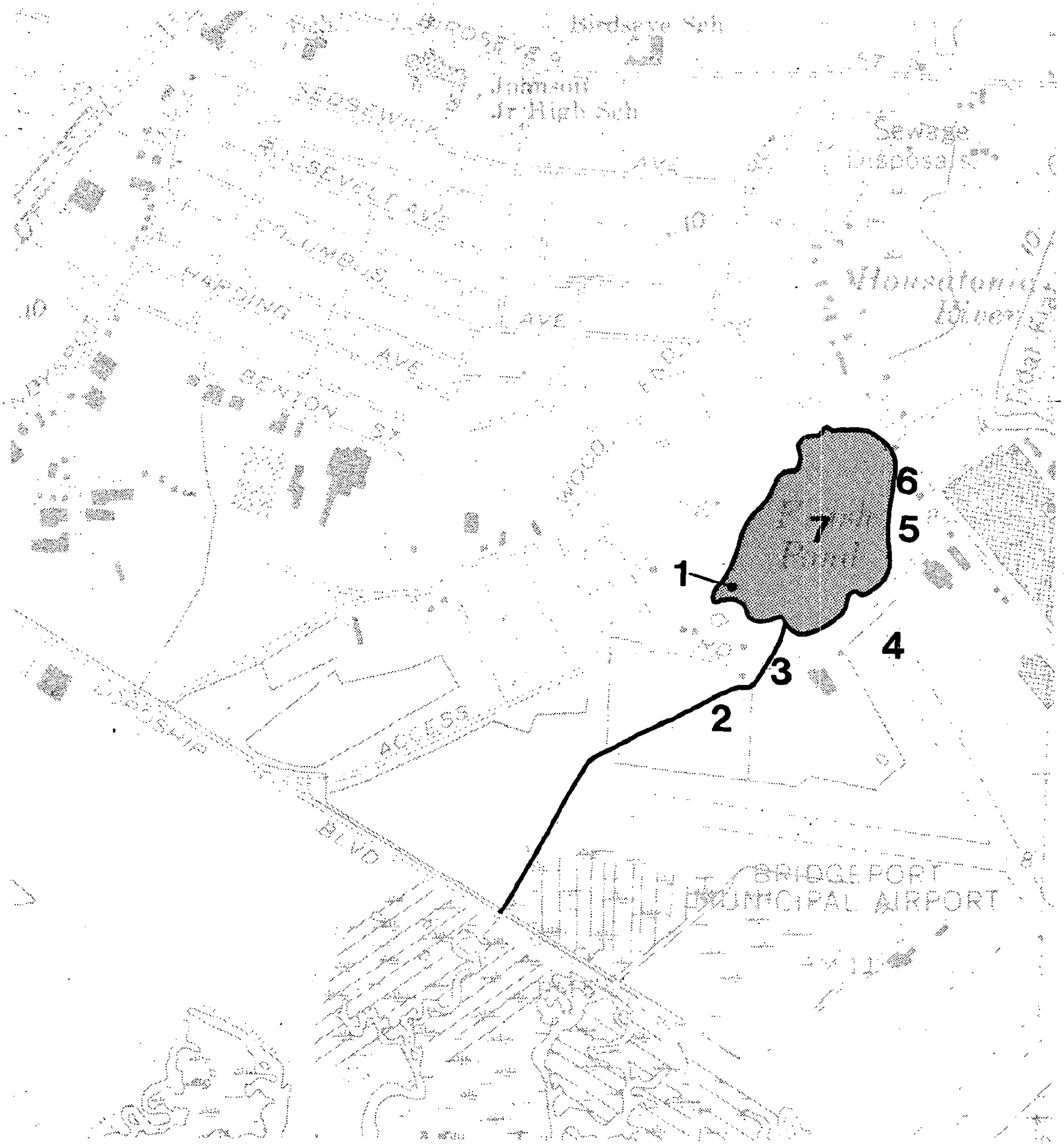
Tidal exchange with the pond is severely limited by the narrow channel and twin 36-inch diameter tidal gates at Lordship Boulevard. The gates shut during incoming tide and release drainage from the pond and marsh on the north side of the road during an outgoing tide. Consequently, salinities in the pond are very low and vegetation such as Phragmites is dominant. The gates also impede the movement of fish such as herring and shad into the canal and pond.

D: Problem Analysis

Constricted Tidal Flushing

The twin 36-inch diameter tide gates are located where the channel passes under Lordship Boulevard, and are designed to keep Lewis Gut tidal water from penetrating up the channel. Consequently, the system above the gates has low salinities and an aquatic system adapted to a brackish environment. Vegetation which thrives in fresh and brackish water is well established around the pond (See Figure 15.6).

Fine sediment apparently flushes out the channel on an ebb tide, as very dark silt has settled on the bottom outside of the gates. The material most likely comes from the marshes contiguous to the channel, because the bottom of the pond is sandy.



Scale: 1" = 1000'

FIG 15.6 FRASH POND ENVIRONMENTAL PROBLEMS

Problem Areas

1. Corner of pond being vegetated by wetlands
2. Channelized canal limits tidal flow
3. Culvert constricts tidal flow
4. Stormwater runoff from airport runways
5. Surface runoff from industrial site; potentially hazardous chemicals on site
6. Fill stored on site is encroaching on pond
7. Closed to shellfishing

Fish Loss

Frash Pond used to experience large shad and herring runs each spring around March and April. Degraded water quality and tide gates are blamed for the decline over the past years. Shad runs, in general, have declined in Long Island Sound, so it is difficult to attribute the decline exclusively to the gates. Moreover, other changes, such as closure of the former Gut inlet and industrial discharges, have been cited as having caused significant decline in the general productivity of Lewis Gut. Historically, Bridgeport Fittings discharged industrial wastes to the Gut not far from the Frash Pond tide gates. Pollutants included heavy metals, acids, and suspended solids. Though the plant no longer discharges its wastes, it is likely that these pollutants are continually resuspended by tidal currents and storms, and may continue to impact the ecosystem.

Siltation and Riparian Encroachment

Erosion of upland soil, wind blown matter, and siltation of suspended solids from the water have contributed to the gradual silting in of the southern part of Frash Pond. Phragmites, which favors tidally constricted environments, has quickly vegetated the shallows and is now well established as the dominant wetland species. According to a series of aerial photos dating back to 1934, the southern end of the pond remained open until the 1950's, when accelerated construction of surrounding upland property probably contributed significant volumes of sediment through erosion. Given the minimal tidal flushing of the pond and its lack of any tributaries, there was no significant transport mechanism to shift the sediment to other parts of the pond. The result was an ideal condition for expansive growth of Phragmites communis.

On the north shore there has been some gradual filling of the pond over the past 20 years. A & B Enterprise, a construction and building company, stores dirt and gravel in the back of its land, right at the water's edge. Dirt and gravel occasionally slide into the pond or erode into the embayment during rainstorms. This gradual erosion and sediment movement has created some new upland and shallow water conditions along the shore.

PROBLEM SUMMARY

Marine Basin

1.	Siltation	Minor	(b)
2.	Pollution	Moderate	(a)

Lewis Gut

1.	Circulation Constriction	Moderate	(b)
2.	Pollution	Moderate	(a)
3.	Wetland Loss	Serious	(a)

Frash Pond

1.	Constricted Tidal Flushing	Major	(b)
2.	Fish Loss	Moderate	(b)
3.	Riparian Landfilling	Moderate	(a)
4.	Siltation	Minor	(b)
5.	Water Pollution	Minor	(b)

KEY: (a) Conditions becoming worse (b) No change (c) Conditions improving

CHAPTER 16 FAIRFIELD EMBAYMENTS

INTRODUCTION

The Town of Fairfield is located in Fairfield County and is bordered to the east by Bridgeport and to the west by Westport. The town covers an area of 29.8 square miles all of which are located within the Western Connecticut Coastal Basin. During 1970 to 1978, the population increased 4.6 percent (1970-56,487; 1978-59,100), which is approximately the same rate of growth as the state. The number of Fairfield housing units during that same period increased by 8.2 percent, approximately 60 percent of the state increase of 13.5%.

The population density of the town is 1,983 persons per square mile, over three times the state average of 652. The population is found in the three communities of Greenfield Hill, Southport, and Mill Plain, as well as Fairfield's central downtown. Nearly all of the Southport downtown area is sewered, as is the case for the neighborhoods along Ash Creek (See Figure 16.1).

Four major streams within Fairfield flow to Long Island Sound: the Rooster River, Pine Creek, Mill River and Sasco Creek. Most of the town's open space is located along those four streams and their tributaries. Fairfield's commercial and industrial development has settled within a well-defined strip along U.S. 1, which runs parallel to the shoreline approximately 1 to 3 miles inland. The most active residential development has occurred in the southeastern part of town.

The geology of Fairfield has been altered significantly by glacial processes. Formations include Paleozoic bedrock overlain with till and stratified drift. The till in Fairfield is dense, and ranges in thickness from several inches to more than 40 feet. The permeability of the till is low, due to a large clay content. The stratified drift formations are found mostly along Fairfield's valleys and coastal lowlands. The sediment has a large infiltration capacity and is capable of storing large volumes of stormwater which are later released to adjacent streams and other surface water.

The two major harbors of the town are Southport to the west and Ash Creek to the east, on the Bridgeport border. Southport is the old harbor and has many elegant historical buildings along the waterfront. Several millponds, which originally harnessed water power for early industry, now regulate water flow as it drains to the harbor. Ash Creek is the relatively new boating center of the town that was created by dredging and filling tidal marshes behind Jennings Beach. The creek has a wide floodplain near the mouth and narrows further upstream. The Ash Creek floodplain is heavily industrialized between Fairfied and the Conrail line.

The five embayments originally considered for study in this report included Ash Creek, the Mill River, Horse Tavern Creek, Pine Creek, and Turney Creek. Pine Creek was dropped, because the town has just completed a report on the embayment and had committed $265,000 to correct the problem. Turney Creek was dropped because new tide gates had recently been installed to correct circulation problems, wetland loss, and fish loss. the other embayments were included in the study because their problems were significant and had not yet been resolved.

ASH CREEK

A: Physical Description

Locaiton

Ash Creek is located on the eastern end of Fairfield and forms the common municipal boundary of Fairfield and Bridgeport (See Figure 16.1). On the east bank are the neighborhoods of Grover Hill and Black Rock. The western bank includes Jennings Beach and some industrial development along the upper reaches. The center of Fairfield is 2.5 miles to the west. Bridgeport is 4 miles to the east.

Site Orientation and Configuration

The river meanders within a wide floodplain, but the overall orientation is north to south. It is 800 feet at its widest point and narrows to 75 feet in the upper reaches. For the purpose of this report, the study area of this embayment is from the mouth of Ash Creek (Long Island Sound) north to the intersection of Interstate 95. The length of this river segment is approximately 2.5 miles. The Conrail line intersects the river approximately 800 feet south of I-95. U.S. 1 crosses the river approximately 1 mile upstream of the mouth.

Tidal Data

Mean tidal range -	6.9 ft.
Spring tidal range -	7.9 ft.
Mean tide level -	3.4 ft.

Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth:	Unknown
Channel Depth:	Unknown

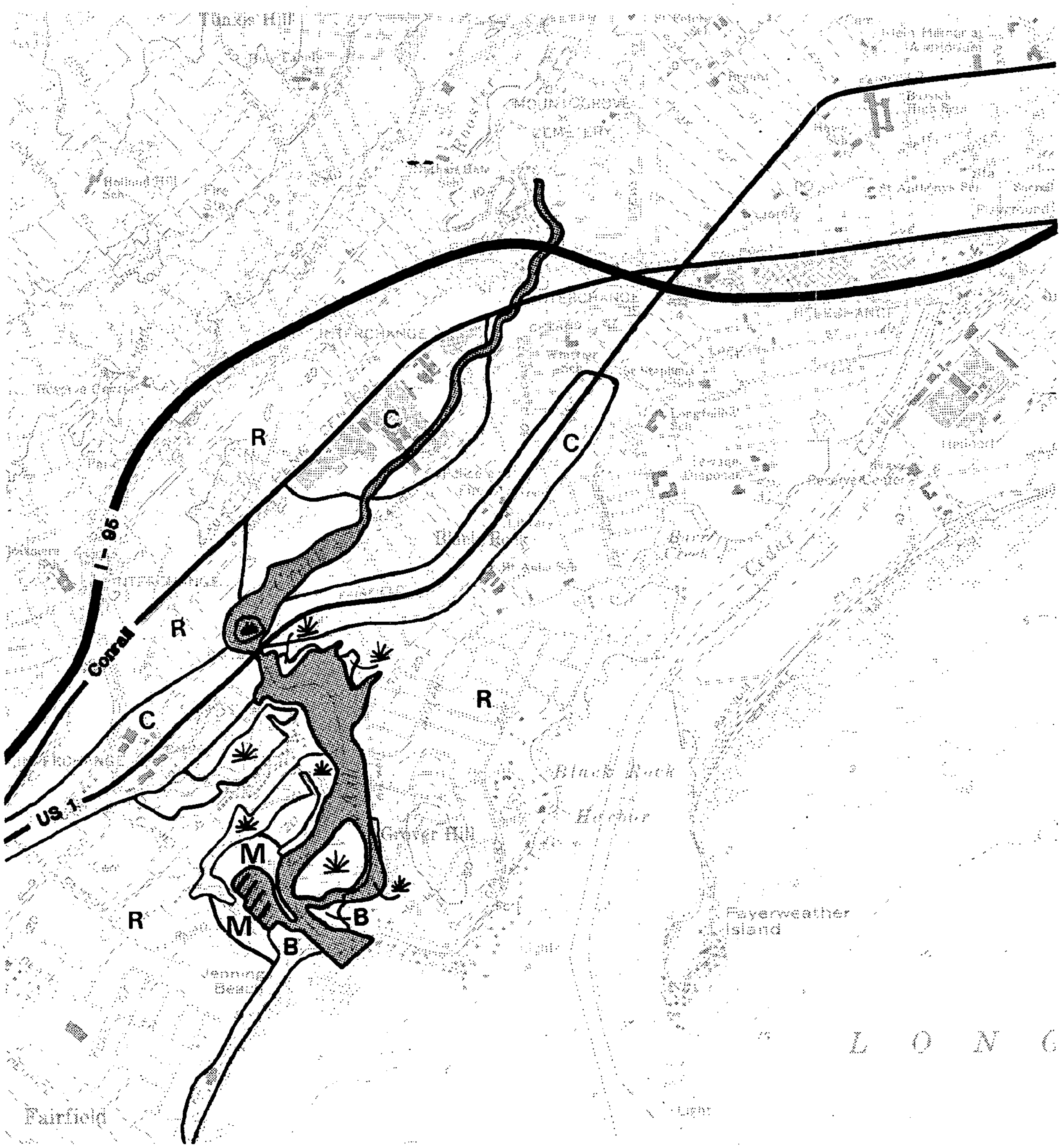
Additional Comments: Channel to municipal marina is maintained by Fairfield and is presumed to be at least 5 feet deep (MLW).

Source: NOAA National Ocean Survey Maps

Basin Hydrology

Regional Drainage Basin: Western Connecticut Coastal Basin
Embayment Basin Area: 15.3 square miles

Tributaries to Embayment: Rooster River



Scale: 1" = 2000'

FIG 16.1 ASH CREEK ENVIRONMENTAL LAND USE

Legend:

- wetlands
- **A** agriculture
- **R** residential
- **C** commercial/industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Basin Hydrology
(con't)

Additional Significant Sources of Fresh Water Inflow: Much of Ash Creek drainage basin is urbanized, so stormwater runoff comprises a source of water during storm events.

Constrictions to Tidal Flow and Circulation:

Structure	% Constriction	Distance from Mouth
Fairfield Ave. Bridge	50-75	0.9 miles
Black Rock Turnpike Bridge	75-100	1.5 miles
Conrail R.R. Bridge	50-75	2.0 miles
State St. Bridge	0-25	2.2 miles
I-95 Bridge	0-25	2.3 miles
Kings Highway Bridge	0-25	3.2 miles
Brooklawn Ave. Bridge	0-25	3.8 miles
Stratford Rd. Bridge	0-25	4.4 miles

Sources: U.S. Geological Survey, Connecticut Drainage Basin Gazeteer, 1981; Conn. Dept. of Environmental Protection

Water Quality
Conditions

Upstream Water Quality Classification: SC/SB

Embayment Water Quality Classification: Yet to be classified

Direct Discharges:

Source	NPDES Permit #	Waste Characteristics
Bridgeport Molded Prod.	CT0000213	Cooling water, thermal discharge, variable pH
Bullard Co. White Cons. Ind, Inc.	CT0001686	Metal sludge, chromium, copper, iron, magnesium cyanide, suspended solids, thermal discharge

Direct Discharges:

Source	NPDES Permit #	Waste Characteristics
Clark Metal Prods.	CT0000329	Cooling water boiler blowdown
Handy & Harman	CT0002151	Metal & oily waste
Heim Universal Corp.	CT0022560	

Future Status of Discharges: The intent of the NPDES program is to proceed to pretreatment of wastes, but there has been a delay in implementation and some expired permits have not been reviewed and reissued.

Sewer Service Area and Discharge Point: Most of the lower reaches of the Ash Creek basin are sewered, except some houses along Jennings Beach. The treatment and discharge sites are located along the Pine Creek estuary off Reef Road (See Figure 16.1).

Storm Sewer Outfalls: Many storm sewer outfalls are located along the creek, as the basin is one of the most developed sections of Fairfield.

Significant Non-Point Pollution Sources: Coastal drainage from local streets and building roof tops comprises a significant percentage of creek flow during storms.

Shoreline and Bottom Sediment Conditions

Extent of Shoreline Modification: The western shore of the lower reaches of Ash Creek has been filled and excavated to transform a former wetland area into a town recreation area. The town property includes a marina, dock facilities, boat ramp, and picnic-recreation area. Most of the creek shoreline below the U.S. 1 bridge remains in its natural state as tidal wetlands. Some exceptions, which are located just south of the bridge, include shore stabilization with seawalls, riprap, and bulkheads. A road embankment next to the western shore has altered the drainage and covered some of the coastal wetlands with the gravel road bed. Almost 40% of the creek shoreline above the bridge has been stabilized with seawalls and bulkheads and altered with fill.

Shoreline and Bottom Sediment Conditions (con't)

Significant Areas of Erosion: The earthen island protecting the mouth of the public marina shows signs of erosion. The sand spit protruding into the mouth of Ash Creek from Grover Hill appears to be very unstable.

Shoaling and Sedimentation: The mouth of the harbor consists of unstable sand with shoaling and natural bar development. This presents a minor problem for navigation, and the town dredges the area regularly. The dredging also improves circulation and tidal flushing within the Ash Creek estuary.

Bottom Sediment Conditions: The lower reaches of the creek are composed of fine sand while the upper reaches (above the U.S. 1 bridge) are predominantly silty.

Surrounding Lands

Maximum Basin Elevation:

Location	Height
Grover Hill, Bridgeport (east shore)	70 feet
Mount Grove Cemetery (east shore)	60 feet
Fairfield Ave. (sothwest of Ash Creek bridge)	50 feet
Tunxis Hill	170 feet

Topography: The Ash Creek basin is relatively flat near the coast and becomes hilly inland. There are two minor areas of moderately steep slopes near the creek: 1) 1000 feet from the west bank, just north of Fairfield Avenue, and 2) on the east bank near the Mount Grove Cemetery.

General Vegetation Characteristics: The region is considerably urbanized and most vegetation is limited to landscaped trees and bushes.

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Agawam	fine sandy loam	0-3	very poor
Agawam	fine sandy loam	3-8	very poor

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Beaches	-	-	-
Charlton-Hollis	fine sandy loam	3-8	poor
Charlton-Hollis	fine sandy loam	15-40	very poor
Hollis-Rock Outcrop	complex	3-15	very poor
Hollis-Rock Outcrop	complex	15-35	very poor
Leicester	fine sandy loam	-	very poor
Merrimac	sandy loam	3-8	very poor
Paxton	fine sandy loam	3-8	poor
Paxton	fine sandy loam	8-15	poor
Saco	silt loam	-	very poor
Sutton	fine sandy loam	3-8	poor
Typic Udorthents	cut and fill	-	variable
Westbrook	mucky peat	-	very poor
Westbrook	mucky peat, low salt	-	very poor
gravel pit	-	-	-

Shellfish and Finfish Resources

Ash Creek has been subject to considerable shellfish loss, and there are no longer any beds in the embayment. The entire Ash Creek basin is closed to shellfishing.

There are no fish runs up the creek, though sport fishing is very popular at the mouth of the embayment.

Wetlands

Most of the fringe wetlands, consisting primarily of Saltmarsh Cord-grass (Spartina alterniflora), remain intact south of the Fairfield Avenue bridge (See Figure U-1). There is a large wetland island near the mouth of the creek. The shoreline north of the Fairfield Avenue bridge has been extensively filled and stabilized, and few tidal wetlands still remain.

Wetlands (con't)

The fringe marshes of the lower reaches of the creek serve as important habitat and a natural buffer between uplands and the embayment waters. As a buffer, the marshes help stabilize the shoreline, filter coastal drainage and absorb excess nutrients in the estuarine system.

History of Wetland Filling: Some of the wetlands of the lower reaches have been filled for housing development. Major alterations of wetlands are required for construction of the Fairfield Small Boat Marina. Specifically, construction of bulkheads was required to carve out enough space for 9 large finger piers and a boat ramp.

The shoreline upstream of the Fairfield Avenue bridge has been filled and stabilized for both residential and industrial development. Most of this activity took place between 1935 and 1960.

At present, little additional wetland filling is anticipated in the future. Several of the tide gates serving small creeks off the embayment need to be replaced to improve tidal flushing and productivity of the wetlands.

Environmentally Sensitive Areas

The Pine Creek marsh is located off Old Dam Road east of Sasco Hill. Approximately 24 acres of the marsh were purchased in 1970 for conservation, education and wildlife habitat.

The Pine Creek marsh comprises the most important part of the only estuarine wetland area in Fairfield that has not been permanently altered by man's activities. It is surrounded by areas of former wetlands that have been filled within the past 80 years to provide space for housing, schools, roads, recreation, and solid waste disposal. The system provides valuable habitat and serves as a natural buffer for the Pine Creek estuary. Wetland vegetation species include Saltmarsh Cord-grass (Spartina alterniflora), Saltmeadow Cordgrass (Spartina patens), Saltgrass (Distichlis spicata) Marsh Elder (Iva fructescens), Samphire (Salicornia europaea) and Reed Grass (Phragmites communis). It should be noted that the Pine Creek marsh is unditched, and, as such, is a particularly valuable tidal wetland. Major emphasis sould be placed on protecting and maintaining the marsh in this current state.

B: Land Use Analysis

Current Shoreline and Water Use

The creek is used primarily for recreation, flood control, conservation, and waste disposal. The Town of Fairfield Small Boat Marina is located at the mouth of Ash Creek and offers both boat slips and a launch ramp. Additional open space next to this marina provides picnic sites and nature trails, both in upland areas and along the tidal marshes.

Storm water outfalls and tide gates are located along the shoreline to improve the drainage of developed neighborhoods and commercial property. Industrial outfalls discharge waste to the creek between Fairfield Avenue and the Conrail line bridge (see Subsection A-6 for details) (See Figure 16.2).

Many waterfront homes in the lower reaches of Ash Creek, south of Fairfield Avenue, have docks and store boats in their yards. Few people swim in the creek because of its low water quality.

Current Upland Use

The lower reaches of the creek south of Fairfield Avenue are mainly residential, except for the small boat marina. Property along Fairfield Avenue is commercial and includes roadside shops, food stores, restaurants, car dealers and discount outlets. North of Fairfield Avenue lies a mix of industrial and residential land. Most of the industry is on the west side of the river and includes Bullard Company, Clark Metal Products, Bridgeport Molded Products and the Aristol Company. None of these companies is water dependent, but they rely on the creek for effluent disposal.

Historical and Significant Land Use Changes

The floodplain south of the Conrail line was once tidal wetlands. The early center of development in Fairfield was Southport, and it was not until the 20th century that the eastern part of town became densely developed. By the 1930's, the waterfront neighborhoods south of Fairfield Avenue had roads, but few houses. By the 1950's, considerable infilling had occurred, and by 1970 the neighborhoods were completely developed. Relatively minor development continues today.

The Fairfield Small Boat Marina was developed during the late 1960's and early 1970's as Fairfield's major public boating center for town residents. The area was formerly wetlands and tidal creeks. Construction required excavation of large volumes of peat and sediment to create a large boat slip area. Bulkheading was later installed to stabilize the shoreline. A picnic area and nature trails were added to broaden recreational use of the property.

Historical and Significant Land Use Changes (con't)

Aerial photographs show that industry has been located between the creek and the railroad since at least the 1930's. The most significant change since then has been the expansion of older companies and the addition of several new ones. Industrial frontage on the west side of the creek between Fairfield Avenue and the Conrail line has increased approximately 5 fold over the past 50 years.

Public Access and Recreation Opportunities

The major public recreation area on Ash Creek is the Fairfield Small Boat Marina. As already discussed in this section, the primary purpose of the marina and open space is to enhance the recreational opportunities of town residents. Aside from boat slips, a launch ramp and a gas dock, the recreation area includes a waterfront picnic area and nature trails. Next to the marina is Jennings Beach, one of the town's several bathing areas.

C: Problem Identification

Local Departments and Offices Consulted

Stratford Conservation Commission
Stratford Public Works Department
Stratford Planning Department

Response from Questionnaires and Local Meetings

According to local officials, water pollution is regarded as the most severe embayment problem. The origin of the problem is believed to be local and has existed for at least 15 years. During this period water quality conditions have declined, but are not expected to become worse in the future.

Circulation and eutrophication are regarded as moderate problems. Shallow channels near the mouth of the creek impede tidal flushing and contribute to stagnation. Tide gates exacerbate the problem by preventing tidal exchange with the creeks, thus limiting the productivity of the marshes. The problem has existed for at last 15 years. One solution proposed by the town is to dredge the Ash Creek channel to a minimum of 10 feet (MLW) and install self-regulating tide gates in place of the old ones. Eutrophication is related to the circulation problem, but is principally caused by BOD loading from upstream sources.

Response from Questionnaires and Local Meetings (con't)

According to the town, eutrophication has affected the embayment for at least 15 years, during which time the condition has become more severe. Though not specified, the source of the eutrophication problem is presumed to be stormwater discharge, coastal drainage and leachate from forty septic systems.

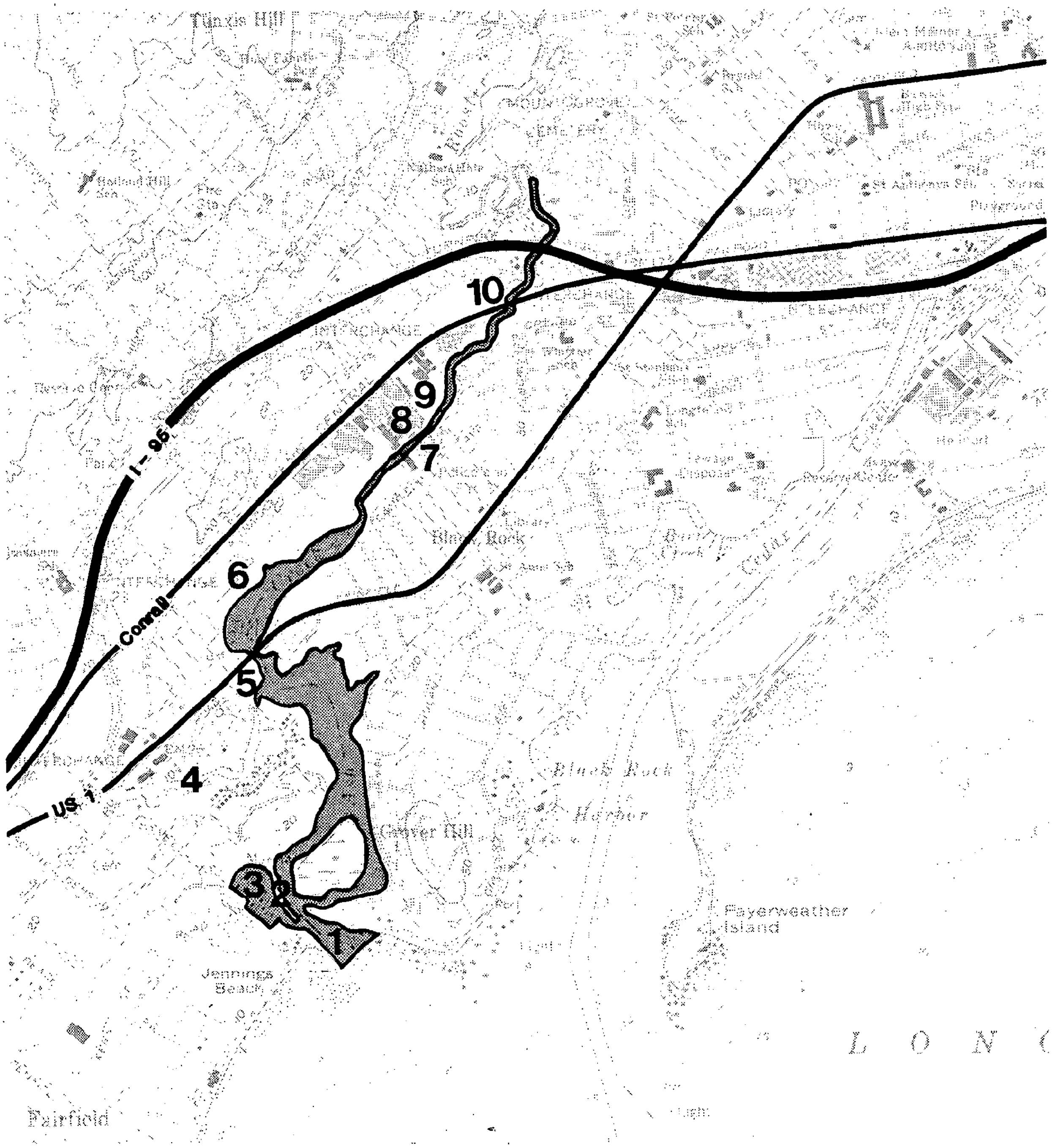
Results of Field Survey and Research

The survey of the embayment confirmed the shoaling condition at the creek mouth and shallow nature of the lower reaches. A dike had been constructed near the Coast Guard station at the mouth of the creek in preparation for limited dredge spoil disposal. All of the marina shoreline was sufficiently stabilized, except for an earthen barrier protecting boats from easterly winds. The barrier showed visible signs of erosion such as steep scarps where chunks of earth are breaking off into the water (See Figure 16.2).

Stormwater appears to drain into the creek in a rather diffuse manner along the shoreline. Some of it enters by way of street ends and highway drainage ditches, but the majority flows through storm sewers. Water that is discharged to the tidal creek, which is also called Ash Creek (located north of the public marina), eventually flushes out the main channel after it flows through several box culverts. Drainage flowing to the small creek immediately north of the marina passes through one or two regulated tide gates.

The two other significant sources of water pollution are industrial effluent and marina wastes. The industries along the middle reaches of Ash Creek discharge a variety of pollutants, including heavy metals, cyanide (amenable), suspended solids, cooling water (heated effluent), acids and caustic solutions. Over the past 10 years they have upgraded their treatment and gradually tied in waste streams that can be handled by the municipal plant. Discharge has not stopped, however, and there also is some concern about the fate of previously discharged heavy metals. They are now likely tied up in the bottom sediments and may continue to impact the ecosystem for many years.

It is difficult at this time to quantify the current impact of boat wastes. Accidentally spilled outboard oil, gas and grease are common around marinas and can have a significant impact on local ecology. Since the artificial peninsula protecting the harbor reduces circulation, spilled substances take longer to flush and the pollution problem is intensified. No spills were observed during the site visit, as few boats were in the water that early in the spring. Sanitary wastes discharge from boat heads can also become a problem as the effluent increases bacteria levels and eutrophies the receiving waters.



Scale: 1" = 2000'

FIG 16.2 ASH CREEK ENVIRONMENTAL PROBLEMS

Problem Areas

1. Closed to shellfishing
2. Eroding banks
3. Siltation of marina
4. Stormwater runoff from residential neighborhoods
5. Bridge constricts tidal flow
6. Stormwater runoff from homes
7. Industrial wastewater discharge
8. Industrial wastewater discharge
9. Industrial thermal discharge
10. Railroad bridge constricts water flow

D: Problem Analysis

Circulation Constriction

The mouth and lower reaches of the creek are quite shallow. This condition impedes navigation and constricts tidal exchange in the embayment. The constriction is caused by accelerated sedimentation in the lower reaches of the creek (See Figure 16.2). As the creek basin widens, the flow velocities decrease, thus silting out signficant loads of sediment. In addition, wind and tidal currents rework littoral deposits of sand moving along the Sound shoreline.

To combat this recurrent problem, the town has initiated its own dredging projects. For example, in 1970, approximately 90,000 cubic yards of sediment were dredged from the channel. This past spring, the town once again dredged the inlet. Unfortunately, the dredging projects are usually designed to solve the immediate need to improve navigation, as opposed to a large scale project that would alter the embayment circulation. Of course, such activity would generate large volumes of dredge spoil and would present a problem for disposal, but disposal is generally a problem for any large scale dredging project.

The other circulation problem stems from faulty design and faulty operation of tide gates. The two gates serving the modest-sized creek just north of the marina basin have functioned inadequately in the past. The upstream gate was just recently replaced by a new one with a self-regulated design. The downstream gate, near Ash Creek, has yet to be replaced. Hopefully, the productivity of the marsh will improve after both new gates are installed.

Pollution

The three significant sources of water pollution in Ash Creek are stormwater runoff, industrial discharge, and marina-related wastes. Stormwater runoff appears to be the single largest waste component, due to the extent of urbanization within the basin and the inclination of developers to move surface runoff as quickly as possible to storm sewers (See Figure 16.2). This drainage design objective stems from the fact that the floodplain and surrounding uplands along the lower and middle reaches of the creek are relatively flat. Under such conditions, drainage is usually an overriding concern. It was not until recently that retention basins were routinely included in development design. Unfortunately, building density in this part of Fairfield precludes retroactive construction of the basins.

Pollution
(con't)

Most industry along Ash Creek is located between U.S. 1 and the Conrail line. The industrial processes include mostly metal plating and plastic moulding. Pollutants in the different waste streams include heavy metals, some light metals, cyanide (amenable), cooling water, suspended solids, acids, caustic solutions, and oil and grease. The volume of discharges from the NPDES-regulated industries totals 1.2 mgd. The long-term objective of the U.S. Environmental Protection Agency and the Connecticut DEP is to encourage industries to pretreat their own wastes and then, if possible, discharge the treated effluent to municipal sewer systems. Implementation of the pretreatment regulations has been slowed by the lack of guidance on effluent standards from the U.S. EPA and the tremendous backlog of expired permits. For example, of the four industries discharging to the Ash Creek basin under NPDES permit, three industries have expired permits that have yet to be renewed. One of the permits has been expired without renewal for over two years (See Figure 16.2).

Though the boat wastes from the Fairfield marina have impacted the local water quality of the marina basin, the impacts are not as broad as the industrial discharges and stormwater discharge. Gasoline can be quite toxic to plankton and other small organisms inhabiting the top foot of the water column. Oil has similar effects, and the crude or degraded forms of refined oil sink to the bottom and cover the sediment. Ultimately, the oil becomes part of the sediment itself.

Head discharge from boats is also a problem. Human wastes, aside from their obvious negative aesthetic impacts, lead to BOD loading and bacterial contamination. This is of particular concern here, as Jennings Beach, one of Fairfield's public swimming areas, is so close to the marina basin. In addition, the tidal constriction of the basin magnifies the impacts of BOD loading on the water body.

MILL RIVER/POND

A: Physical Description

Location

The embayment is located in the southwestern part of Fairfield (See Figure 16.3). It is roughly 1 mile west of the center of Fairfield and 5 miles east of Westport. Neighborhoods along the east bank include Perry's Millpond and Mill Plain. Mill Hill, Sherwood Millpond and Southport are along the west bank. For purposes of this report, the study area includes the segment of the Mill River from Old Mill Road (just south of Perry's Millpond) to the Mill Pond dam on Harbor Road (See Figure 16.3). The embayment is intersected by U.S. 1 (800 feet north of the Harbor Road dam), the Conrail line (1200 feet north of the dam), and Interstate 95 (1600 feet north of the dam). The width of the Harbor Road dam is 280 feet.

Site Orientation and Configuration

The embayment is roughly linear with its axis oriented north to south. The length of the river segment covered in this report is 1.1 miles. The width of the river along this stretch ranges from 50 to 350 feet. Most of the 1.1 miles of river is divided into 3 sub-basins. The lower basin is between the dam and the U.S. 1 bridge, the middle basin lies between U.S. 1 and the Conrail line, and the upper basin runs from I-95 to the northern limit of the study area.

Tidal Data

Mean tidal range -	6.9 ft.
Spring tidal range -	7.9 ft.
Mean tide level -	3.4 ft.

Source: U.S. Department of Commerce, <u>1980 Tide Tables: East Coast of North and South America</u>

Bathymetry

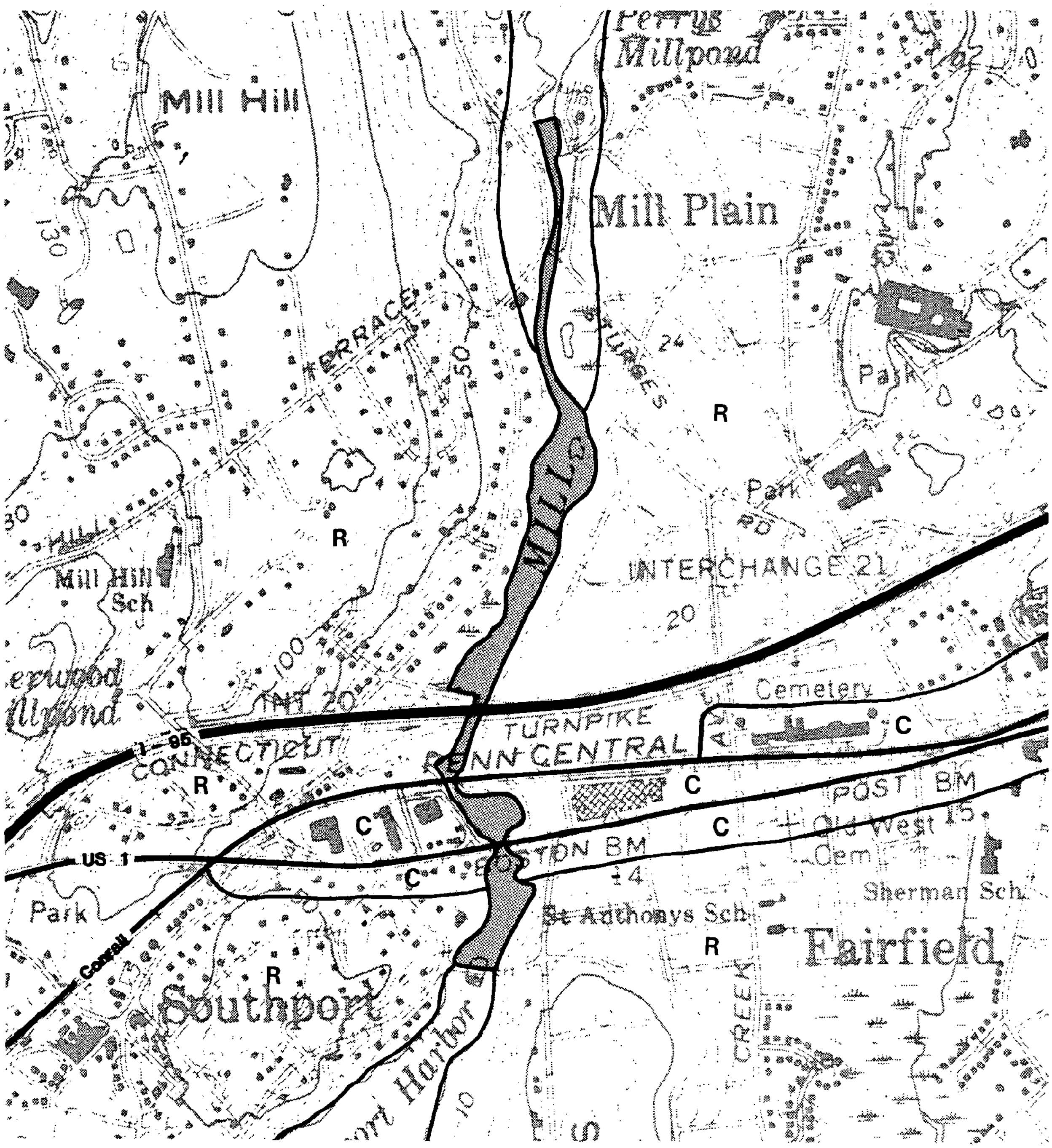
Range of Depth:	2-7 ft. (MLW)
Channel Depth:	4-7 ft. (MLW)
Additional Comments:	Channel is privately maintained.

Source: NOAA National Ocean Survey Maps

Basin Hydrology

Regional Drainage Basin: Western Connecticut Coastal Basin
Embayment Basin Area: 32.1 square miles

Tributaries to Embayment: Browns Brook
Cricker Brook



Scale: 1" = 1000'

FIG 16.3 MILL RIVER/POND ENVIRONMENTAL LAND USE

Legend:

- wetlands
- **A** agriculture
- **R** residential
- **C** commercial/industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Basin Hydrology (con't)

Additional Signficiant Sources of Fresh Water Inflow: The drainage basin is urbanized, so stormwater runoff is a significant source of drainage during storm events. Drainage from parking lots and commercial and industrial buildings along U.S. 1 represents a significant component of this stormwater flow.

Constrictions to Natural Flow and Circulation:

Structure	% Constriction	Distance from Mouth
Sturges Rd. Bridge	0-25	1.9 miles
I-95 Bridge	75-100	1.3 miles
Conrail Railroad Bridge	50-75	1.2 miles
U.S. 1 Bridge	75-100	1.1 miles
Harbor Road Dam	75-100	0.9 miles

Sources: U.S. Geological Survey, Connecticut Drainage Basin Gazeteer, 1981; Conn. Dept. of Environmental Protection

Water Quality Conditions

Upstream Water Quality Classification: Not yet classified

Embayment Water Quality Classification: Not yet revised, but currently qualifies as a Class C water body

Direct Discharges:

Source	NPDES Permit #	Waste Characteristics
E.I. Dupont Co.	CT0000418	Cooling water
ESB Inc.	CT0000442	Lead discharge & cooling water iron, suspended solids, variable pH, thermal discharge

Water Quality Conditions (con't)

Future Status of Discharges: The Exide Storage Battery Company will be closing and will cease discharge at that time.

Sewer Service Area and Discharge Point: Parts of the embayment shoreline and drainage basin are sewered. Those areas not sewered include the neighborhoods from the Conrail bridge to the Sturges Road bridge and most of the shorefront around Perry's Mill pond. The state has identified these unsewered areas as wastewater treatment "problem areas". The sewer system treats and discharges the wastes at Pine Creek near Reef Road.

Storm Sewer Outfalls: Storm sewers discharge surface runoff to the creek at many points along the river and pond. Little provision for retention of this drainage is included along the shorefront. Most of the stormwater drains from neighborhoods, while a significant percentage drains from U.S. 1 roadside ditches (See Figure 16.3).

Shoreline and Bottom Sediment Conditions

Extent of Shoreline Modifications: Much of the embayment shoreline from the I-95 bridge to the End Road dam has been filled and stabilized, as it has had a long history of industrial use. Several dams, once used to generate water power for mills, still remain. The rest of the embayment shoreline north of the I-95 bridge has not been altered, and most houses are set back from the river at least 50 feet. There are a few exceptions. One house on Bronson Road was built on a lot that required shoreline fill in order to provide enough space for the foundation.

Bottom Sediment Conditions: According to town officials, the sediment from the I-95 bridge into the Harbor Road Reservoir is highly contaminated with lead. The lead discharge originated from an ESB Corporation outfall pipe located between the Conrail bridge and the U.S. 1 highway bridge. The company manufactures batteries.

Shoaling and Sedimentation: The series of basins from the Conrail bridge to the Harbor Road dam provide ideal conditions for the settling of suspended material. Much of the sediment in these basins is contaminated with lead originally discharged by ESB Corporation.

Surrounding Lands

Maximum Basin Elevation:

Location	Height
Mill Hill (West Shore)	170 feet
Round Hill (East Shore)	170 feet
Orchard Hill (East Shore)	180 feet

Topography: The area around the Mill River basin is hilly. The western bank of Mill Pond near the Harbor Road dam and the banks from I-95 to Perry's Millpond have a moderately steep slope. They are essentially part of the slopes of Southport and Mill Hill, respectively.

General Vegetation Characteristics: The area is moderately developed. Some property within the basin still has significant stands of mature trees and dense ground vegetation. The upper reaches have a broader valley and are less developed, exhibiting more trees and other natural vegetation.

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Carlisle	muck	-	very poor
Charlton	fine sandy loam	8-15%	very good
Charlton	fine sandy loam	15-25%	poor
Charlton-Hollis	fine sandy loam	3-15%	poor
Charlton-Hollis	fine sandy loam	15-40%	very poor
Haven	silt loam	0-3	very poor
Haven	silt loam	3-8	very poor
Hinckley	gravelly sandy loam	3-15	vey poor
Paxton	fine sandy loam	0-3	poor
Paxton	fine sandy loam	3-8	poor
Paxton	fine sandy loam	8-15	poor

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Rumney	fine sandy loam	-	very poor
Typic Udorthents	cut and fill	-	variable
Westbrook	mucky peat		very poor
Woodbridge	fine sandy loam	0-3	poor
Woodbridge	fine sandy loam	3-8	poor

Shellfish and Finfish Resources

The upper reaches of the Mill River, above Harbor Road dam, is a fresh to brackish system, and thus does not support clams or oysters.

The river contains a diversity of freshwater fish, including sunfish, largemouth bass, white perch, and pickerel.

Wetlands

There is a large designated inland wetland system (classified #855 by the Conservation Commission) located between Unquowa Road and Perry's Millpond (See Figure 16.3). The inland wetland borders the shoreline and forms several islands in the river and ponds. The wetlands serve as a food source, erosion control, a flood buffer, and as habitat.

Historically, segments of the Mill River shoreline have been filled as part of the past industrial development and for waterfront housing.

At present most filling of inland wetlands along the Mill River has stopped through effective implementation of inland wetland regulations.

Environmentally Sensitive Areas

The inland wetlands of Mill Pond and Perrys Millpond are important wildlife habitat and natural buffer areas.

These wetland systems stabilize the river banks, provide an important food source and habitat for wildlife, absorb flood impacts and enhance water quality by absorbing excess nutrients and filtering out suspended sediment.

B: Land Use Analysis

Current Shoreline and Water Use

The major waterfront uses in the embayment include passive recreation, fishing in the upper reaches (fishing around the Millpond is prohibited due to lead contamination), limited boating, industrial waste disposal, and conservation. Most of the industrial waste disposal is clustered around the junction of the river and U.S. 1. The most significant discharge comes from ESB Company, which manufactures batteries (see details on effluent in Subsection A-6).

To enhance recreational use, several trails provide access to the more densely vegetated section of upper Mill Pond and Perry's Millpond. Boardwalks connect the trails in marshy areas. Parking and picnic areas are also available to users.

Current Upland Use

Upland uses include industrial and commercial use around the junction of U.S. 1, residential use south of U.S. 1, and residential and commercial use north of the Interstate 95 bridge. The land between the I-95 bridge and the Conrail bridge is underutilized. The two major parks north of the I-95 bridge within the embayment study area are Mill Hollow Park and Perry's Millpond conservation area. The former is designed more for active recreation, as it contains maintained fields and picnic areas. The latter is designed more for passive use, as there is little acreage set aside for instensive use, and most of the land is committed to non-use (soils too wet) and protected areas for wildlife and unique vegetation.

Historical and Significant Land Use Changes

The Mill River Basin used to serve as one of the town's important industrial centers. Such industry was initially water dependent, but none of the present iudustry uses water power. Increased reliance on the car encouraged strip commercial development of U.S. 1 and thus introduced commercial land use adjacent to the river. Additional industry, such as Electric Storage Battery Company (ESB), moved to Fairfield following World War II.

Housing development pressures have also increased dramatically in the past 30 years. Market pressures combined with modern engineering have encouraged builders to seriously consider building homes on steep slopes, flood prone areas, and poorly drained soils. For example, subdivision and building plans were drawn up in the early 1960's to develop the freshwater bay at Perry's Millpond. The entire project was finally abandoned after 1965, when the engineers discovered that driving piles into the 40 foot deep deposits of muck would be too expensive.

Historical and Significant Land Use Changes (con't)

Today, approximately 35 percent of the west bank of the river from the I-95 bridge north to Mortar Lake is town-owned open space. Along the east bank, 45 percent of that stretch is now town-owned open space. Only limited infilling of the residential sections of the riverbank and pond frontage has occurred over the past twenty years. The former grist mill located in the middle of the Harbor Road bridge is now used for office space.

Public Access and Recreational Opportunities

Good views are available from the Harbor Road bridge, and the Sturges Road bridge. No swimming, crabbing, or fishing is permitted in the lower reaches of the embayment study area due to lead contamination from ESB Company.

The two major park areas within the study area that provide excellent recreational opportunities are Mill Hollow Park and Perry's Millpond conservation area. The former is designed more for active recreation and includes parking, picnic areas, maintained fields, boardwalks and nature trails. The latter is designed more for passive use, as it features protected areas for wildlife, unique vegetation, sensitive areas for non-intensive use, and wet areas recommended for no use. Perry's Millpond also has a system of nature trails.

C: Problem Identification

Local Departments and Offices Consulted

Fairfield Conservation Commission
Fairfield Public Works Department
Fairfield Planning Department

Response from Questionnaires and Local Meetings

Town officials identified pollution, circulation constric- tion, and fish loss as the three major problems affecting the embayment. No moderate or minor problems were noted. Pollution was cited as the longest term impact, and dates back at least 30 years. The problem is believed to have become more severe since the 1950's, but is expected to become less severe in the future.

Results of Field Survey and Research

Though no visible signs of lead contamination were present at the time of the site visit, the location of the ESB outfall pipe was confirmed (See Figure 16.4). Signs prohibiting clamming, crabbing and swimming were also noted in the vicinity. Water sampling on the Mill River since 1977 has documented the lead contamination from ESB wastes. The results of the sampling are summarized in the discussion in Subsection D-2 below. Pollutants in the ESB waste stream (in addition to lead) include oils, acids, and iron.

A visit to the Millpond dam at Harbor Road confirmed the existence of a significant impediment to tidal mixing. The dam design includes 2 spillways, with the one on the east side at a slightly higher level than the west side. The month prior to the visit had been a period of exceedingly dry weather, and consequently the water level at the dam was low. The west spillway was dry, but the east spillway showed significant flow. No fish were observed on either side of the dam, though a Canada Goose and a Mute Swan were observed feeding on algae in the shallow water area next to the dry spillway.

Repeated reference was made to ESB as the primary pollution source in the embayment. Lead is the most significant component of the ESB waste stream, and both contaminates bottom sediments and is absorbed into the food chain. Currently, ESB is under a Connecticut DEP order to dredge the river.

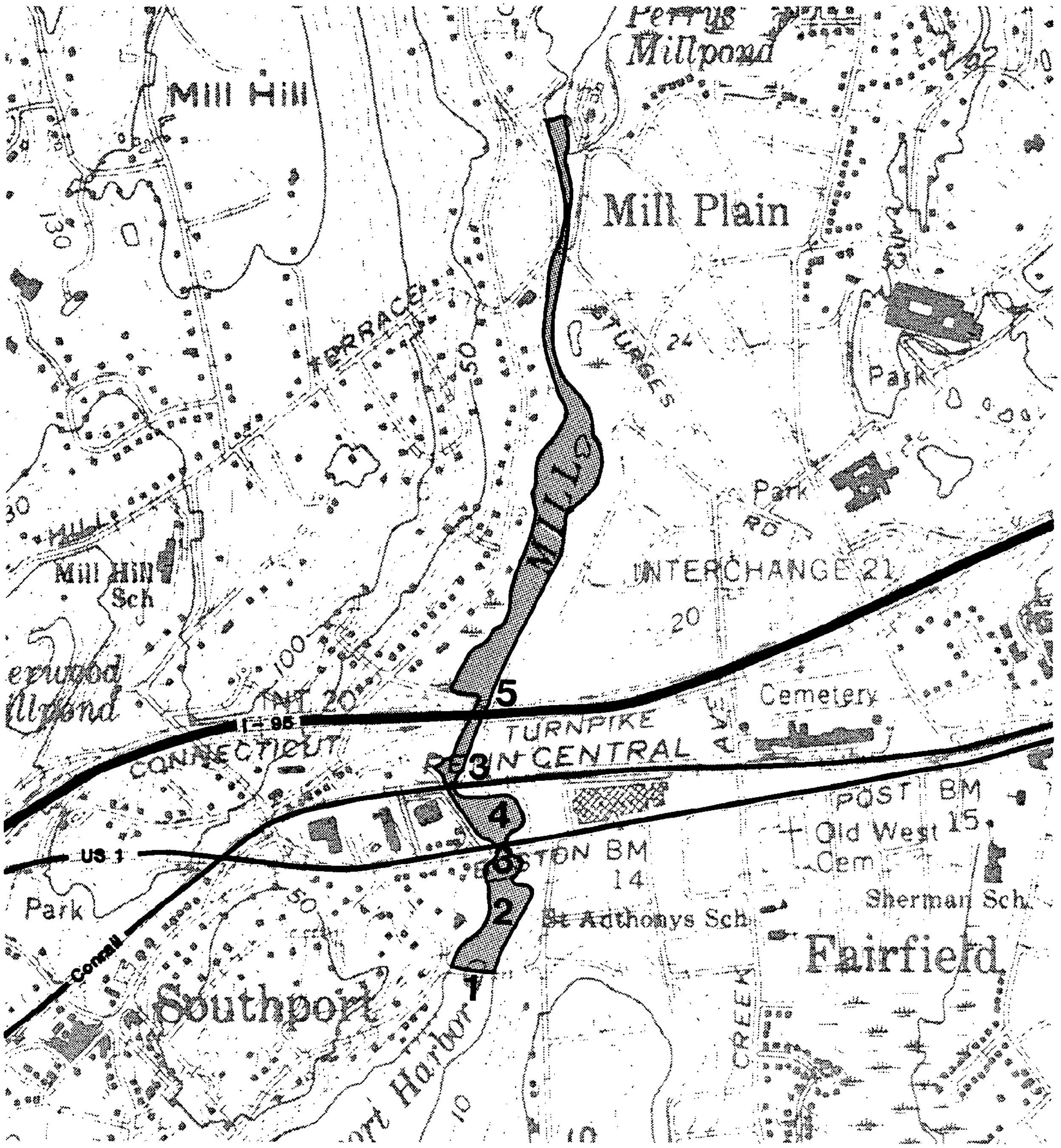
The Harbor Road dam in Millpond completely restricts harbor waters from mixing with the freshwater environment of the middle reaches. Town officials believe this condition reduces overall productivity of the system and results in a loss of anadromous fish, such as eels and alewives. One suggestion proposed by several officials would be to enlarge the opening of the dam spillway and install semibuoyant tide gates to allow for proper flushing.

D: Problem Analysis

Circulation

Tidal exchange on the Mill River is restricted above the Mill Pond dam and spillway at Harbor Road (See Figure 16.4). The spillway creates approximately a four to five foot rise in the riverbed elevation, and thus prevents most normal tides from penetrating further up the river on an incoming tide.

Though the tidal range averages 6.9 feet at the mouth of the river, the range is dampened considerably upstream. A high spring tide would be required to move tidal water over the spillway.



Scale: 1" = 1000'

FIG 16.4 MILL RIVER/POND ENVIRONMENTAL PROBLEMS

Problem Areas

1. Spillway blocks tidal influence
2. Closed to shellfishing
3. Bridge constricts river flow
4. Lead contaminated sediment
5. Railroad bridge constricts river flow

Circulation (con't)

Consequently, the aquatic system north of Harbor Road may be described as a brackish to freshwater environment. Wetlands vegetation above the dam is essentially of fresh water variety. Plant species include Cattails, Reed grass, Water weed, Arrowhead, Bulrush, Burreed, Pickerelweed, and Water lilies. Freshwater fish include largemouth bass, sunfish, white perch, pickerel and stocked trout.

In addition, the bridges along the river encroach on the floodway and constrict circulation and flow. For example, the U.S. 1 bridge opening is less than 25 percent of the original river bed width, and the Conrail bridge opening is less than 50% of the original width. This condition creates settling basins within some segments of the river, such as the reach between the Conrail and U.S. 1 bridges. Such conditions encourage the siltation of sediment and localization of pollution. This effect also helps to account for the localized high levels of lead contamination near the ESB outfall pipe (just north of U.S. 1).

Pollution

The Electric Storage Battery Company, (ESB) located along U.S. 1, is the single most significant point-source polluter within the embayment. The company was established in 1948 amid considerable controversy. Development of their site required conveyance of town land to the company, in return for assurances that their manufacturing would not significantly impact the river.

The industrial discharge from the battery plant includes oils, acids, iron, and lead in various forms. ESB received its first NPDES permit in 1974. That same year, the Mill River Wetlands Committee asked the Connecticut DEP to consider removing contaminated sludge and sediment from the river bottom in an effort to reduce the lead problem. The DEP rejected the idea, and suggested that the town take action on the local level.

According to a report prepared by the Fairfield Conservation Commission, there have been subsequent incidents creating ecological and downstream impacts that are tied to the ESB discharge. In 1975, discharged oil and sludge were traced to ESB on at least two occasions. During 1976, Mill River residents reported numerous cases of wildlife lead poisoning, particularly Mute swans.

Pollution
(con't)

In 1977, Fairfield started periodic sampling of lead in the pipe effluent, bottom sediment, plants, and animals. Results ranged from 7 to over 636,000 ppm in sediment, and over 28,000 ppm in aquatic plants. Though the lead effluent limitations in the NPDES permit are set at 1 ppm, samples showed repeated violations, with some samples greater than 25.0 ppm. In 1978, sampling results from the Mill River were compared to results from Ash Creek and Sasco Creek and were found to be 7 to 15 times higher in the sediment, 17 to 25 times higher in vegetation, and six times higher in animals. One of the sediment samples collected at the basin receiving the discharge exceeded 120,000 ppm. Today, the lead contamination problem appears to be clearly traced to ESB Company.

Shellfish and
Finfish Losses

Several species of fish rely on the Mill River estuary habitat. The most common ones include alewives, eels, bluefish, striped bass and white perch. Habitat above Harbor Road is effectively cut off from the system by the dam. This reduces productivity and puts greater pressures on downstream habitat to provide all of the system's needs. In addition, the dam blocks migrations of spawning fish.

Shellfish loss is primarily attributed to pollution, particularly from the ESB discharge. Though there are still shellfish beds in the lower reaches of the river (Southport), they are now condemned. From 1966 to 1974 the harbor used to be closed to shellfishing only during the summer months (May 1 - September 30). In 1975, however, the State Agriculture Division directed to the State Health Department to close the beds in 1975 due to acid, heavy metals, and coliform contamination. According to a town report, this quarantine was imposed 23 years after the sanitary sewer was installed along the Boston Post Road, and 12 years after the Southport Harbor Road area was serviced with sanitary sewers. This implies that the decision to close the beds was linked more to an obvious source of contamination (such as ESB) rather than septic problems which had been identified and monitored for many years.

HORSE TAVERN CREEK

A: Physical Description

Location

This small embayment is located near the mouth of Southport Harbor on the west bank. It is approximately 0.25 miles south of the downtown center of Southport. The creek is crossed by Harbor Road at the mouth. Center Street borders the embayment to the north, Pequot Avenue is to the west, and Westbury Road is to the south (See Figure 16.5).

Site Orientation and Configuration

The embayment is oriented roughly east to west. Its length is approximately 2200 feet and its width is no more than 30 feet. The upper reaches mender within a narrow floodplain and originate in an area of inland wetlands.

Tidal Data

Mean tidal range -	6.9 ft.
Spring tidal range -	7.9 ft.
Mean tide level -	3.4 ft.

Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth: Unknown
Channel Depth: None
Additional Comments: None
Source: NOAA National Ocean Survey Maps

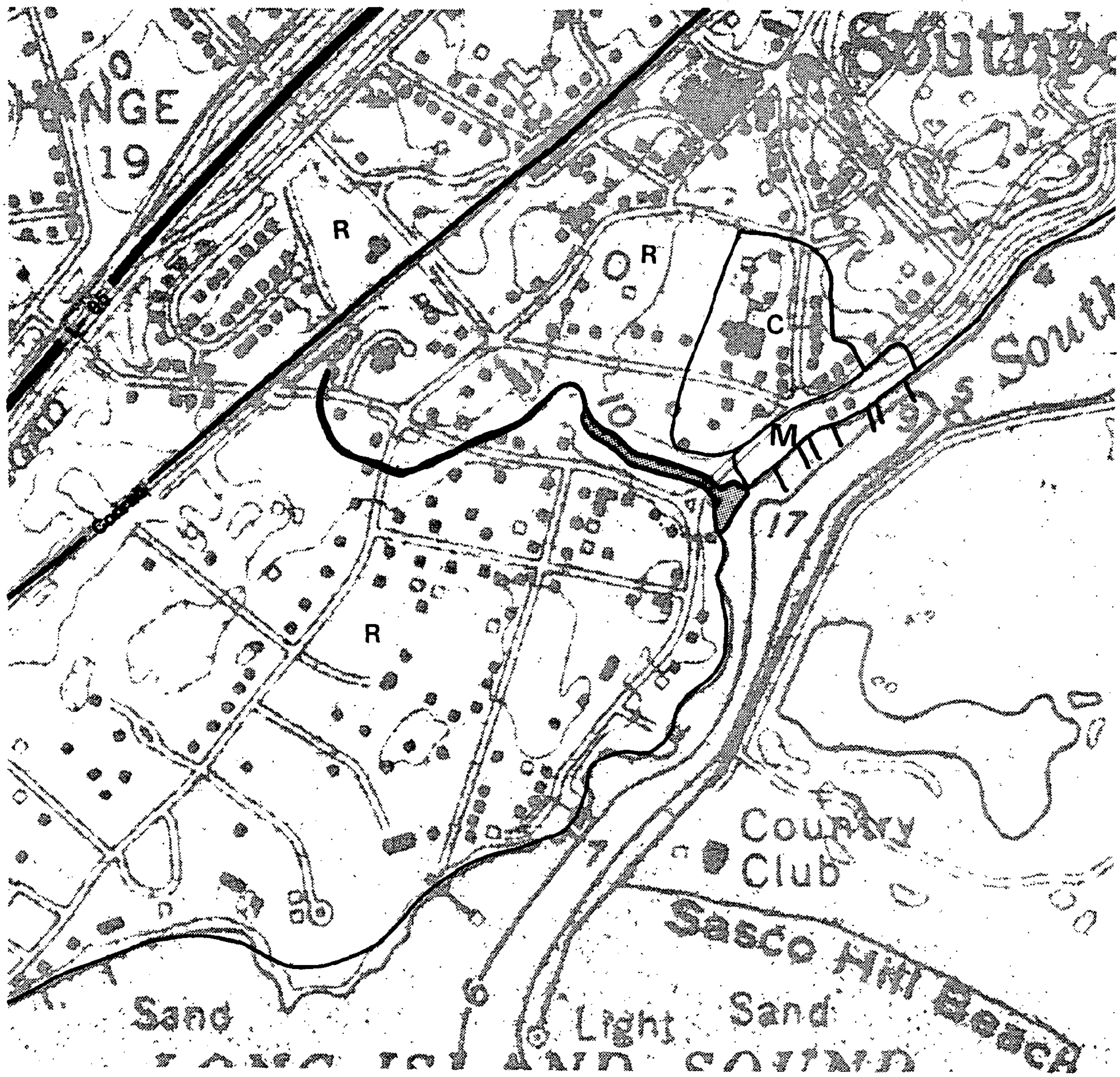
Basin Hydrology

Regional Drainage Basin: Western Connecticut Coastal Basin
Tributaries to Embayment: None

Additional Significant Sources of Fresh Water Inflow: Some stormwater runoff drains from surrounding residential property (rooftops, driveways, streets).

Constrictions to Tidal Flow and Circulation:

Structure	% Constriction	Distance from Mouth
Harbor Rd. Flood Gates	75-100	At Mouth
Westway Rd. Culvert	0-25	0.15 Miles



Scale: 1" = 666'

FIG 16.5 HORSE TAVERN CREEK ENVIRONMENTAL LAND USE

Legend:

- wetlands
- **A** agriculture
- **R** residential
- **C** commercial/industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Constrictions to Tidal Flow and Circulation:

Structure	% Constriction	Distance from Mouth
Pequot Ave. Culvert	0-25	0.2 Miles
Westway Rd. Culvert	0-25	0.3 Miles
Conrail R.R. Culvert	0-25	0.4 Miles

Sources: U.S. Geological Survey, Connecticut Drainage Basin Gazeteer, 1981; Conn. Dept. of Environmental Protection

Water Quality Conditions

Embayment Water Quality Classification: Not yet reclassified.

Direct Discharges:

Source	NPDES Permit #	Waste Characteristics
C. O. Jelliff Corp.	CT0000817	Cooling water

Future Status of Discharges: The NPDES permit for Jelliff Corporation's discharge of 68,000 gallons of cooling water per day expires in 1984. At that time, the state will decide whether it wishes to revise the effluent limitations or allow them to remain the same.

Sewer Service Area and Discharge Point: Sewers serve all of the embayment basin area. Treatment and discharge of the wastes occurs at Pine Creek, off Reef Road.

Storm Sewer Outfalls: Several small storm drains discharge into Horse Tavern Creek.

Shoreline and Bottom Sediment Conditions

Extent of Shoreline Modifications: The lower reaches of the creek have a natural floodplain and have been altered only minimally. The shoreline along the upper reaches beyond Pequot Road has been filled, channelized in sections and stabilized. The creek is very small in the upper reaches and serves to drain surrounding land which has a high water table. A tide gate is located at the mouth of the creek.

Significant Areas of Erosion: There are no significant areas of erosion in the embayment study area.

Shoaling and Sedimentation: The reduced tidal flushing caused by the new tide gates at the mouth of Horse Tavern Creek may increase the current rate of sedimentation in the embayment.

Shoreline and Bottom Sediment Conditions (con't)

Bottom Sediment Conditions: Tide gates have restricted tidal flushing of the embayment and have accelerated sedimentation. The sediment of the lower reaches is very silty and has a high clay component.

Surrounding Lands

Maximum Basin Elevation:

Location	Height
Pequot Avenue (south of creek)	20 feet
Intersection of Post Rd. and I-95	50 feet
North Shore of Sherwood Pond	160 feet

Topography: The embayment study area is relatively flat. There is a minor area of steep slopes along the eastern shore of Sherwood Pond (headwaters of Horse Tavern Creek).

General Vegetation Characteristics: There is a small stand of mature trees on the north side of the creek near the mouth. The rest of the basin is moderately developed, with most vegetation comprised of landscaped trees and shrubbery. The upper reaches of the tributary penetrate undeveloped land with forest and other natural vegetation.

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Agawam	fine sandy loam	-	very poor
Beaches	-	-	-
Carlisle	muck	-	very poor
Charlton-Hollis	fine sandy loams	3-15	poor
Merrimac	sandy loam	3-8	very poor
Scarboro	muck	-	very poor
Sudbury	sandy loam	-	very poor
Typic Udorthents	cut and fill	-	variable
Westbrook	mucky peat	-	very poor
Woodbridge	fine sandy loam	3-8	poor

Shellfish and Finfish Resources

There are no clams or oyster beds reported within Horse Tavern Creek, though a few of the organisms may exist near the mouth. Shellfishing in the creek or the Mill River is prohibited.

Eels and blue claw crabs rely on Horse Tavern Creek for spawning and habitat.

Wetlands

Tidal wetlands are located in the embayment floodplain between Pequot Avenue and Harbor Road (See Figure 16.5). Pockets of freshwater marsh (inland wetlands) are located near Westway Road, South Gate Lane and further upstream.

This type of tidal fringe marsh provides food and habitat for wildlife, some flood storage capacity, and serves as a natural buffer by anchoring sediment and absorbing excess nutrients in the system.

The history of development around Horse Tavern Creek dates back to at least the eighteenth century. At one time, the creek is presumed to have had a much wider floodplain. However, subsequent development has encroached on the floodplain, leaving a meandering but constrained watercourse. The wetlands along the watercourse remain intact but directly abut uplands, stabilized by stone embankments in some sections.

Flap gates were recently installed at the mouth of the embayment to cut off tidal exchange within the tidal wetland. The Fairfield Conservation Commission believes that Reed (Phragmites) will consequently take over the marsh through succession over the next four years.

Environmentally Sensitive Areas

The inland wetlands of Mill Pond and Perry's Millpond are important habitat for wildlife and serve as natural buffer areas.

This system of wetlands stabilizes the river banks, provides an important food source and habitat for wildlife, absorbs flood impacts and enhances water quality by absorbing excess nutrients and filtering out suspended sediment.

B: Land Use Analysis

Current Shoreline and Water Use

The primary functions of the embayment are conservation, flood protection, and some passive recreation. No shellfishing is permitted in the embayment.

Current Upland Use

Almost all land use surrounding the embayment is residential (See Figure 16.5). Two exceptions are the C.O. Jelliff Corporation which is an industrial use, and a church. Both the church and Jelliff Corporation are located on Pequot Avenue.

Historical and Significant Land Use Changes

Much of the development along the lower reaches of the embayment is old and dates back to at least the nineteenth century. Some buildings were built in the seventeenth century. The major changes since the 1930's have occurred along the upper reaches, where some relatively new homes have been built over the past thirty years.

Public Access and Recreational Use

Visual access to the embayment is provided from Harbor Road and from Pequot Avenue. Public use is limited to passive recreation, particularly along the waterfront.

C: Problem Identification

Local Departments and Offices Consulted

Fairfield Conservation Commission
Fairfield Public Works Department
Fairfield Planning Department

Response from Questionnaires and Local Meetings

Town officials identified circulation constriction, fish loss, and saltmarsh loss as the three major problems associated with Horse Tavern Creek. The three problems all relate to the recent construction of new flap gates at the mouth of the embayment. Town officials believe that since the design effectively reduces or eliminates tidal exchange, the saltmarshes in the lower reaches of the embayment will be succeeded by Reed grass (Phragmites communis). The reduction in circulation combined with the succesion of Phragmites is anticipated to significantly reduce the productivity of the marsh.

Results of Field Survey and Research

A visit to the site confirmed the presence of the new flap gates and the minimal tidal exchange afforded by their design. Currently, the tidal marsh upstream of the gates appears to be in healthy condition.

Results of Field Survey and Research (con't)

The impact of reduced tidal exchange on marsh vegetation is well documented in the scientific literature. As in the case of the Stratford tide gates, constriction of flood tide flows consistently leads to the replacement of saltmarsh grasses by Reed (*Phragmites communis*). The impact of this change often produces an undesirable wetland condition.

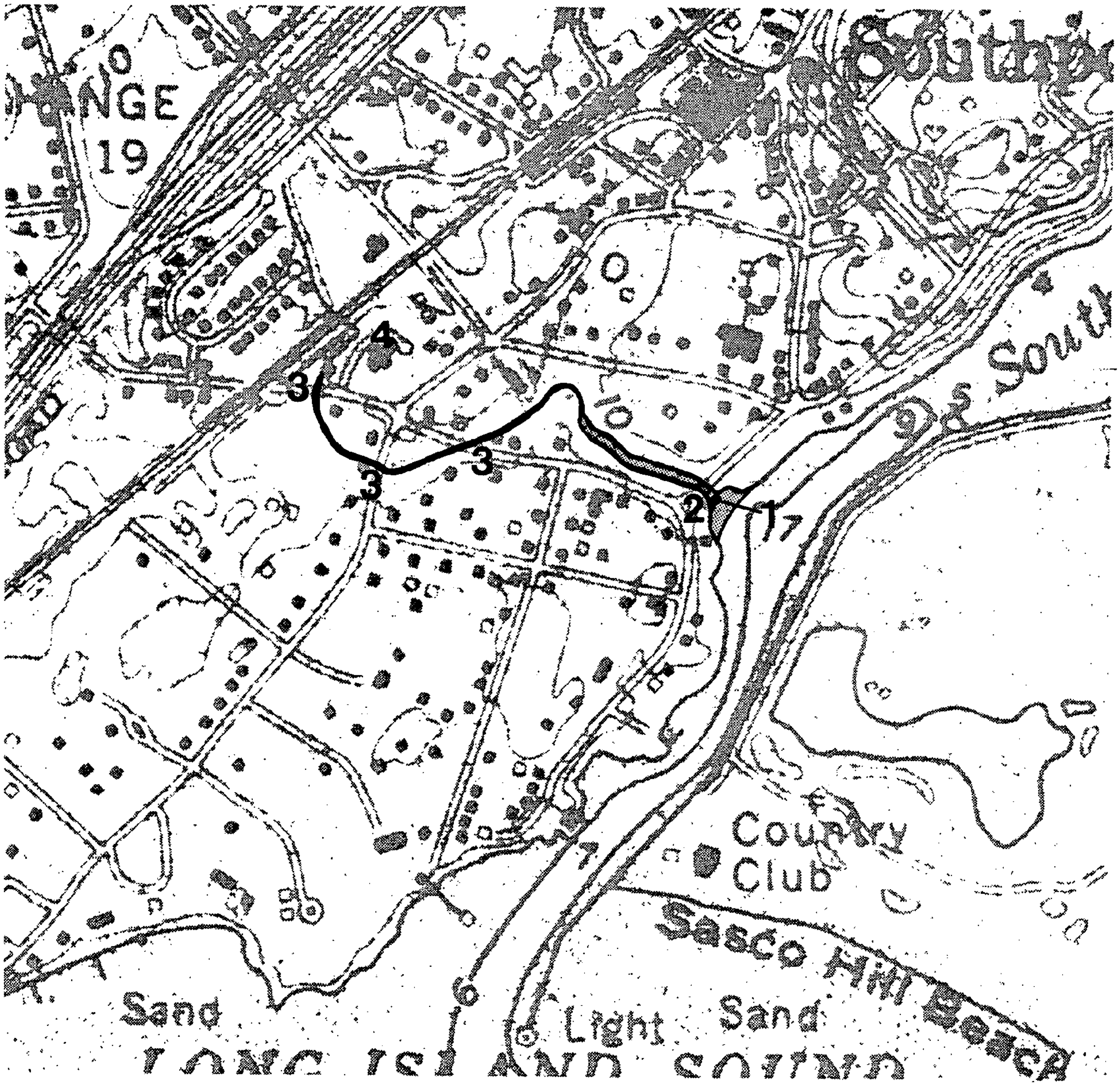
D: Problem Analysis

Tidal Flow Constriction

The major problem affecting Horse Tavern Creek is the recent installation of two new 24-inch flap gates at the mouth of the embayment (See Figure 16.6). Prior to their installation, the creek received adequate mixing with harbor waters on a daily basis. The new flap gates, however, close firmly during the flood tide and prevent the intrusion and mixing of saltwater in the tidal marsh.

Research clearly shows that regular inundation is essential for the continued dominance of saltmarsh cordgrass (*Spartina alternaflora*). Without it, the *Spartina* will be succeeded by Reed grass (*Phragmites communis*), as has happened in many other regulated tidal marshes in Connecticut. When this happens there is usually an overall decline in productivity of the marsh, as *Phragmites communis* is a less favorable habitat and does not have the food value of *Spartina*.

Reduced tidal exchange also lowers salinities and may exclude organisms that cannot tolerate brackish to fresh water. Such conditions, through they may favor the introduction of some new species, will probably reduce the overall diversity and productivity of the system.



Scale: 1" = 666'

FIG 16.6 HORSE TAVERN CREEK
ENVIRONMENTAL PROBLEMS

Problem Areas

1. Closed to shellfishing
2. Tide gates restrict tidal flow
3. Culvert constricts water flow
4. Industry discharges cooling water

PROBLEM SUMMARY

Ash Creek

1.	Circulation Constriction	Moderate	(b)
2.	Pollution	Moderate	(b)

Mill River/Mill Pond

1.	Circulation Constriction	Minor	(b)
2.	Pollution	Severe	(b)
3.	Shellfish and Finfish Losses	Moderate	(b)

Horse Tavern Creek

1.	Tidal Flow Constriction	Severe	(a)
2.	Habitat Loss	Moderate	(a)

KEY: (a) Conditions becoming worse (b) No change (c) Conditions improving

CHAPTER 17 WESTPORT EMBAYMENTS

INTRODUCTION

The Town of Westport is located in Fairfield County and is bordered to the east by Fairfield and to the west by Norwalk. The town has an area of 19.9 square miles and drains into the Western Connecticut Coastal Basin. During 1970 to 1978, the population increased 6.1 percent (1970 - 27,414; 1978 - 29,100), which is 30% greater than the state average rate of growth for that same period. The number of Westport housing units increased 6 percent during that same period, showing a parallel growth with population. Housing unit growth was significantly less than the average for Fairfield County (12.1%) during 1970 to 1978.

The density of the town is 1,462 persons per square mile, over twice the state average of 652, but only slightly higher than Fairfield County's average of 1,333 persons per square mile. The community is broken into three main regions: downtown Westport, which is along U.S. 1; and Compo and Saugatuck which are locatd closer to the Long Island Sound shore. Almost all of Westport's downtown is sewered, as is much of Compo, east and north of Gray's Creek.

The major roads serving the Westport area include the Merritt Parkway in the northern part of town, and U.S. 1 (Boston Post Road) and Interstate 95, both located close to the coast. The Conrail line provides connections to both New York and New Haven.

The geology of Westport has been shaped most significantly by glacial processes. Ridges of bedrock overlain with till and stratified drift are oriented in a north-south direction and are less pronounced toward the coast. The surficial geology of the coast includes large deposits of sand and gravel. The coastline is highly irregular and consists of large wetland areas protected by sandy barrier formations. Examples include Sherwood Island State Park, Compo Beach, Owenoke, and Canfield Island.

The Saugatuck River is the largest river in the town. The lower segment of the river serves as the community's only port, and was the center of commerce when the town first started. The rest of the town is drained by smaller streams such as Muddy Creek, Sasco Brook and Farms Brook. These small drainageways provide essential freshwater drainage to the town's coastal wetlands and estuaries.

Both Gray's Creek and Bermuda Lagoon, originally considered for study, are included for environmental analysis in this chapter. They were chosen because they have documented environmental problems that have not been addressed in previous federal, state, or local investigations.

BERMUDA LAGOON

A: Physical Description

Location

The embayment is located on the western edge of Westport, approximately 2 miles south of the center of town (See Figure 17.1). The mouth of the embayment is on Long Island Sound, and the embayment is bordered by Saugatuck Shores and Seymour Point immediately to the east and Canfield Island (Norwalk) immediately to the west. No highways cross the embayment though Harbor Road provides the main access to private houses along the shoreline of the area.

Site Orientation and Configuration

The embayment is comprised of a recreational boat basin and a 2000-foot long navigational channel providing access to the Sound. The basin length is 1800 feet and the width is 600 feet. The long axis of the basin is oriented NW to SE and the channel is oriented approximately the same, slightly more to the north. The average width of the channel is 80 feet.

Tidal Data

Mean tidal range -	7.0 ft.
Spring tidal range -	8.0 ft.
Mean tide level -	3.5 ft.

Source: U.S. Department of Commerce, <u>1980 Tide Tables: East Coast of North and South America</u>

Bathymetry

Range of Depth:	2-13 ft. (MLW)
Channel Depth:	7-13 ft. (MLW)

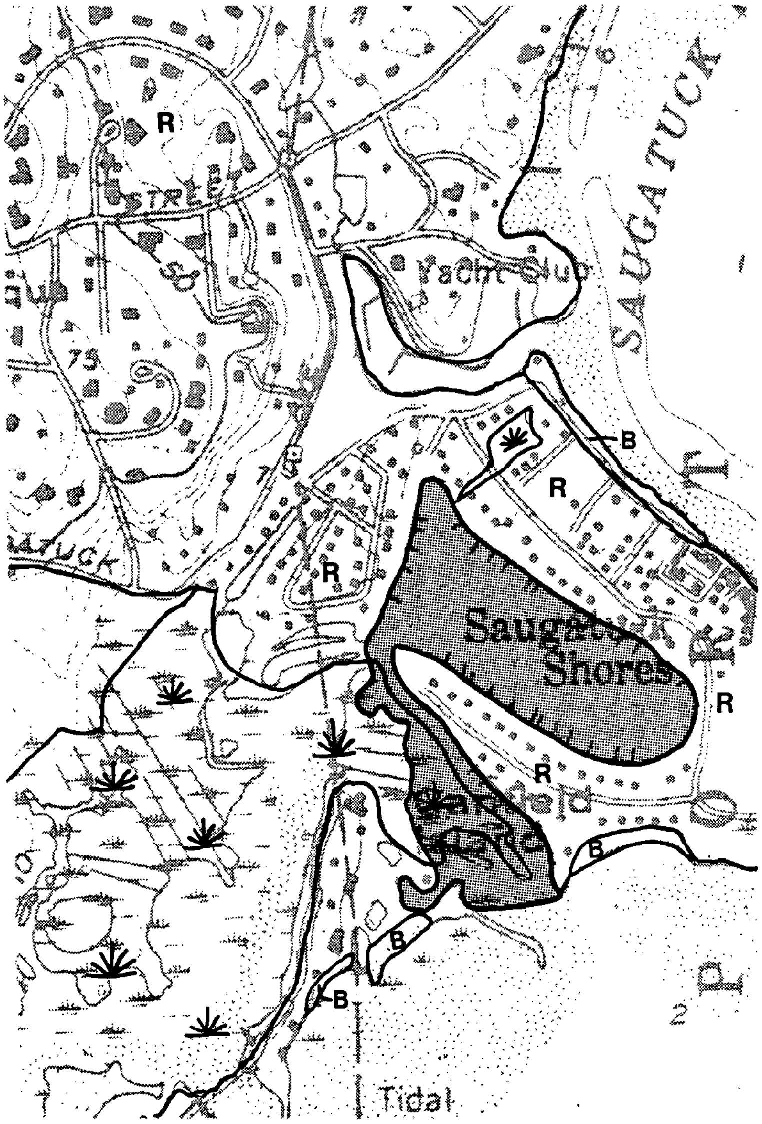
Additional Comments: Channel is privately-maintained and dredged.

Source: NOAA National Ocean Survey Maps

Basin Hydrology

Regional Drainage Basin: Western Connecticut Coastal Basin
Embayment Basin Area: Includes only coastal drainage
Tributaries to Embayment: None

Additional Significant Sources of Fresh Water Inflow: Most of the stormwater runoff from surrounding residential development and roads drains into the embayment.



Scale: 1" = 1000'

FIG 17.1 BERMUDA LAGOON ENVIRONMENTAL LAND USE

Legend:

- wetlands
- **A** agriculture
- **R** residential
- **C** commercial/ industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Basin Hydrology (con't)

Constrictions to Natural Flow and Circulation: none

Sources: U.S. Geological Survey, Connecticut Drainage Basin Gazeteer, 1981; Conn. Dept. of Environmental Protection

Water Quality Conditions

Embayment Water Quality Classification: Not yet reclassified.

Direct Discharges: None

Sewer Service Area and Discharge Point: Sewers do not service the Bermuda Lagoon area. No sewer plant outfalls are located near the embayment.

Storm Sewer Outfalls: Storm sewers from the streets drain directly into the embayment.

Significant Non-Point Pollution Sources: Many of the waterfront lawns appear to be heavily fertilized and could be a significant source of nutrient loading.

Shoreline and Bottom Sediment Conditions

Extent of Shoreline Modification: The entire embayment is unnatural, as the area, which was once all wetlands, has since been filled for a housing development. The sloping, protected shoreline is gradually being vegetated with pockets of Saltmeadow cord grass (*Spartina patens*).

Significant Areas of Erosion: The end of the Bermuda Lagoon peninsula and opposite shoreline are being eroded by tidal currents and by wave action. Several seawalls inside the embayment are failing, also because of erosion.

Shoaling and Sedmentation Problems: A well-maintained channel serves the Bermuda Lagoon waterfront. There is more potential for shoaling or bar development at the mouth of the lagoon channel (between the point and Canfield Island).

Bottom Sediment Conditions: The intertidal and near shore subtidal areas consist of gravel and some sand. The bottom of the Lagoon consists of a combination of silt and sand.

Surrounding Lands

Maximum Basin Elevation:

Location	Height
Bermuda Lagoon	Less than 15 feet

Topography: The area surrouding the lagoon is flat and has no steep slopes.

General Vegetation Characteristics: The area was formerly wetlands, but has since been filled and completely developed for housing. Consequently, ground cover is limited to landscaped vegetation. A small stand of aspens is located at the point of the lagoon peninsula.

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Agawam	fine sandy loam	0-3	very poor
Agawam	fine sandy loam	3-8	very poor
Charlton	fine sandy loam	3-8	very good
Charlton	fine sandy loam	8-15	very good
Charlton-Hollis	fine sandy loam	3-15	poor
Hinckley	gravelly sandy loam	3-15	very poor
Hollis-Rock Outcrop	complex	3-15	very poor
Merrimac	sandy loam	3-8	very poor
Sutton	fine sandy loam	3-8	poor
Tisbury	silt loam	0-3	very poor
Typic Udorthents	cut and fill	-	variable
Westbrook	mucky peat	-	very poor

Shellfish and Finfish Resources

Most of the embayments clam and oyster beds in the embayment are located at the mouth of the Bermuda Lagoon inlet. All shellfish areas in the western part of Westport, including the area of Bermuda Lagoon, are closed to shellfishing.

Shellfish and Finfish Resources (con't)

Menhaden, bluefish, and flounder are frequently observed in the area. Striped bass and blue claw crabs are observed less frequently.

Wetlands

Wetlands inhabit the intertidal zone of the lagoon and cover expansive areas at the mouth next to Canfield Island (See Figure 17.1). The marshes are in the early stages of development, but do provide some habitat and natural buffering capacity.

The entire area now occupied by the Bermuda Lagoon development, was formerly coastal wetlands. Following World War II, the wetlands were filled with gravel and sand and subdivided for housing developments.

At present, pioneer wetland vegetation (consisting of Spartina and Phragmites) in the intertidal zone of the lagoon has not become well established in the embayment. Additional growth and expansion is anticipated as the marsh builds up a peat substrate over the coarse gravel.

Environmentally Sensitive Areas

The marshes of the lagoon and those adjacent to Canfield Island greatly enhance the biological productivity of the region. They serve as a food source, breeding grounds, habitat for juvenile species of fish, a natural buffer to stem soil erosion and nutrient loading, and a flood storage area.

B: Land Use Analysis

Current Shoreline and Water Use

Bermuda Lagoon is intensively used for private water-related recreation. Nearly every waterfront home has a large dock, and both boating and swimming are quite popular. Most of the boats kept in the lagoon are of shallow draft, but there are some sailboats with deeper drafts.

Current Upland Use

Almost all of the surrounding upland is used for housing. Marshes on the west side of the embayment inlet and a small aspen forest at the lagoon point are protected as conservation areas.

Historical and Significant Land Use Changes

Prior to the 1960's, Bermuda Lagoon was an undeveloped natural wetlands area. U.S. Geological survey maps from 1960 show the area, formerly called Saugatuck Shores, as a vast marshy area situated between already developed areas of Saugatuck Shores to the east and north, and a natural barrier spit to the south. Developing Bermuda Lagoon required tremendous volumes of sand and gravel, which were placed on the wetlands in the shape of a hook oriented east to west (See Figure 17.1). Much of the sand and gravel came from lagoon dredging, which was undertaken to provide navigational access to the waterfront property. Today, the development contains over 80 single family homes.

Public Access and Recreational Opportunities

Though street access is not restricted by gates, the development is generally regarded as a rather exclusive neighborhood. All waterfront property in Bermuda Lagoon is private.

C: Problem Identification

Local Departments and Offices Consulted

Westport Conservation Department

Response from Questionnaires and Local Meetings

Saltmarsh loss was regarded by town officials as the only severe problem in the embayment. Pollution and fish loss were viewed as moderate problems. Officials believe that Bermuda Lagoon has been losing its wetlands for approximately ten to fifteen years now, and the man-made problem has grown worse during that period. The condition is expected to become worse in the future (See Figure 17.2).

Fish loss is a relatively recent phenomenon of the past two years. The problem is apparently caused when fish such as menhaden get trapped in the warm lagoon waters of summer under low dissolved oxygen conditions. In the past, northwest winds have driven the fish up on shores. The problem is not expected to become worse in the future.

Town officials indicate that Bermuda Lagoon surface waters have been subject to local man-made pollution problems over the past five years. Subsequent discussions with the town identified stormwater runoff and failing septic systems as likely sources of the problem. At present, officials are unsure about the future trends associated with the problem.

Results of Field Survey and Research

A field survey of Bermuda Lagoon confirmed the wetland erosion problem cited by town officials. Most of the erosion is occurring on both the east and west shore of the inlet leading to the cove. Steep eroded scarps, carved into the peat substrate, appear to be the work of natural tidal currents, boat wakes, and wind-generated waves. Prior to the lagoon development and channel dredging, the local bathymetry was flat and shallow. However, with the increased demand for boating, the community has been compelled to maintain deep navigational channels which do little to dampen waves as they approach the wetland shoreline. In addition, natural tidal currents, as they sweep around the turn in the inlet channel, contribute significantly to the erosion problem.

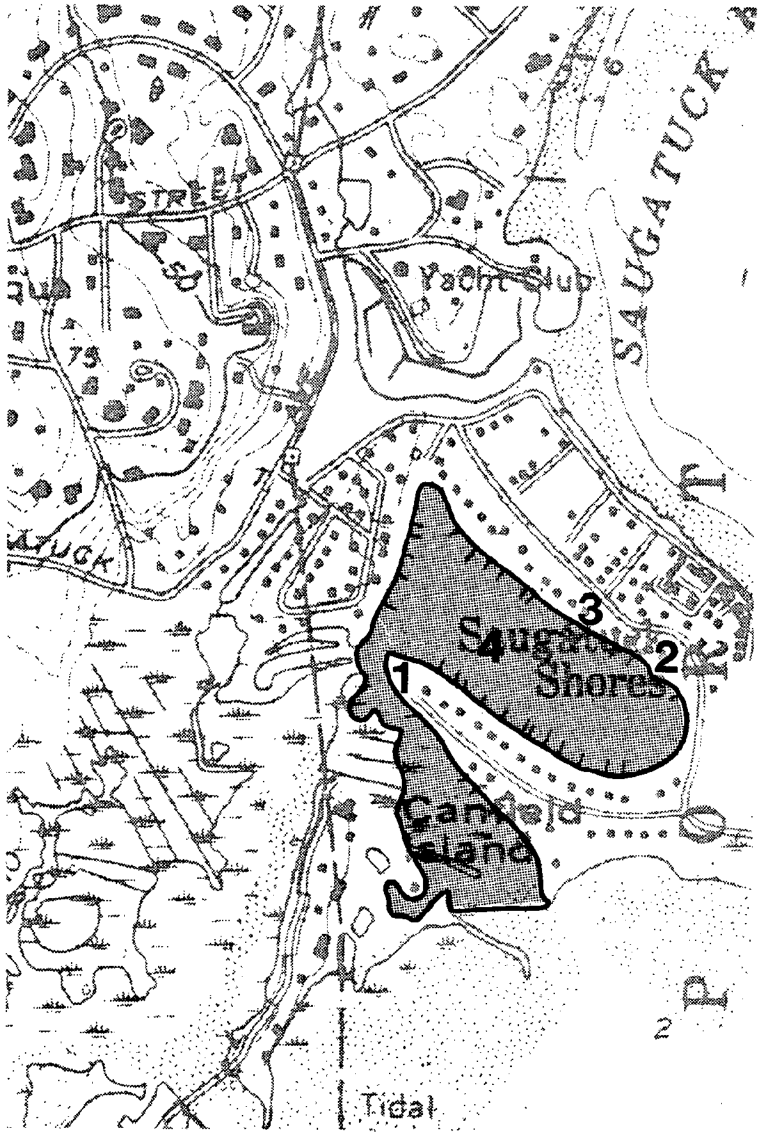
The major concern over water pollution of the embayment relates to bacterial contamination of Bermuda Lagoon's bathing areas. Over the past two years the embayment has been closed to swimming by the town on several occasions, because of excessively high coliform bacteria counts. Bermuda Lagoon is not sewered, and thus its individual septic systems are suspected sources of much of the contamination. The septic systems are buried in the sand and rock used to fill the wetlands, and the porous material is a poor soil for wastewater treatment. Nitrates are highly mobile under these conditions, and there is even a possibility of septic tank leachate breaking out along the shoreline.

Fish kills in Bermuda Lagoon appear to be the result of a coincidence of unfavorable conditions. These factors include extended periods of warm weather, low dissolved oxygen (D.O.) levels and the migration of large schools of fish. Since weather and fish migrations are clearly natural phenomena, there is a question whether activities in and around the lagoon may account for the depressed D.O. levels. There is some concern as to whether these depressed D.O. levels are in some way related to rising pollution levels.

D: Problem Analysis

Wetland Erosion

Wetland loss in the Bermuda Lagoon area is of major concern to the town. Though some of this process is natural, part of the erosion problem is caused by excessive boat traffic operating with large wakes. Controlling the size of wakes and boat speeds would be a good first step toward reducing the rate of erosion of the area's wetlands.



Scale: 1" = 1000'

FIG 17.2 BERMUDA LAGOON ENVIRONMENTAL PROBLEMS

Problem Areas

1. Eroding shoreline
2. Some failing seawalls and erosion
3. Stormwater runoff from surrounding shoreline
4. Closed to shellfishing

Wetland Erosion (con't)

With respect to the natural component of erosion, it is interesting to note that a 1956 Army Corps of Engineers' report describes the former natural shoreline of Saugatuck Shores (now called Bermuda Lagoon) as an area highly prone to erosion. Historic information in the report indicates that from 1835 to 1933, particularly those areas directly exposed to the open water of Long Island Sound, some segments of marsh receded over 1000 feet. This was at least partially compensated by accretion in other surrounding areas. From this information, it is clear that the lagoon area's shoreline has a history of instability, and this condition probably still prevails today.

Water Pollution

As discussed earlier, there are two potential sources of contamination of lagoon surface water. The first and most likely source is malfunctioning septic systems. The second and highly likely source is stormwater runoff from street sewers and residential drainpipes. The key parameter of pollution is fecal coliform bacteria, an enteric bacteria that comes from warm-blooded mammals. It is a common component of septic tank leachate, but its presence in the environment is constrained by several factors. Foremost is the fact that the bacteria does not migrate through soil well. Consequently, any contaminated leachate polluting the embayment could not travel through much soil before it reaches the water. This points to a septic tank discharge pipe or overflow pipe as the most likely conduit of the pollution. A second factor is that coliform bacteria dies rapidly in saltwater. To exceed state bacteria standards in water as salty as Bermuda Lagoon, there must be a significant source of pollution.

Stormwater runoff from the surrounding streets and residential property is a less likely source of coliform bacteria in a suburban setting such as Bermuda Lagoons. Potential runoff sources of bacteria would include dog and waterfowl feces. Both animals are present in the neighborhood, but it is doubtful that their population is sufficient to cause a significant increase in bacteria levels.

Fish Kills

The fish kills are very likely caused by the concurrent presence of warm water temperatures, low D.O., and migrating fish. The configuration of Bermuda Lagoon is such that a school of fish could easily become trapped, or at least temporarily detained, in the lagoon basin. Low D.O. coupled with high temperatures puts tremendous stress on fish. Such conditions (particularly in the case of menhaden) can quickly lead to fish kills.

Fish Kills
(con't)

Shallow basin conditions and the constricted nature of the water body favor higher water temperatures. Dissolved oxygen solubility decreases with rising water temperatures, and since the warm water increases metabolic rates, anoxia might result. A key issue is whether these natural conditions alone can account for the depressed D.O., or whether it is the result of human input.

In a water body experiencing high bacteria levels one potential source of BOD loading is organics from sanitary waste discharge. Other possible sources include high BOD's from stormwater runoff, dumped grass clippings or decaying marine organics such as seaweed or benthic invertebrates. At this point there is not enough information to establish clear cause for critical conditions, but it would be helpful if future monitoring considered weather patterns and the visual condition of lagoon waters.

GRAY'S CREEK

A: Physical Description

Location

Gray's Creek is located at the mouth of the Saugatuck River approximately 2 miles south of the center of Westport (See Figure 17.3). The embayment is surrounded by the neighborhoods of Owenoke and Compo Hill and the Westport Longshore Club Park. Cedar Island lies in the center of the embayment and Kitts Island lies 800 feet west of the creek mouth. Compo Road South is the main access highway to the embayment study area.

Site Orientation and Configuration

The creek has an irregular shoreline with a large island in the center (See Figure 17.3). The orientation of the embayment is roughly in an east to west direction. The creek mouth is on the western end. The embayment is roughly 0.6 miles long and 800 feet at its widest point.

Tidal Data

Mean tidal range -	7.0 ft.
Spring tidal range -	8.0 ft.
Mean tide level -	3.5 ft.

Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth:	0 feet (MLW)
Channel Depth:	No Channel Dredged

Additional Comments: Creek consists of exposed tidal flats at low tide.

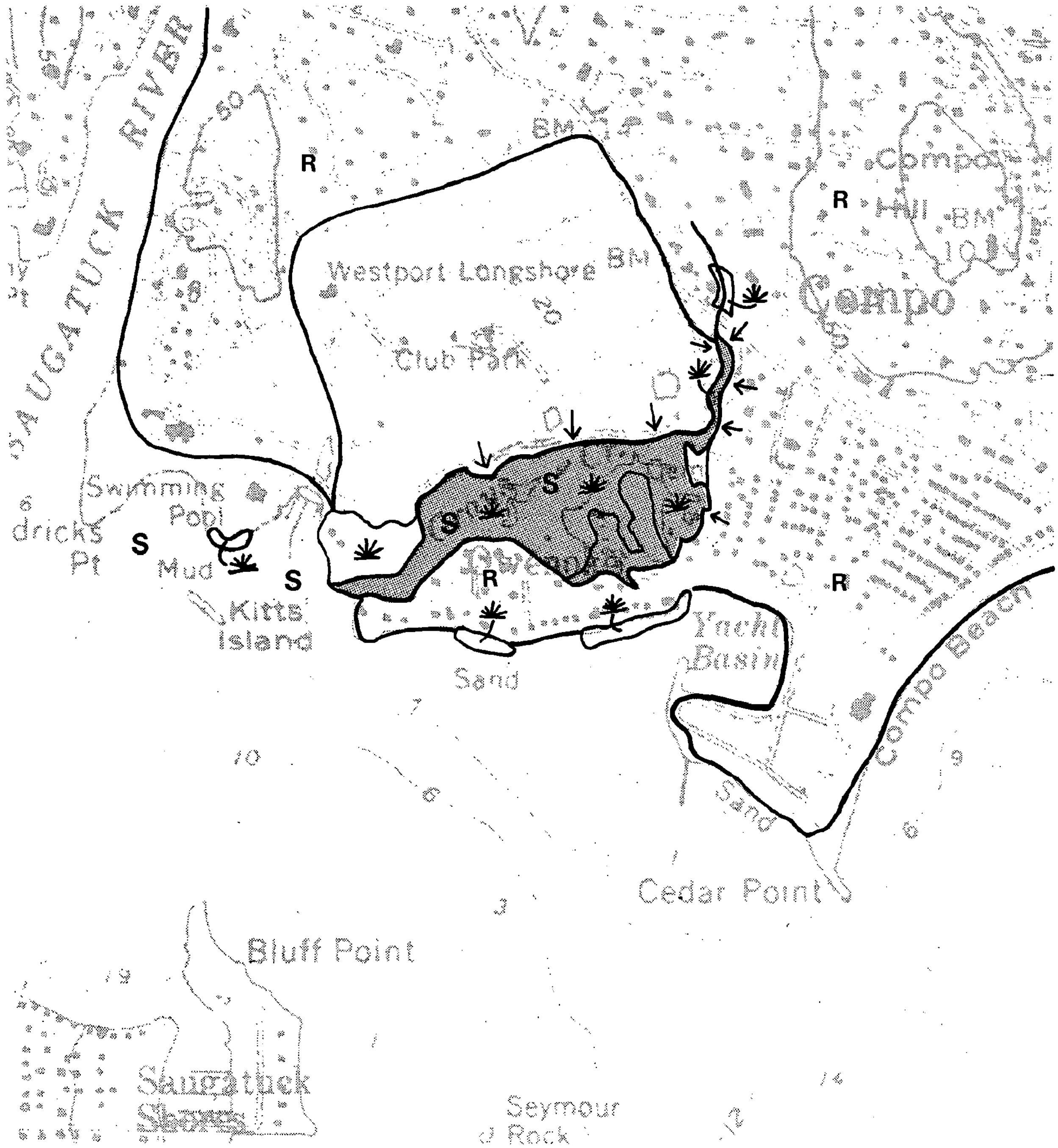
Source: NOAA National Ocean Survey Maps

Basin Hydrology

Regional Drainage Basin: Western Connecticut Coastal Basin
Embayment Basin Area: 1.0 square miles

Tributaries to Embayment: Small unnamed creek

Other Sources of Fresh Water Inflow: Runoff from the Longshore Country Club drains into creek along the northern shore (See Figure 17.3).



Scale: 1" = 1000'

FIG 17.3 GRAY'S CREEK ENVIRONMENTAL LAND USE

Legend:

- wetlands
- **A** agriculture
- **R** residential
- **C** commercial/industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Basin Hydrology (con't)

Constrictions to Tidal Flow and Circulation: None.

Sources: U.S. Geological Survey, Connecticut Drainage Basin Gazeteer, 1981; Conn. Dept. of Environmental Protection

Water Quality Conditions

Embayment Water Quality Classification: Not yet reclassified.

Direct Discharges: None

Storm Sewer Outfalls: A major storm sewer drains runoff from surrounding neighborhoods and discharges the effluent to the head of Grays Creek.

Signficant Non-Point Pollution Sources: Runoff from the country club lawns and golf course may contain fertilizers and pesticides.

Shoreline and Bottom Conditions

Extent of Shoreline Modification: Approximately one-half of the shoreline has been stabilized with seawalls and riprap. The shoreline modifications also include fill for a road embankment along one of the access roads to the Longshore Country Club. Most of the seawall construction and placement of rip rap has occurred near the mouth of Gray's Creek.

Significant Areas of Erosion: Wetlands on the north side of the mouth of the creek appear to be eroding. In addition, the country club road embankment is steep and probably subject to erosion during rainstorms.

Shoaling and Sedimentation: The inner two-thirds of the embayment appear to be silting rapidly, and make navigation very difficult. The sediment comes from three possible sources: 1) stormwater runoff from the stormwater outfall located at the head of the creek, 2) erosion of fill material from the country club access road embankment, and 3) from the suspended sediment in turbid Long Island Sound waters.

Bottom Sediment Characteristics: The bottom sediment is a fine silty muck with a significant organic and clay component.

Surrounding Lands

Maximum Basin Elevation:

Location	Height
Longshore Country Club Golf Course	20 feet
Cedar Island	10 feet
Compo Hill (east of creek)	100 feet

Surrounding Lands (con't)

Topography: The area surrounding the embayment is level. There are no steep slopes.

General Vegetation Characteristics: Cedar Island is densely vegetated with large mature trees and shrubs (See Figure 17.3). To the south, Owenoke is developed with houses, and vegetation is limited to residential landscaping. The Longshore Country Club Golf Course lies to the north and is grass-covered.

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Adrian and Palms	muck	-	very poor
Agawam	fine sandy loam	0-3	very poor
Agawam	fine sandy loam	3-8	very poor
Charlton	fine sandy loam	3-8	very good
Charlton	fine sandy loam	8-15	very good
Charlton-Hollis	fine sandy loam	3-15	poor
Hinckley	gravelly sandy loam	3-15	very poor
Hinckley	gravelly sandy loam	15-35	very poor
Hollis-Rock Outcrop	complex	3-15	very poor
Hollis-Rock Outcrop	complex	15-35	very poor
Merrimac	sandy loam	3-8	very poor
Sutton	fine sandy loam	3-8	poor
Tisbury	silt loam	0-3	very poor
Typic Udorthents	cut and fill	-	variable
Westbrook	mucky peat	-	very poor
Westbrook	mucky peat, low salt	-	very poor

Shellfish and Finfish Resources

Shellfish beds are located throughout the embayment, however, all of the creek is closed to shellfishing. The beds may serve as important seed stock for other larger beds located at the mouth of the Saugatuck River.

The creek is regarded as an important nursery area for a number of finfish common to Long Island Sound.

Wetlands

The inner half of the embayment is bordered almost completely with fringe marshes (See Figure 17.3). Approximately half of the outer embayment area has stabilized shorelines, while the rest consists of pockets of Saltmarsh cordgrass (Spartina alterniflora) and some Reed (Phragmites). Almost all of the waterfront along the golf course is lined with Phragmites. Some Spartina inhabit intertidal and subtidal waters off the golf course.

These fringe marshes provide an important nursery ground for juvenile fish. In addition, the marshes serve as flood storage areas, a natural buffer for water quality, and a food source for waterfowl.

Prior to development of the area, the golf course was a vast tidal wetland that was connected to Gray's Creek. Owenoke was formerly a barrier spit with a fringe of wetlands in the lee of its sandy formation.

Today, most of the wetlands along the Owenoke shoreline have been filled and stabilized (See Figure 17.3). The same situation applies to the Westport Longshore Club Park property. The majority of wetlands that still remain intact are around Cedar Island, or have formed islands in the middle of the embayment.

Wetlands, particularly (Spartina alterniflora), are expanding into intertidal flats that have been subject to considerable siltation over the past 15 years. Consequently, some areas of the creek that have been stabilized with seawalls now have substantial wetlands seaward of their boundaries. This trend should continue in the future if no dredging is done and siltation continues.

Environmentally Sensitive Areas

Cedar Island is located in the middle of Gray's Creek and is surrounded by wetlands and water at high tide and intertidal flats and wetlands at low tide.

The area is an important nesting habitat for birds. The state documented and reaffirmed the ecological value of the island in rejecting a developer's wetland application to build a causeway to Cedar Island for future development.

B: Land Use Analysis

Current Shoreline and Water Use

The embayment is currently used for conservation, flood control, fisheries, stormwater disposal, and passive and active recreation. As a conservation area, Gray's Creek provides valuable nesting habitat, upland habitat for mammals and a food source for a range of wildlife. Cedar Island is particularly valuable to the embayment, primarily because it acts as a biologic preserve for vegetation and wildlife.

Wetlands line the embayment, providing flood storage and an important breeding ground for fish common to Long Island Sound. Juveniles frequently remain in the marsh seeking the protection and food of the Gray's Creek estuary until they are capable of surviving in open waters of the Saugatuck River and Sound.

Due to the silty conditions of the embayment waterfront, homeowners apparently have little interest in having a dock. Though a significant portion of the developed shoreline is bulkheaded or stabilized with seawalls, no docks are visible, nor are any boats stored in people's yards. This implies that the waterfront homeowners use the creek for passive recreational features rather than boating or swimming.

Developing the wetlands around Gray's Creek required the construction of storm sewers to remove stormwater from flood prone areas, and the sewers were used to draw down the high water table. The storm sewer outfall is at the head of Gray's Creek and is designed with a floodgate mechanism to prevent back up. Currently, the mechanism is not operating properly because sediment is blocking free movement of the gate.

Current Upland Use

Land to the east and south of the embayment is used for housing. The Westport Longshore Club Park golf course is a town recreation area, and forms the north shore. A small park access road runs along the top of the embankment adjacent to the waters edge.

Historic and Significant Land Use Changes

Areas of the golf course and residential property around the embayment used to be wetlands approximately 120 years ago. Since then, these areas have been filled with local sand, gravel, and dredge spoils, with natural drainage diverted through a system of storm sewers. Over the past 50 years, wetland areas in the lee of the Owenoke Island sand spit have been filled to support new housing. Today much of that filled land is stabilized with bulkheads and seawalls.

Historic and Significant Land Use Changes (con't)

A parking lot and club house have been built on the north side of the Gray's Creek inlet during the past 30 years.

Public Access and Recreational Opportunities

The former Longshore Country Club, located on the north shore of the embayment was purchased by Westport and is now called the Westport Longshore Club Park. The park provides good visual access to the creek from a small service road that parallels the shoreline of the embayment. In addition, the town is considering building a marina and breakwater at the mouth of the creek to expand public boating opportunities available to the community.

C: Problem Identification

Local Departments and Offices Consulted

Westport Conservation Department

Response from Questionnaires and Local Meetings

Town officials perceive some of the siltation in Gray's Creek to be a potential problem. Respondents to the questionnaire indicated that the siltation problem is a relatively recent problem; however, a review of past environmental conditions of the embayment reveals that there is little evidence to support this observation. The embayment conditions have changed very little over the past 2-3 years, and thus there are no apparent factors that could have recently accelerated sedimentation.

Erosion and wetland loss are regarded as only moderate problems. The former is believed to have existed for at least twenty years, while the latter has existed for at least fifteen years. All three of the problems are anticipated to become more severe in the future.

In the past, the town has done very little to maintain the channels of the creek. Currently, however, the Public Works Department is considering channel dredging in the embayment. Any future decisions will be based on careful consideration of environmental impacts.

Response from Questionnaires and Local Meetings (con't)

With the major demand for boating and waterfront housing, town officials feel the embayment area will be increasingly subject to strong development pressures. Thus far, the Connecticut DEP has challenged a developer's desire to connect Cedar Island to the mainland and subdivide the conservation area for housing. In addition, there is growing interest in building a marina and large jetty at the mouth of the embayment. Consultants have been hired by the Owenoke Park Association to study the potential impacts of the marina.

Results of Field Survey and Research

The field survey confirmed the existence of some siltation in Gray's Creek, however, most of this is natural. Over two-thirds of the embayment bottom becomes exposed tidal flats at low tide, which can potentially limit boat access during part of the day. It should be pointed out, however, that numerous shore birds have been observed feeding on these tidal flats, and that the areas serve as important habitat. It should also be noted that there is currently little boat use by waterfront property owners in the cove.

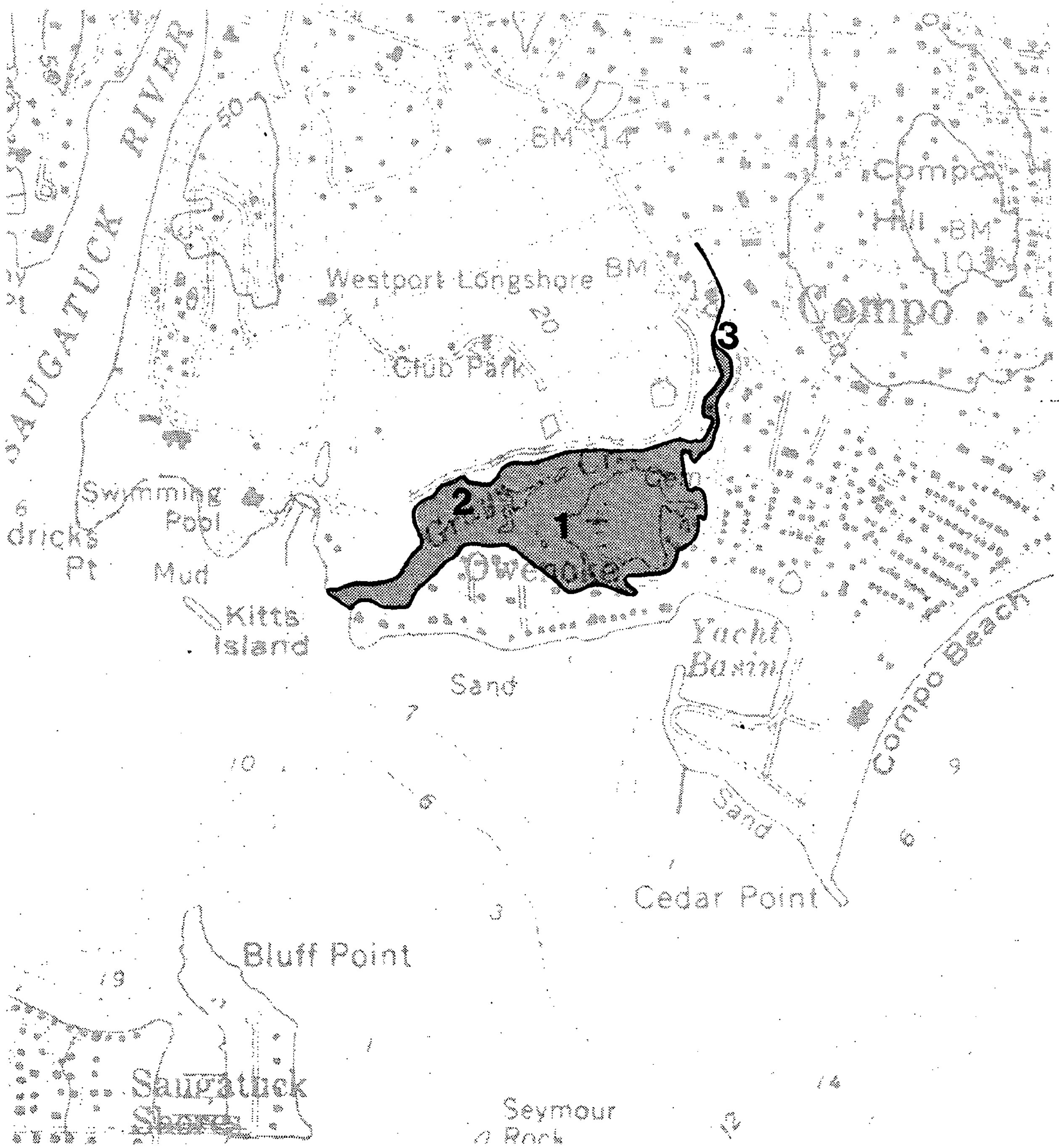
No obvious signs of wetlands loss were visible during the survey, but it is possible that some marsh loss is occurring at the mouth where tidal currents are strongest (See Figure 17.4). If anything, there may be a net increase in saltmarsh as Spartina alterniflora continues to colonize silted tidal flats.

The storm sewer outfall is partially blocked by silt, and there is doubt whether it will function adequately in the future without maintenance. The tidal creek leading to the outfall must be dredged in order to adequately free the hinged flap at the end of the pipe.

D. Problem Analysis

Siltation

The embayment is experiencing some siltation (See Figure 17.4). Over two-thirds of the embayment becomes tidal flats at low tide and serves as an important feeding area for shorebirds and other wildlife. The sediment is almost black, very soft, and appears to have a high organic content. Composition of the sediment generally becomes more coarse as one approaches the mouth of the embayment or from the center of the creek bed to the shoreline.



Scale: 1" = 1000'

FIG 17.4 GRAY'S CREEK ENVIRONMENTAL PROBLEMS

Problem Areas

1. Considerable siltation
2. Closed to shellfishing
3. Storm sewer outfall

Siltation (con't)

There are three potential sources of the sediment. First, it is likely that some silt is discharged to the creek by the storm sewer outfall located at the head of the embayment (See Figure 17.4). Second, some sediment appears to be eroding from the service road embankment on the north side of the creek. Most of the embankment is composed of unconsolidated sediment and is subject to erosion by surface runoff from the golf course. Third, some of the silt may originate from the Saugatuck River and Long Island Sound in the form of resuspended bottom sediment. Waves and tidal currents could possibly resuspend the fine silt, which, once transported into the creek by a flood tide, may settle out in the quiet environment of the creek.

When considering the high organic content of the bottom sediment, north bank erosion may not adequately account for current conditions. The more likely sources of sediment are storm sewer drainage and resuspended bottom sediment from outside the embayment.

Pollution

The storm sewer discharge at the head of Gray's Creek appears to have some effect on the water quality and ecology of the embayment. This concusion is inferred from observations made during the field visits.

Discharge from the outfall has eroded a substantial creek in the wetlands indicating significant flows during peak storm periods. Mud flats, exposed at low tide are very dark and odorous, indicating potential nutrient and BOD (biological oxygen demand) loading. Shorebirds were actively feeding on areas of the tidal flats, so that despite potential impacts of storm sewer discharge on the mud flats, there appears to be a viable benthic community. Further research is required to analyze the specific impacts of the storm sewer effluent on the embayment.

PROBLEM SUMMARY

Bermuda Lagoon

1.	Wetland Erosion	Minor	(a)
2.	Water Pollution	Moderate	(b)
3.	Fish Kills	Moderate	(b)

Gray's Creek

1.	Siltation	Minor	(b)
2.	Pollution	Moderate	(a)

KEY: (a) Conditions becoming worse (b) No change (c) Conditions improving

CHAPTER 18 NORWALK EMBAYMENT

INTRODUCTION

The City of Norwalk is located in Fairfield County and is bordered to the east by Westport and to the west by Darien. The town has an area of 23 square miles, all of which drain into the Western Connecticut Coastal Basin.

The population of Norwalk (79,100) did not increase between the years 1970 and 1980. The population density of 3,439 persons per square mile is more than 2-1/2 times the Fairfield County average of 1,333 persons per square mile. Norwalk's post offices divide the city into the centers of Norwalk, South Norwalk, Rowayton and Beldon. Norwalk is a member of the South Western Regional Planning Agency.

The geologic features of the Norwalk area are predominantly due to the process of glaciation. The bedrock in the area, called the Hartland Formation, consists of complex metamorphic rock formations. Overlying these bedrock formations is a glacial drift, with sediment particle sizes ranging from clay size to boulders 10 feet in diameter. The upland area along the coastline is mostly low lying (less than 100 feet above mean sea level) wooded hills, separated by areas of saltmarsh and open water. The shoreline is very irregular and has many coves, rivers, and inlets.

Lying approximately one mile offshore is a series of small, low-lying islets called the Norwalk Islands. These consist of 4 large islands (the largest covering about 1/10 square mile), 9 small islands and 20 tiny islands or "hammocks". Much of the shoreline in protected areas behind these islands has developed into saltmarsh - peat wetland.

Originally, nine marine systems were investigated as part of this study. These include: the Canfield Island wetlands, Harborview wetlands, Mill Pond Village Creek Wilson Cove, Charles Creek, Five Mile River, Farm Creek and Norwalk River/Harbor. Of these nine, three embayments - Canfield Island wetlands, Mill Pond and Village Creek, were selected for in-depth analysis. The other six embayments were deleted for a variety of reasons. The Harborview wetlands, Wilson Cove, and Charles Creek areas had only minor problems, although some concern was raised over illegal filling of wetland areas. Farm Creek, with no mooring or marina development, has been identified as a proposed open space acquisition area by the City of Norwalk. The Five-Mile River, although heavily used by boating traffic, has good circulation and tidal flow characteristics, and erosion and sedimentation problems are minor. Finally, the Norwalk River/Harbor area was deleted because it is included as a federal navigation project area by the U.S. Army Corps of Engineers.

CANFIELD ISLAND

A: Physical Description

Location

The embayment is located on the eastern edge of East Norwalk approximately 3 miles from the center of town (see Figure 18.1). The center of Westport is 3.5 miles to the east, and Darien is 5.5 miles to the west. Along the shoreline, Saugatuck Shores is immediately to the east and Shorehaven and Calf Pasture Beach are immediately west. Sprite Island lies approximately 0.5 miles southeast of the embayment.

Site Orientation and Configuration

The northern shore of the embayment is irregular, with protruding fingers of marsh vegetation penetrating the intertidal region. The southern shore (Canfield Island) is more regular, comprised of drifting sand deposits. The embayment length is approximately 0.6 miles, and 0.15 miles (800 feet) at its widest point. The long axis of the embayment is oriented roughly from NE to SW. The mouth of the embayment is approximately 300 feet wide.

Tidal Data

Mean tidal range -	7.0 ft.
Spring tidal range -	8.0 ft.
Mean tide level -	3.5 ft.

Source: U.S. Department of Commerce, <u>1980 Tide Tables: East Coast of North and South America</u>

Bathymetry

Range of Depth:	1-2 ft. (MLW)
Channel Depth:	No Channel

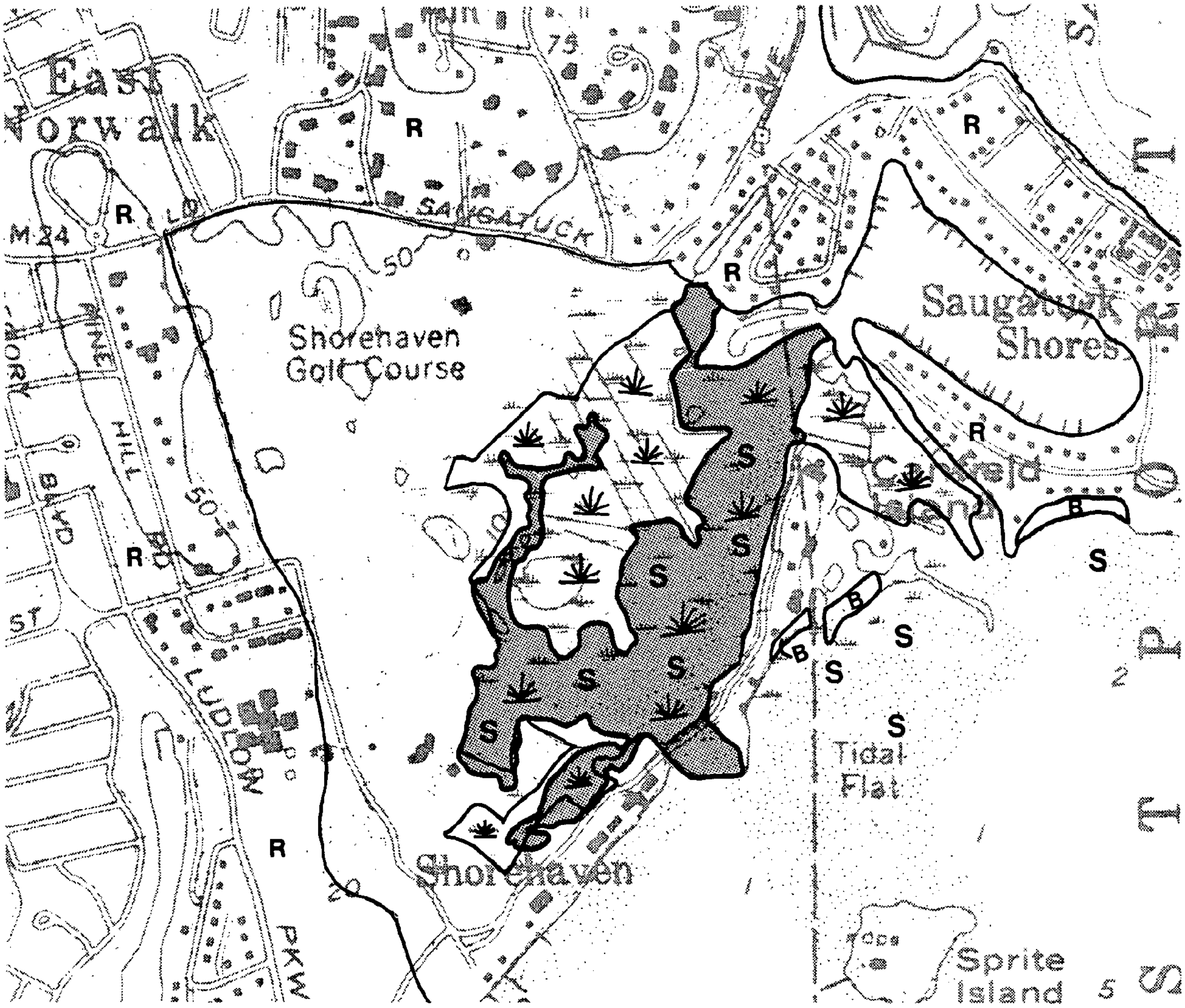
Additional Comments: Natural embayment, no dredging in saltmarsh area.

Source: NOAA National Ocean Survey Maps

Basin Hydrology

Regional Drainage Basin: Western Connecticut Coastal Basin
Embayment Basin Area: .66 square miles
Tributaries to Embayment: None

Other Sources of Freshwater Inflow: Surface runoff and street drainage.



Scale: 1" = 1000'

FIG 18.1 CANFIELD ISLAND ENVIRONMENTAL LAND USE

Legend:

wetlands	**B** beach
A agriculture	**M** marina
R residential	**S** shellfish beds
C commercial/ industrial	→ public access

Constrictions to Tidal Flow and Circulation:

Structure	% Constriction	Distance from Mouth
Bridge to Canfield Island-On Pilings (Approx. 300' Long)	At mouth	0-25

Sources: U.S. Geological Survey, Connecticut Drainage Basin Gazetter, 1981 Conn. Dept. of Environmental Protection

Water Quality Conditions

Upstream Water Quality Classification: Not updated

Embayment Water Quality Classification: Not updated

Direct Discharges: None

Sewer Service Area and Discharge Point: Portions of the Shorehaven area were recently sewered, alleviating a known problem area. Canfield Island residences and Saugatuck shores (Westport) are not sewered.

Storm Sewer Outfalls: None

Significant Non-Point Pollution Sources: The Shorehaven golf course lies within the watershed of the embayment and may be a significant source of nutrient rich runoff due to use of fertilizers for greens maintenance. Residences on Canfield Island and in the Saugatuck Shores area of Westport represent significant non-point pollution sources, as soils in these areas have severe limitations for septic system use as defined by the SCS.

Shoreline and Bottom Conditions

Extent of Shoreline Modification: At the mouth of the embayment, the shoreline has been modified by stone seawalls. The remaining shoreline is relatively unchanged except at the western end, where dumping and filling is occurring.

Significant Areas of Erosion: The shoreline of Canfield Island that faces Long Island Sound is an area of significant erosion. Many of the banks of the marshland inside the embayment are eroding and sloughing off into the water.

Shoaling and Sedimentation Problems: Offshore sands continually shift seaward of the mouth of the channel. Navigation depths are only 1-2 feet at mean low water in most places. Sand has been depositing on the shoreline in an area northeast (marshland side) of the Canfield Island bridge.

Shoreline and Bottom Conditions (con't)

The marsh channels have not experienced signficant sedimentation problems, although the mouth was reportedly dredged some 10 years ago.

Bottom Sediment Characteristics: Cores and probings in the saltmarsh indicated that the marsh grew over deposits of glacial sand and gravel. The marsh sediments are very fine grained, with an average thickness of 7 to 9 feet. The two main tidal channels in the marsh have maintained the same relative position throughout the growth of the marsh. This was inferred from the saltpeat deposits, since they extend down to the edge of the channels, and the deposits of the channels contain few layers of peat. The bottom sediments of the channel are sand and mud near the mouth, and mostly sand/gravel and mud extending in the shallow waters seaward of the mouth.

An extensive tidal mud flat is found between Sprite Island and Canfield Island during low tide.

Surrounding Lands

Maximum Basin Elevation:

Location	Height
Sasqua Hill (to north)	100 feet
Canfield Island	10 feet
Golf Course	50 feet

Topography: The coastal area is relatively flat. No slopes exceed 15% in the Basin area.

General Vegetation Characteristics: Extensive saltmarsh development is present in the Canfield Island estuary. Upland areas are predominantly wooded residential areas with lawns. A golf course borders the wetlands to the north, and an area of rock-fill is encroaching on the southwestern end of the embayment.

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Agawam	fine sandy loam	3-8	poor
Charlton	fine sandy loam	3-8	good
Charlton	fine sandy loam	8-15	good
Charlton-Hollis	fine sandy loam	3-15	good

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Hinckley	gravelly sandy loam	3-15	poor
Hollis	rock outcrop complex	3-15	very poor
Merrimac	sandy loam	0-3	poor
Merrimac	sandy loam	3-8	poor
Sutton	fine sandy loam	3-8	poor
Tisbury	silt loam	0-3	poor
Typic Udorthents	cut and fill	-	variable
Westbrook	mucky peat	-	very poor

Shellfish and Finfish Resources

An abundant number of horse mussels are found in the embayment along with moderate numbers of oysters, barnacles, and clams. Fish runs of bluefish, manhaden, and other migratory fish occur in the estuary.

Wetlands

Extensive saltmarsh development is found within the areas of tidal influence (See Figure 18.1). Marshland is found in the backwaters adjoining the Shorehaven Golf Course, in the western arm of the estuary, and next to Bermuda Lagoon. The large marsh adjoining the golf course is in excellent condition and is highly productive. The other marsh areas have been badly impacted through recent filling and dumping of rock and debris. Some of this activity appears to be due to illegal "lot extension" by land owners.

Portions of the marshland banks are sloughing off due to a combination of tidal action and heavy wakes from power boats.

Environmentally Sensitive Areas

The remaining wetlands in Norwalk and in Canfield Island represent a valuable diminishing resource. These wetlands are currently offered moderate protection through ownership, but are being significantly impacted through illegal dumping of rock and debris, and adverse uses, including heavy foot and boat traffic. Concentrated human activity within the marsh areas also limits the marsh utility for wildlife.

B: Land Use Analysis

Current Shoreline and Water Use

There are only a few private docks for boat use inside Canfield wetlands. At the western end of the Canfield Island bridge, a small boat house and house floats have been constructed to service the Sprite Island Yacht Club. There is no significant amount of bulkheading or fixed shorefront featured within the embayment. The waters inside the bridge, although shallow and narrow, are reportedly heavily used by powerboats for cruising and water skiing. The wetlands are accessible by water under the Canfield Island bridge and by a channel connection to Bermuda Lagoon (Saugatuck Shores) located to the northeast (see Figure 18.1). Most of the boat traffic is from the Bermuda Lagoon area, which is a man-made lagoon with highly concentrated waterfront (dock) development. The wetlands are also used for nature walks and hunting.

Current Upland Use

Two major upland uses are found in the area: Shorehaven Golf Course, which forms the northern boundary, and single-family reisdences which ring the remainder of the embayment (see Figure 18.1). In the western arm of the embayment, recent dumping of rock and debris has encroached upon the saltmarsh. This dumping has apparently occurred without proper permits and represents a problem of significant concern to the City of Norwalk.

Historical and Significant Land Use Changes

Most of the upland land uses seen today were in existence in 1934. The Shorehaven Golf Course, residences at Shorehaven and Canfield Island, the Canfield Island bridge and the Sprite Island Yacht Club dock were all present in 1934. Change which occurred between 1934 and 1951 involved some residential infilling and land subdivision.

The most significant changes to the area came in the period 1951-1970. During this period, a channel was cut through the western arm of the marsh to improve water access to adjacent property, and the residential development on man-made Bermuda Lagoon in Westport was started (See Chapter 17, Section 1 for details). The Bermuda Lagoon development significantly increased the amount of local boating traffic, as well as creating a new source of potential water pollution problems.

Public Access and Recreational Opportunities

There are no points of direct public access by land to any portion of the Canfield Island Wetlands.

C: Problem Identification

Local Departments and Offices Consulted

City of Norwalk: Planning and Zoning Commission, City Council, Shellfish Commission, Dept. of Public Works, Conservation Commission and Area Residents.

Response from Questionnaires and Local Meetings

Response from the questionnaire and local meetings indicated concern over saltmarsh encroachment, pollution,and siltation and erosion. A number of area residents strongly voiced their concern over water-use conflicts, such as boating and walking in the marsh areas.

Results of Field Survey and Research

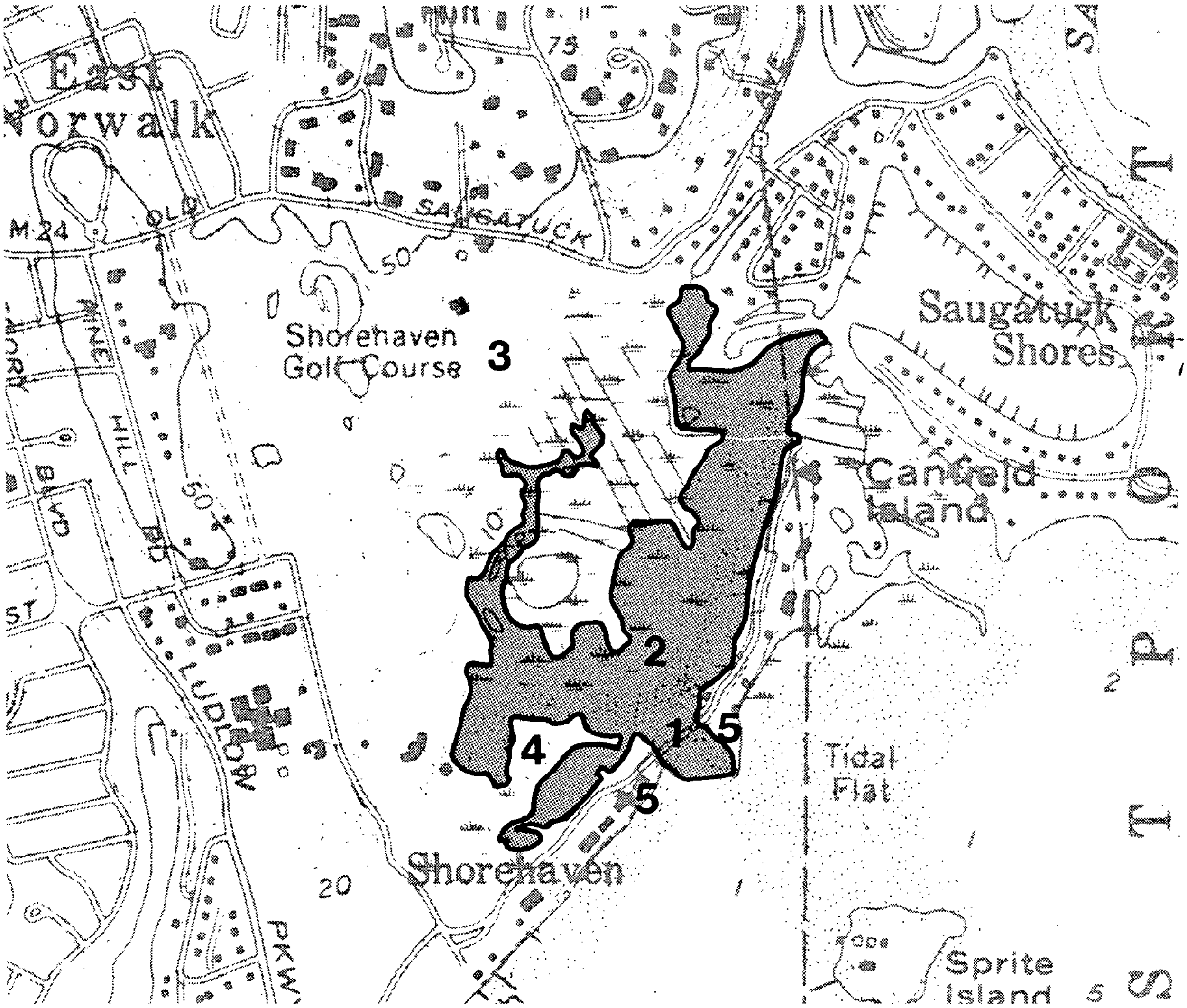
The field survey confirmed reports of dumping of debris in wetland areas; sand deposition along the shoreline on the marshland side of Canfield Island; and areas of signficant erosion, both within the marsh and on the seaward side of Canfield Island.

Water quality data for the area are limited; however, several non-point pollution sources are readily identifiable. These include nutrient rich surface runoff from the Shorehaven Golf Course, non-sewered residential areas, and boat traffic from local users and the Bermuda Lagoon area. These combined factors (within a regional picture of degraded water quality) result in a closure of tidal areas to shellfish harvesting.

D: Problem Analysis

Sedimentation and Erosion

The saltmarsh of the Canfield Island areas developed at a time when the areas were sheltered from wave action. Geological and Natural History Survey Data indicate that Canfield Island was once partially protected by a tombolo between Sprite Island and the mainland. This area is now a mud flat inundated at high tide. Since the removal of this protective land, the exposed salt peat deposits at the seaward side of Canfield Island (most notably near the Canfield Island bridge) are being actively eroded by wave action, (see Figure 18.2). Short of the construction of a breakwater or other device to reduce wave action there is little that can be done to slow this natural process.



Scale: 1" = 1000'

FIG 18.2 CANFIELD ISLAND ENVIRONMENTAL PROBLEMS

<u>Problem Areas</u>

1. Sediment deposition
2. Bank erosion
3. Nutrient rich loading from upland
4. Dumping/filling in wetlands
5. Shoreline erosion

Sedimentation and Erosion (con't)

Inside the Canfield Island bridge, isolated deposits of saltmarsh peat visible along the banks of the two main channels indicated that these channels are widening somewhat and eroding the adjacent marsh. Although this is also a natural process of wave action, the rate of erosion can be increased due to localized sources of wave energy such as wakes from powerboats. Heavy boat traffic in the area may accomplish in a short time, that which would take decades under natural processes (see Figure 18.2).

The same wave action mechanism that is eroding the marshland at the seaward side of Canfield Island is responsible for sediment transport of sand and silt into the estuary. Some of this material is being deposited on the leeward shore of Canfield Island between the bridge and a privately owned seawall, resulting in a growing sand bar (see Figure 18.2). This area of sand deposit does not limit navigation, but is of concern to local residents who are finding sand being transported into land that was formerly mudflat or was landscaped. It is likely that sand will continue to be deposited in this area unless alterations are made which would increase the rate of tidal flushing or scouring in the area.

Saltmarsh Encroachment

The western side of the marshland has recently been the dumping grounds for a large volume of rock debris and other construction and waste material. Tree cuttings, waste oil, and refuse have been indiscriminately dumped in the area. The result is a slow but continual encroachment into the saltmarsh. Although a regulatory problem, this dumping is degrading the environmental quality of the marshland, reducing its biological productivity and its capacity to act as a buffer for coastal flood protection (see Figure 18.2).

Boat Traffic and Other Water-Use Conflicts

High levels of boating traffic and concerns over hunting in the marshlands were voiced by local residents. Although these problems are mostly nuisances, they can create environmental harm to the natural system. As discussed previously, boating use can cause erosion through wave action, and heavy repetitive foot traffic in the marsh by hunters can degrade the resource. A closer look at these problems is warranted in view of these additional environmental impacts.

MILL POND

A: Physical Description

Location

The embayment is located near the mouth of Norwalk Harbor next to Seaview Park in East Norwalk (see Figure 18.3). The pond is approximately 1.5 miles south of the center of Norwalk and 4 miles southwest of Westport. Old Saugatuck Avenue Passes by the eastern end of the embayment and East Avenue runs along the northern shore. Seaview Avenue crosses the mouth of the pond, blocking off tidal circulation except for limited flows through a 3-foot diameter culvert. The Yacht Club is located across Seaview Avenue from the embayment.

Site Orientation and Configuration

The pond is long and narrow, has a regular shoreline and is oriented approximately NE to SW. Its length is 1600 feet and the width is an average 200 feet.

Tidal Data

Mean tidal range -	7.1 ft.
Spring tidal range -	8.2 ft.
Mean tide level -	3.5 ft.

Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth: Unknown
Channel Depth: None

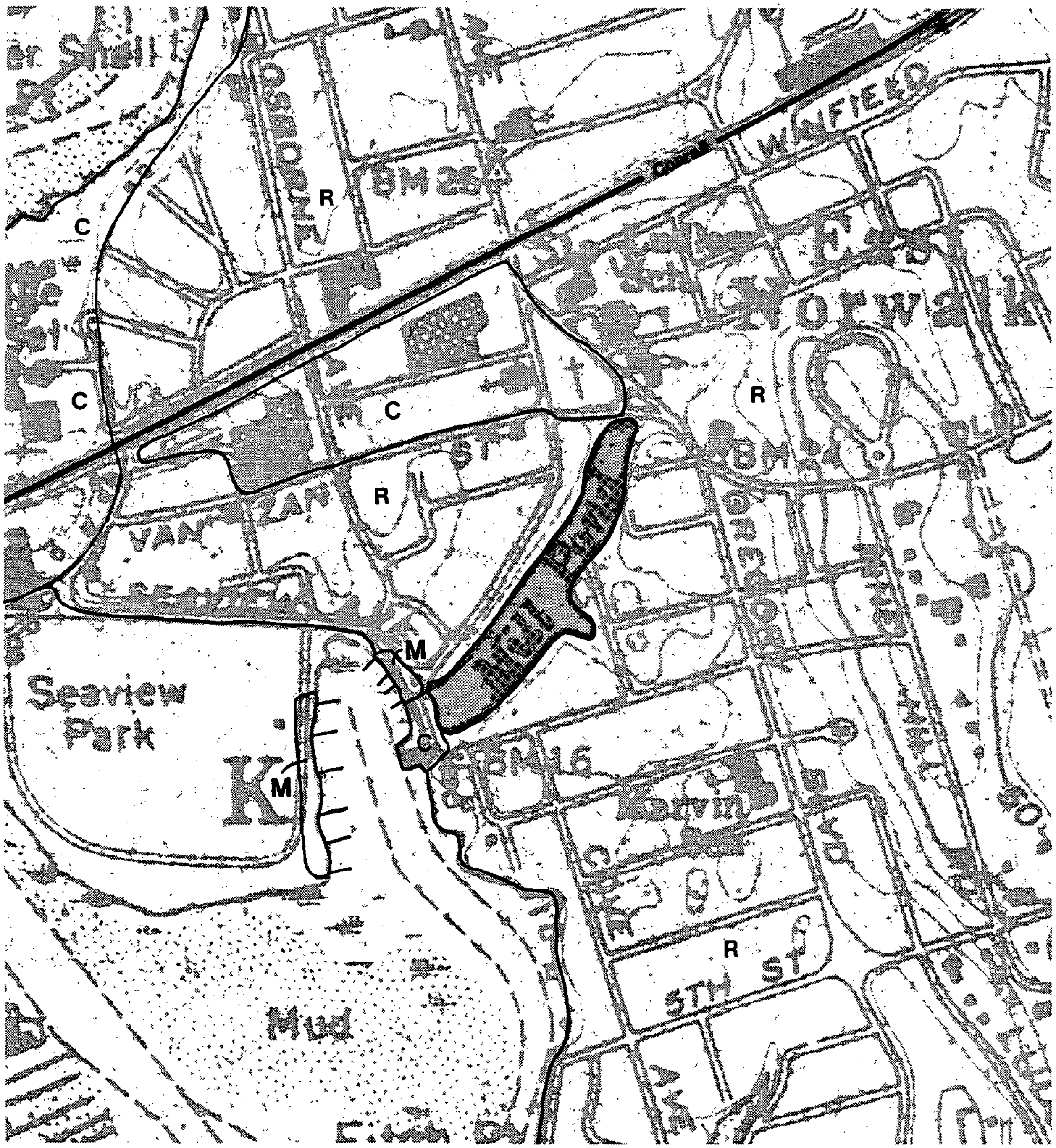
Additional Comments: Embayment connected to Norwalk Harbor via a culvert. Depth of pond is presumed to be 1-3 feet at mean low water.

Source: NOAA National Ocean Survey Maps

Basin Hydrology

Regional Drainage Basin: Western Connecticut Coastal Basin
Embayment Basin Area: 1.52 square miles
Tributaries to Embayment: None

Additional Significant Sources of Freshwater Inflow: A channelized drainage canal has replaced a former streambed and discharges to the northern end. Stormwater runoff drains from surrounding streets and parking lots and during storm events.



Scale: 1" = 666'

FIG 18.3 MILL POND ENVIRONMENTAL LAND USE

Legend:

- wetlands
- **A** agriculture
- **R** residential
- **C** commercial/ industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Constrictions to Tidal Flow and Circulation:

Structure	% Constriction	Distance from Mouth
Seaview Ave. culvert	75-100	Located at Mouth

Sources: U.S. Geological Survey, Connecticut Drainage Basin Gazeteer, 1981; Conn. Dept. of Environmental Protection

Water Quality Conditions

Embayment Water Quality Classification: Not yet reclassified.

Sewer Service Area and Discharge Point: The entire neighborhood surrounding the embayment is served by sewers. Treatment and disposal occurs on the east bank of the Norwalk River, just north of the Conrail bridge, and does not impact the embayment.

Storm Sewer Outfalls: A storm sewer discharges to the embayment on the east bank.

Significant Non-Point Pollution Sources: The Emerson Street drainage project now discharges large volumes of surface runoff from surrounding neighborhoods to the head of Mill Pond. The Merchants Bank has a large parking lot which drains directly to Mill Pond.

Shoreline and Bottom Conditions

Extent of Shoreline Modification: Approximately half of the shoreline of this small embayment has been filled or altered in some manner. The western end of the pond has been filled and currently is used for parking for surrounding businesses and the Yacht Club across the street. Several property owners along the northern shoreline have filled the waterfront to provide yards for their homes. A bank parking lot at the eastern end of the pond was recently built on wetlands at the water's edge. A steep section of the southern shore has been stabilized with a heavy stone wall.

Significant Areas of Erosion: The parking lot at the western end of the pond is eroding slightly. Stormwater runoff from the bank parking lot has caused some erosion where drainage runs into the pond.

Shoaling and Sedimentation: The storm sewer at the head of the pond and the steep banks contribute significant volumes of sediment to the embayment. Appoximately one-third to one half of the embayment becomes exposed mud flats at low tide.

Shoreline and Bottom Conditions (con't)

Bottom Sediment Characteristics: The bottom is composed of a fine silt with a significant organic component. Approximately one-third of the pond bottom is exposed as tidal flats at low tide. The two probable sources of sediment are erosion of the (15-20 feet) high steep banks that surround the pond, and sediment discharged from a storm sewer box culvert located at the head of the pond.

Surrounding Lands

Maximum Basin Elevation:

Location	Height
Pine Hill (east of pond)	60 feet
Route 136 (north of pond)	60 feet
Van Zant Street (west of pond)	10 feet

Topography: The surrounding area has slightly rolling hills. There are no large steep slopes in the area, though the banks around the embayment rise rather steeply to approximately 15 feet. Houses are located on top of the banks.

General Vegetation Characteristics: The neighborhood surrounding the pond is heavily developed and vegetation is limited mostly to residential landscaping. There is also a fringe of trees surrounding the pond which helps to stabilize the banks.

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Charlton	fine sandy loam	3-8	very good
Charlton	fine sandy loam	8-15	very good
Charlton-Hollis	fine sandy loam	3-15	poor
Hinckley	gravelly sandy loam	3-15	very poor
Merrimac	sandy loam	0-3	very poor
Merrimac	sandy loam	3-8	very poor
Sutton	fine sandy loam	3-8	
Typic Udorthents	cut and fill	-	variable
Westbrook	muck peat	-	poor

Shellfish and Finfish Resources

No shellfish beds are reported to exist in the embayment. All waters in Mill Pond and Norwalk Harbor are closed to shellfishing.

The embayment does not support any fish runs; however, some juvenile fish were observed in the pond.

Wetlands

A small pocket of Saltmarsh cordgrass (Spartina alterniflora) exists at the end of the pond along Seaview Avenue. A Reed grass (Phragmites communis) marsh is located at the head of the embayment. (See Figure 18.3)

The Spartina marsh provides some minor habitat and helps stem erosion. The Phragmites marsh filters detritus and serves as a nesting area for birds.

The most significant filling of wetlands occurred as part of the site development for the Merchants Bank. The bank parking lot and possibly the bank building sit on land that was formerly wetlands. Some additional filling of wetlands has occurred along the shoreline of the pond. It should also be noted that Mill Pond was once open to the harbor, but the mouth was filled to provide a sufficient roadbed for Seaview Avenue. The exchange is now provided by culvert.

Little or no additional wetland filling is anticipated in the future, because current lot lines are well established and there is little development pressure.

Environmentally Sensitive Areas

The Village Creek tidal marsh is bordered by commercial building along Woodward Avenue to the east and by industrial buildings along Wilson Avenue to the west (see Figure 18.3).

The tidal marsh is a highly productive estuarine habitat that experiences good flushing and tidal exchange with Long Island Sound. The marshes serve as important feeding areas for shore birds and provide ideal habitat for both juvenile and mature spawning fish. The fiddler crab is the most prevalent crustacean throughout the marsh.

B: Land Use Analysis

Current Shoreline and Water Use

The pond is primarily used to dispose of stormwater from surrounding uplands. The embayment also has some marginal conservation value. Recreational value is limited to informal use of the shore by children. Most waterfront homes landscape their yards to screen their view of the water body.

Current Upland Use

Surrounding upland includes a mixture of residential, commercial and recreational land use (see Figure 18.3). A bank is located at the north end of the pond, housing is located along both the east and west banks, and a food stand and yacht club are located at the southern end of the embayment along Seaview Avenue.

Historical and Significant Land Use Changes

The houses and roads (including Seaview Avenue) around Mill Pond have existed for more than 50 years. The major changes from 1934 to 1951 include the construction of the yacht club at the mouth, and the filling and stabilization of land next to Mill Pond for Norwalk's new Seaview Park (see Figure 18.3). Also, significant residential infilling occurred over this 17 year period. A public marina and large apartment complex have been built on the harbor waterfront.

Public Access and Recreational Opportunities

The land on the southern end of Mill Pond along Seaview Avenue is publicly owned. It is currently used as parking space for the yacht club and surrounding businesses. A local councilman has informally proposed converting the underutilized land to a small park.

C: Problem Identification

Local Departments and Offices Consulted

Norwalk Planning and Zoning Commission

Response from Questionnaires and Local Meetings

No embayment problems were cited as severe; however, erosion, siltation, pollution, circulation, and saltmarsh loss were noted as moderate problems. Most of the problems have existed for at least 20 years and are believed to be of man-made origin. Siltation is the exception, as it is regarded as a natural problem that has existed over the past 5 years.

City officials believe that all the problems have become more severe over time and that all problems except for erosion are anticipated to intensify in the future. Restricted circulation is perceived as one of the more important problems and the cause of current eutrophic conditions. To mitigate the problem, Norwalk plans to install a new, large culvert under Seaview Avenue.

Results of Field Survey and Research

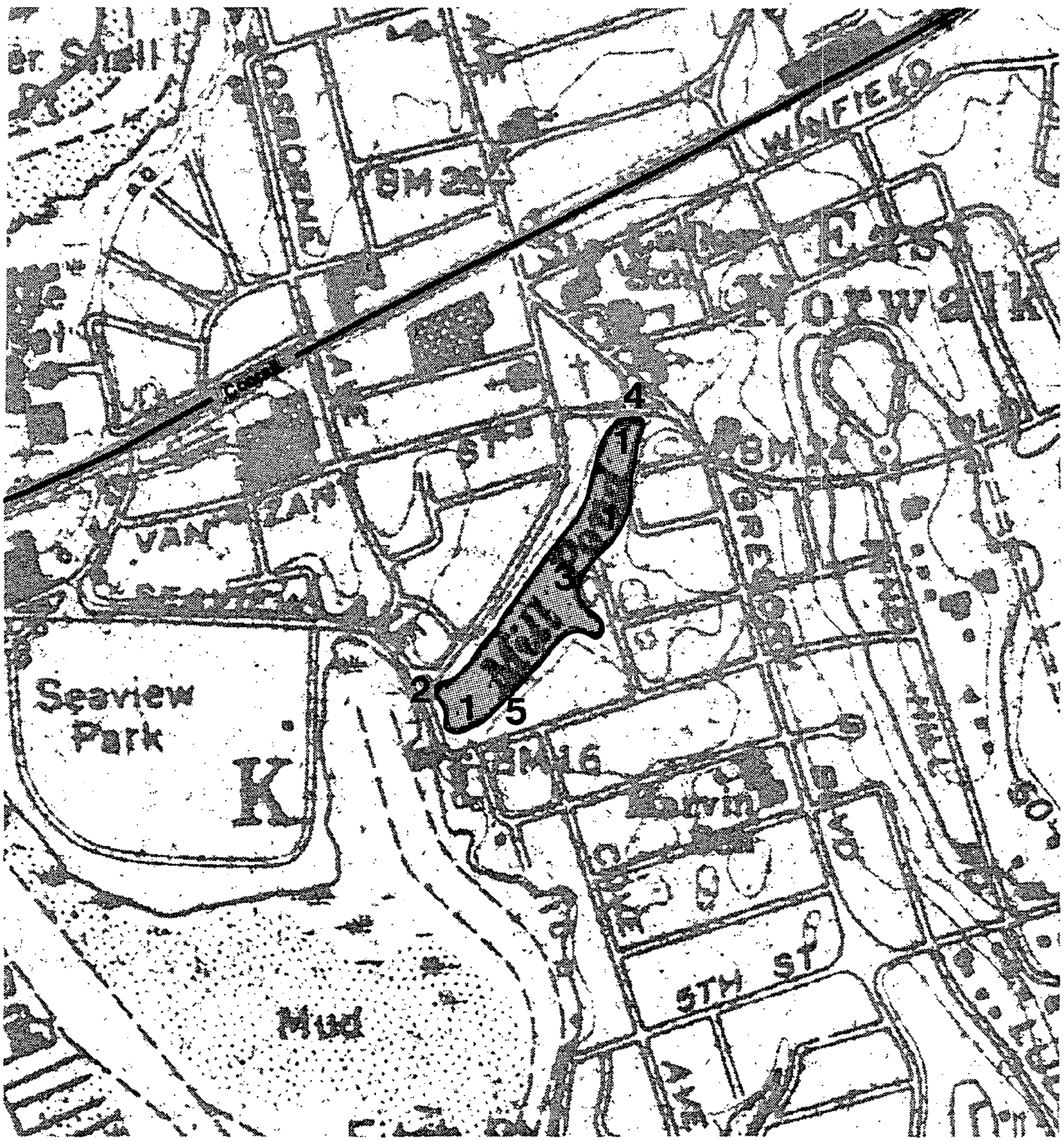
A field survey confirmed the poor circulation and tidal exchange of the embayment. The existing culvert to Norwalk Harbor measures approximately 4 feet in diameter, which is grossly undersized considering the storm sewer box culvert discharging to the other end of the pond measures six to eight feet wide and four feet high.

Eutrophication in the embayment exists in several forms. Foam and surface scum tends to collect at the southern end of the pond, particularly on an ebb tide. Floating organic debris and garbage are visible at the far eastern corner of the Seaview Avenue waterfront. Tidal flat sediment is odorous, dark in color and looks concentrated with organics (see Figure 18.4).

Erosion of the embayment's banks is occurring at numerous locations. Significant erosion was observed at the edge of the Merchants Bank parking lot. In that case, parking lot runoff has undermined fill and has broken off large pieces of asphalt. Moderately steep banks on either side of masonry supporting a sewer overflow outfall are being eroded by surface runoff. The erosion problem area most frequently mentioned by the city is along Seaview Avenue (see Figure 18.4). The grade of the parking lot next to the embayment is about two feet higher than the pond and is gradually eroding away. City officials claim that a substantial portion of the erosion was caused by a recent storm.

Siltation is directly related to erosion of the pond banks and the sediment contribution of the storm sewer discharge. Since bank erosion cannot account for all of the embayment siltation problem, it is presumed that the stormwater component may be significant. Aside from siltation, the stormwater also has a major impact on water quality. Discharge usually has high BOD (biological oxygen demand) and bacteria levels which have a significant impact on embayments with poor flushing, such as Mill Pond.

The principal cause of saltmarsh loss has been erosion and development. Patches of Cord grass (Spartina alterniflora) located on the south end have been eroded by the same forces that have eroded the parking lot fill. Marshes on the other end of Mill Pond were filled and paved over as part of the Merchant Bank's parking lot expansion. Some additional wetland filling and shore stabilization has occurred along the east banks of the embayment.



Scale: 1" = 666'

FIG 18.4 MILL POND ENVIRONMENTAL PROBLEMS

Problem Areas

1. Eroding of shoreline
2. Four foot diameter culvert limits tidal mixing
3. Closed to shellfishing
4. Runoff from parking lots
5. Trash and debris

D: Problem Analysis

Circulation Constriction and Siltation

The most significant impact on the embayment is constricted tidal flushing. During rainstorms, the four foot diameter culvet under Seaview Avenue is of inadequate size to properly flush the large volumes of stormwater discharged by the Emerson Street drainage system. Consequently, Mill Pond has become a type of stormwater retention basin that filters out sediment before releasing drainage to Norwalk Harbor.

One of the products of stormwater retention is a slow but gradual sedimentation of the pond, which is visually evident here in Mill Pond. The large tidal flats document the presence of signficant sediment inflow that probably entered into the system over the past 30 years. Strong odors released by the black sediment are indicative of anaerobic decomposition, and suggest depressed D.O. levels in the embayment water. If severe, this could lead to periods of anoxia and, in turn, fish kills and other ecosystem damage. In addition, chronically low D.O. levels subject an ecosystem to high stress and generally reduce the species diversity and productivity of an estuary. Normally, tidal exchange with the oxygen-saturated waters of outer Norwalk Harbor would replenish critically low D.O. levels, but the tidal constriction caused by the culvert impedes this process (see Figure 18.4). Nutrients fed into the system from the storm drainage, sediment from the shoreline and stormwater, and depressed D.O. levels lead to the problems of sedimentation and eutrophication.

Erosion

Uncontrolled surface runoff and small-scale wave attack are eroding the moderate-to-steep slopes around the embayment. The three incidents that are particularly visible include erosion of the parking lot fill at the south end, undermining of the Merchants Bank's paved parking lot, and some less significant erosion around the sewer overflow outfall on the east bank.

The south end erosion is apparently caused by both constant foot traffic and by periodic storm-generated waves. A site investigation revealed that erosion had carved out 10 feet of the perimeter banks and parking lot. Wetlands along that stretch of shoreline were absent and are presumed to have been eroded by the same forces.

Erosion is also occurring at the Merchants Bank parking lot. The parking lot design does not provide for runoff control and consequently the stormwater drains indiscriminately from the asphalt surface into the embayment. Runoff tends to focus at a few places along the edge of the lot and causes erosion.

Erosion
(con't)

Erosion at the third site on the east bank is caused by stormwater runoff cascading down the bank of the embayment. The slope of the bank is approximately 45 degrees and is easily subject to erosion.

Overall, the erosion problem is relatively minor when compared with existing tidal constriction problems. It appears that adoption of only a few erosion control measures could reduce the problems discussed above.

VILLAGE CREEK

A: Physical Description

Location

Village Creek is located on Long Island Sound between Manresa Island and Wilson Point. The center of Norwalk is 2.5 miles north, Westport is 6.5 miles northeast, and Darien is 3 miles northwest. South Main Street and a Conrail spur serving heavy industry border the west side of the inner creek area. The Village Creek community borders on the east. Hoyt Island is located at the mouth of the creek (see Figure 18.5).

Site Orientation and Configuration

The embayment is widest at the mouth, near Hoyt Island, and narrows progressively as it moves inland. The mouth is approximately 1400 feet wide and narrows to less than 100 feet at the head. The creek is almost 0.5 miles long. The cove shoreline is somewhat irregular, particularly in the wetland areas along the western shore. The axis of the creek is roughly NW to SE (see Figure 18.5).

Tidal Data

Mean tidal range -	7.1 ft.
Spring tidal range -	8.2 ft.
Mean tide level -	3.5 ft.

Source: U.S. Department of Commerce, <u>1980 Tide Tables: East Coast of North and South America</u>

Bathymetry

Range of Depth:	0-5 ft. (MLW)
Channel Depth:	5 ft. (MLW)

Additional Comments: Channel is privately- maintained. Depth last reported in 1965 and is probably shallower now.

Source: NOAA National Ocean Survey Maps

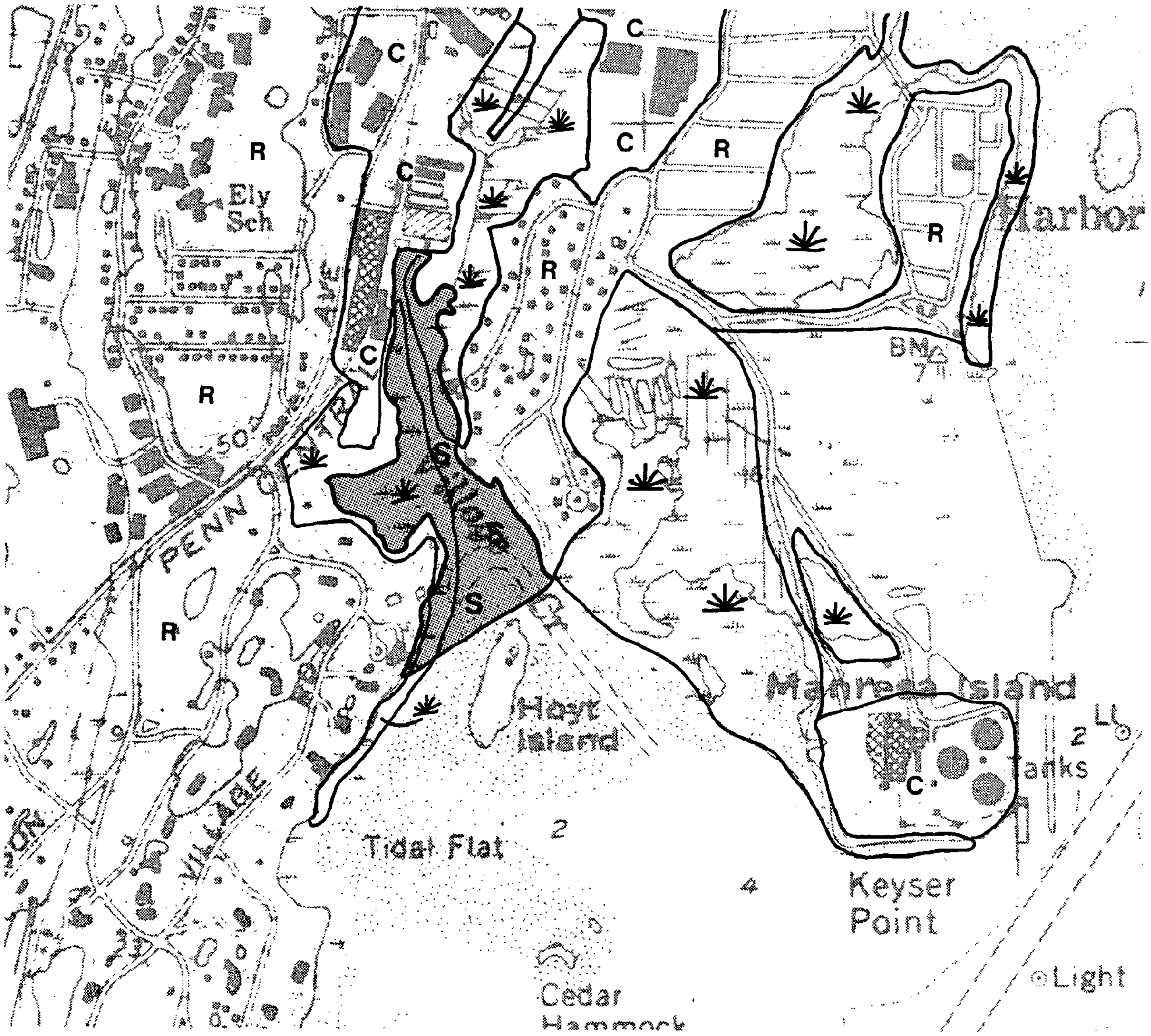
Basin Hydrology

Regional Drainage Basin: Western Connecticut Coastal Basin
Embayment Basin Area: 0.6 square miles

Tributaries to Embayment: Small Unnamed Creek

Additional Significant Sources of Freshwater Inflow: Runoff from South Main Street, Woodward Avenue, surrounding parking lots, and industrial and commercial storage areas drains into the embayment (see Figure 18.5).

Constrictions to Natural Flow and Circulation: None



Scale: 1" = 1000'

FIG 18.5 VILLAGE CREEK
ENVIRONMENTAL LAND USE

Legend:

- wetlands
- **A** agriculture
- **R** residential
- **C** commercial/ industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Water Quality Conditions

Embayment Water Quality Classification: Not yet reclassified.

Direct Discharges:

Source	NPDES Permit #	Waste Characteristics
CT. Light & Power-Nor.	CT 0003093	Fly ash lagoon, cooling water & industrial waste, chlorine, suspended solids, iron, copper, oil and grease, boiler blowdown

Future Status of Discharges: The effluent limitations for the Manresa Power Plant are likely to remain the same in the future.

Sewer Service Area and Discharge Point: The entire upland area surrounding Village Creek is served by sewers. Treatment and disposal occurs at the Norwalk River plant just north of the Conrail bridge.

Storm Sewer Outfalls: A storm sewer discharges into the head of Village Creek.

Significant Non-Point Pollution Sources: Some stormwater runoff drains from surrounding industrial yards, streets, and residential neighborhoods into the embayment.

Shoreline and Bottom Conditions

Extent of Shoreline Modification: Approximately one-half of the wetlands at the head of the creek have been filled and developed for industrial use and warehouse storage. The rest of the shoreline along the Village Creek community and Wilson Point has remained in its natural state.

Significant Areas of Erosion: The Village Creek Association has experienced some erosion of its beach which is located on the east side of Village Creek next to the Association's dock.

Shoaling and Sedimentation Problems: Natural sedimentation is occurring within most of the creek and is impeding navigation. Some shoaling is occurring off the northern end of Hoyt Island. The probable source of the shoaling is resuspension of the Long Island Sound bottom sediment by tidal currents and coastal storms.

Bottom Sediment Characteristics: The bottom sediment is a mixture of silt and sand. Sand is most prevalent along the shoreline of the Village Creek Association and Hoyt Island. Silt is most common at the head of the creek near the tidal wetlands.

Surrounding Lands

Maximum Basin Elevation:

Location	Height
Village Creek Community	50 feet
Wilson Avenue (near Ely School)	90 feet
South Main St. and Woodward Ave.	80 feet

Topography: The land surrounding Village Creek is very hilly and consists of rock outcroppings and bedrock overlain with till. Both the east (Village Creek Community) and west (Wilson Point) have moderately steep slopes.

General Vegetation Characteristics: The eastern shore (Village Creek Community) has a large stand of tall mature trees, while Wilson Point to the west still is covered with extensive natural vegetation. Hoyt Island is densely vegetated with tall trees and shrubs.

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Agawam	fine sandy loam	0-3	very poor
Canton and Charlton	extremely stony		
Canton and Charlton	fine sandy loams	3-15	poor
Charlton-Hollis	fine sandy loams	3-15	poor
Charlton-Hollis	fine sandy loams	15-40	poor
Hollis-Rock Outcrop	complex	3-15	very poor
Hollis-Rock Outcrop	complex	15-35	very poor
Raypol	silt loam	-	very poor
Typic Udorthents	cut and fill	-	variable
Westbrook	mucky peat	-	very poor

Shellfish and Finfish Resources

Clam beds are common throughout the embayment. Some oyster beds also exist in the area. All of Village Creek is closed to shellfishing.

Wetlands

There is a large expanse of wetlands at the head of Village Creek and another moderate-sized marsh along the west side of the embayment seaward of Wilson Avenue (See Figure 18.5). Fringe marshes line the opposite shoreline. Manresa Island, which is outside of the study area, has a very large area of wetlands in its center.

The tidal marsh at the head of the creek is consolidated and surrounded by development on three sides. It provides habitat to wildlife, flood storage, and a natural buffer for embayment water quality. The fringe marshes serve in the same capacity.

Prior to the filling and development of South Norwalk, the wetlands of Village Creek were directly connected to Norwalk Harbor and to the wetlands of Manresa Island. Construction of Woodward Avenue separated these wetland areas and subsequent industrial and commercial development has reduced the Village Creek wetland acreage by half.

Several large warehouse buildings have been built on wetlands since the promulgation of the State Wetlands Act. In addition, industry and commerce surrounding Village Creek continue to fill contiguous wetlands. Local residents believe that the current fill activity is illegal, and are concerned that it will continue without more aggressive enforcement action from the state.

Environmentally Sensitive Areas

The Village Creek tidal marsh is bordered by commercial activities along Woodward Avenue to the east and by industrial activity along Wilson Avenue to the west. The tidal marsh is a highly productive estuarine habitat that experiences good flushing and tidal exchange with Long Island Sound. The marshes serve as important feeding areas for shore birds and provide ideal habitat for both juvenile and mature spawning fish. The fiddler crab is the most prevalent crustacean throughout the marsh.

B: Land Use Analysis

Current Shoreline and Water Use

Most of the embayment shoreline is natural and is used for a variety of purposes, including passive and active recreation, conservation, and fishing. The Village Creek Association maintains a modest boating facility with one main dock and moorings offshore. They also maintain a private beach and swimming area. The Wilson Point Association has no comparable facilities on Village Creek, as the focus of their waterfront activity is located on Wilson Cove (the other side of the peninsula).

Current Shoreline and Water Use (con't)

None of the industries located at the head of the embayment is water dependent (see Figure 18.5).

Current Upland Use

The area surrounding Village Creek is a mixture of industrial, commercial, recreational, and residential land use. The industrial and commercial uses border three sides of the tidal marsh, and recreational uses borders on part of the east side of the marsh. Residential land use is present on the east and west sides of the embayment, south of the marsh (see Figure 18.5).

Industry in the area includes sorting and recycling of junked materials (such as metal and other scrap) and a large storage area for the materials waiting to be processed. Commercial uses include a warehouse for storage of wholesale durables.

The recreation area is near the intersection of Dock Road and Woodward Avenue. It includes a ball field and a play area for young children. A corner of the recreation area was recently used to build a local pump station for the sewer system.

The two residential neighborhoods bordering on the embayment are Village Creek to the east and Wilson Point to the west. Homeowners are automatically part of their respective associations. Roads, bathing areas, docks, and tennis courts and other amenities are owned by the associations and are intended for the exclusive use of members and their friends.

Historical and Significant Land Use Changes

Aerial photos from 1934 show Woodward Avenue as the only development preventing the Village Creek tidal marshes from flushing directly to Norwalk Harbor. The yards of homes next to the marsh clearly show signs of former wetland filling. Residential landscaping is mature, however, so some of the houses had been built for at least 20 years. The Village Creek marsh area in 1937 was at least two to three times its current size.

By 1951, additional housing had been built east of Woodward Avenue, completely separating the Village creek marsh from Norwalk Harbor. Some minor wetland filling had occurred on the western side of the marsh. Considerable residential infilling is evident throughout the area.

Historical and Significant Land Use Changes (con't)

The nineteen year period from 1951 to 1970 shows dramatic housing growth and some industrial growth. A large area of wetlands on the west side of Village Creek marsh has been filled, apparently as part of expansion of existing industry. The Village Creek community, started in the 1950's, is well-established by 1970. A large boat basin and navigation channel has been dredged from their waterfront to Long Island Sound. Large boats are moored in the basin area.

The significant land use change from 1970 to 1980 is the construction of four large warehouses on the east side of Village Creek marsh. In addition, the clear definition of the dredged Village Creek boat channel has faded, indicating the presence of a siltation problem.

Public Access and Recreational Opportunities

Norwalk owns a small public park near the intersection of Woodward Avenue and Dock Road. The site includes a ball field and a play area for children. Parts of the park site are now occupied by a pump station for a recently constructed sewer interceptor.

Although the park borders on the Village Creek wetlands, it is functionally separated from the marsh by tidal Phragmites grass. No effort has been made to derive any benefits from its waterfront location.

C: Problem Identification

Local Departments and Offices Consulted

Norwalk Planning and Zoning Commission Staff

Response from Questionnaires and Local Meetings

Local officials and residents indicated that water pollution, wetlands loss, and siltation were the three major problems confronting the embayment. Most of the saltmarsh loss is due to successive filling of wetlands for both new industrial construction and expansion of existing industry. Residents claim that some of the incremental filling of wetlands adjacent to already-filled uplands never received permits and may be illegal. In addition, they questioned how the state could approve construction of two new warehouses on wetlands after passage of the State Wetlands Act.

Response from Questionnaires and Local Meetings (con't)

The pollution problem is believed to be caused by surface runoff and leachate from a local junkyard and from storm sewer discharge at the head of the creek. The junkyard is located at the head of the creek and there is concern that contaminated runoff drains from the property into the embayment.

According to local residents, the siltation problem has accelerated over the past five years. Siltation apparently is impeding navigation to the point that the Village Creek Association is having difficulty navigating the channel between the docks and Long Island Sound. The channel was dredged seven years ago.

Results of Field Survey and Research

A field survey and additional discussions with residents confirmed the siltation problem in the embayment. The Village Creek Association maintains a common dock for Association use, and sailboat owners with drafts of four feet or more are having a difficult time sailing between the dock and the open Sound at low tide. Observation of the area at low tide revealed large areas of exposed mud flats off both the Association property and other shores, including Hoyt Island.

Not only does the area experience siltation, but erosion as well. The Association dock is acting like a groin and sediment is building on the north side and eroding on the south side. This indicates that net sediment transport generally moves south (out the embayment) on the eastern shore, and may in part explain why the dock area has experienced accelerated sedimentation. An Army Corps report (1956) indicates that the sediment of Village Creek is comprised of mud and gravel. It is believed that the majority of the finer soil components move inshore and form tidal flats, while the gravel predominates in more turbulent areas that are scoured by tidal currents and waves.

It was difficult to detect a pollution problem coming from industrial land around the embayment. Most upland drainage flows through the marsh, and there was no visible discoloration of the tidal creeks, no oil sheen on the surface of the embayment water, nor any repugnant smell coming from the sediment. The marsh itself looked quite healty and vigorous and fiddler crabs, a good healthy index of conditions, were abundant throughout the wetlands and tidal creeks.

Results of Field Survey and Research (con't)

The major apparent impact to the marsh has been filling. Two large warehouses have been built on wetlands along Woodward Avenue during the past ten years. The development, including parking lots, has consumed over 10 acres of marsh. In addition, industry along the west side of the embayment has been moving fill out onto the wetlands. A site visit revealed areas where wetlands were clearly being buried by bulldozed rubble.

D: Problem Analysis

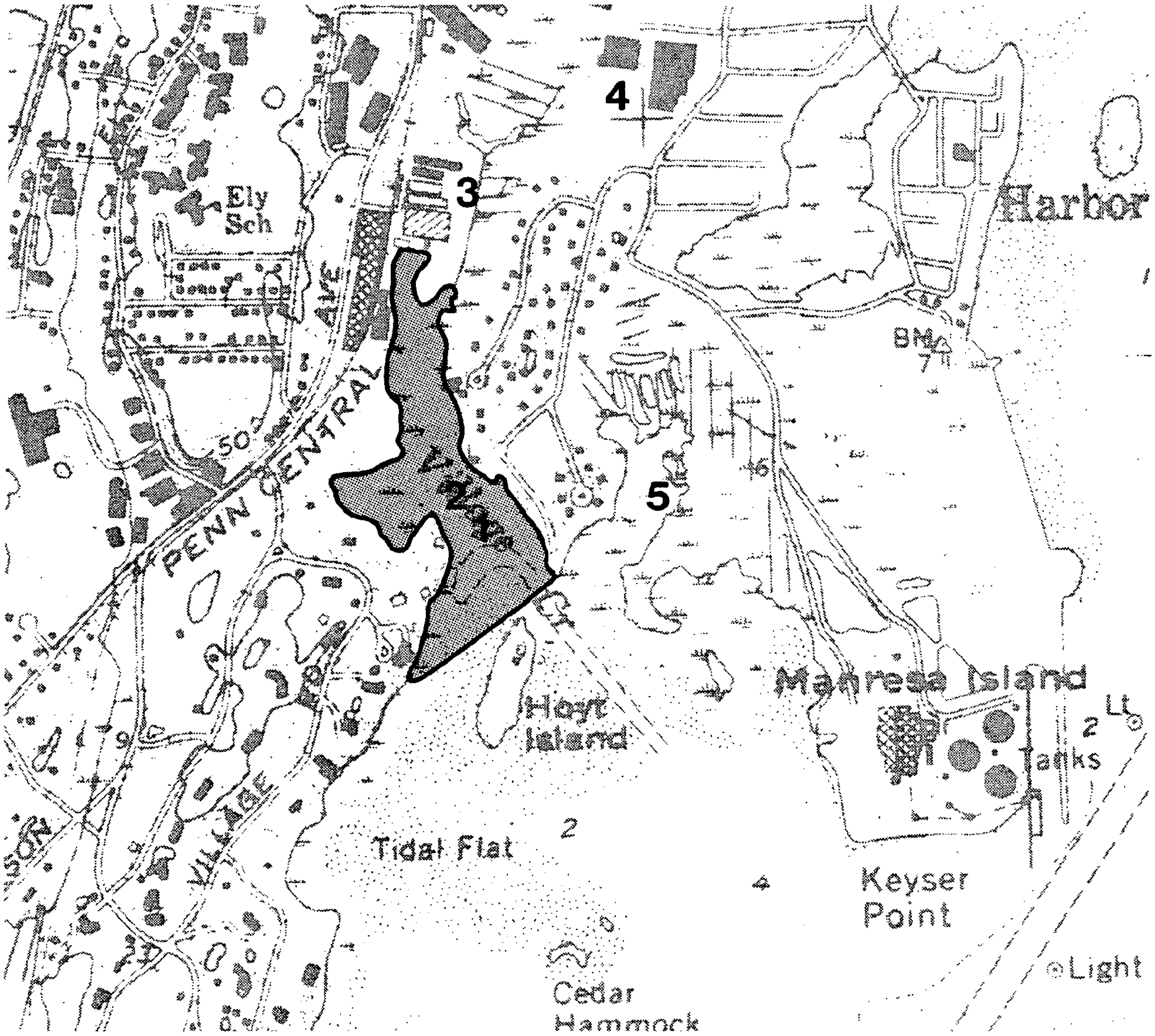
Siltation

The Village Creek siltation problem may be caused by local erosion and/or resuspensions of Long Island Sound sediment. Local erosion, based on site surveys and research, is the least likely source for several reasons. Uplands surrounding the embayment have steep slopes, but the banks are well vegetated and covered with leaves and low ground cover. Eroded rivlets coming from the steep slopes are rare along the shore. In addition, most areas of steep slopes are composed of rock outcropping and are highly resistant to erosion. The shoreline also is quite rocky, which effectively dampens wave erosion and stems shore erosion. Local upland erosion is also dampened by the Village Creek wetlands which anchor soil and serve as a sediment trap (see Figure 18.6).

The more likely source of sediment is resuspension of five bottom materials from Long Island Sound. Ellis' marine geology study (1962) of the Norwalk Islands area shows expansive deposits of sand and mud covering the bottom from the Village Creek shoreline out to Sheffield and Ram Island. Large deposits of soft mud also exist within this area. Consequently, there is a large documented sediment source directly offshore of the embayment that could be brought in by wave action.

The other major reason that Village Creek is conducive to siltation is the high degree of shelter that Hoyt Island provides to near-shore waters. Though wind-generated turbulence can easily disturb offshore waters, once offshore water reaches the embayment through tidal movement, wind and water turbulence are significantly reduced. The quieter environs of the embayment are conducive to settling and may result in sediment loading at the creek mouth.

Aerial photos clearly document this phenomenon. The channel serving Village Creek was dredged in the late 1960's and was almost completely silted-in within ten years. The project was funded by private monies (Village Creek Association). Though a ten year frequency for maintenance dredging is normal for many federal projects, it can be a significant burden to private individuals or groups, such as the Village Creek Association.



Scale: 1" = 1000'

FIG 18.6 VILLAGE CREEK ENVIRONMENTAL PROBLEMS

Problem Areas

1. Siltation of channel
2. Closed to shellfishing
3. Wetland filling
4. Stormwater runoff from parking lots and rooftops
5. Eroding fly ash deposits

Siltation (con't)

One other possible source of siltation (though difficult to quantify) might be eroding flyash from the Manresa Island power plant settling ponds. Aerial photos show ash being transported from the settling ponds out into the channel. The ash is easy to trace in aerials, because its light color clearly shows through shallow water.

Saltmarsh Loss

As discussed in the previous text, filling and development of wetlands accounts for most of the saltmarsh loss around Village Creek. Incidents of filling go back over 50 years, when the urbanized areas of South Norwalk started to expand rapidly toward the Long Island Sound shore. Filling of the Village Creek marsh has continued, with most of the former wetland being used for industrial expansion and new commercial development. The latter use is controversial with surrounding residents, because much of the filling activity took place after promulgation of the State Wetland Act.

Today, the Village Creek marsh appears to be healthy despite past filling and potential contamination from polluted discharge and leachate. Wildlife still depends on the habitat for both breeding and feeding, and there is a great diversity of estuarine organisms, including fish and crustacea, living in the marsh. There is a concern, however, that industry and commercial land uses contiguous to the marsh refrain from further encroachment, as more than half of the original wetland area has already been destroyed.

Water Pollution

The two potential sources of degraded water quality in this embayment are direct discharges of industrial wastes and stormwater runoff. According to NPDES data supplied by both the Connecticut DEP and EPA Region I, there are no direct discharges in Village Creek (regulated by these two agencies). This points to stormwater runoff as the more likely source of water quality degradation.

The field survey of the creek revealed no obvious visual indications of water pollution from surrounding upland sources, but the survey period had been preceeded by unusually dry weather. Thus, there is the possibility that the visual conditions of the marsh and embayment did not reflect normal conditions. Such conditions would have a particularly significant impact on stormwater-generated pollution.

Water Pollution
(con't)

In addition, the Village Creek Association and city officials in subsequent local meetings identified land uses, such as open junk yards around the marsh that would likely be subject to leaching under conditions of rapid overland storm water flow. Recent expansion of low profile, large surface area warehouses also is likely to generate increased surface runoff. Much of the marsh has been ditched as part of a mosquito control program and these ditches are frequently linked to sources of upland runoff. Thus, stormwater runoff is expected to most greatly affect the ecology of the marsh in closest proximity to these ditches. Such degradation was not observed during the embayment field survey.

At this point, a more definitive understanding of the pollution impacts of runoff from surrounding upland areas requires further water quality analysis. However, it should be noted that fiddler crabs were observed in large numbers in the ditches that drain the marsh. Their ubiquitous presence could be regarded as an indication of superior water quality, and the observation tends to indicate that embayment water quality may be less degraded than suspected.

PROBLEM SUMMARY

Canfield Island

1.	Sedimentation of Inner Areas	Moderate	(a)
2.	Erosion of Shoreline/Marshland	Moderate	(a)
3.	Loss of Wetlands	Moderate	(a)

Mill Pond

1.	Circulation Constriction	Severe	(b)
2.	Siltation	Severe	(a)
3.	Erosion	Moderate	(a)

Village Creek

1.	Siltation	Moderate	(a)
2.	Saltmarsh loss	Severe	(a)
3.	Water Pollution	Minor	(b)

KEY: (a) Conditions becoming worse (b) No change (c) Conditions improving

CHAPTER 19 DARIEN EMBAYMENTS

INTRODUCTION

The Town of Darien is located in Fairfield County and is bordered to the east by Norwalk and to the west by Stamford. The town has an area of 12.9 square miles, all of which drains to the Western Connecticut Coastal Basin. During 1970 to 1978, the population increased 12.6 percent (1970 - 20,411; 1978 - 23,000), over two and a half times the state average for the same period. The number of Darien housing units increased only 5.9 percent, possibly indicating a moderate increase in average size of household.

The population density of the town is 1,783 persons per square mile, considerably higher than the Fairfield County average of 1,333 persons per square mile. The population is divided into three main centers of development: Noroton, Noroton Heights, and downtown Darien. Like many other coastal communities in Connecticut, downtown Darien is located on U.S. 1 (Boston Post Road). The strip of commercial development along the highway constitutes the central business district. The other major transportation routes passing through the town include Interstate 95 (Connecticut Turnpike) and the local Conrail line, which runs between New Haven and New York.

As in the case of Westport, the geology of the town has been shaped primarily by large scale galcial processes. Ridges of bedrock are oriented in a north-south direction and are overlain with till and stratified drift. The north-south orientation is quite distinct and consequently has aligned most of the drainageways in parallel lines. Bedrock outcroppings are visible throughout the town.

The Darien shoreline is highly irregular and consists of a series of long and narrow necks of land jutting out into Long Island Sound (See Figure 19.1). Examples include Long Neck and Noroton Neck. Rising sea level since the end of the Ice Age has penetrated several of the narrow river valleys, allowing a tidal intrusion further inland. Rising sea level has increased the irregularity of the shoreline, creating islands, reefs, and subsequent headlands near points of land. Wetlands have vegetated much of the shoreline, especially areas that are protected from direct exposure to southerly winds and waves.

The three rivers that drain the interior of Darien include the Goodwives River, Fivemile River and the Noroton River. The Noroton and Fivemile Rivers define the borders of Stamford and Norwalk, respectively. The latter two are also the most developed of the three and serve as both commercial and boating centers in town.

Gorhams Pond, Holly Pond and Scott's Cove were originally considered for inclusion in this study. Scott's Cove was deleted because the area's marshes are still very productive and there appear to be no significant problems. Gorham's Pond was included due to siltation problems and non-point source pollution. Holly Pond warranted further study due to its pollution problems, poor circulation, shellfish losses, and saltmarsh losses.

HOLLY POND

A: Physical Description

Location

The embayment is on the western edge of town and forms the common border of Darien and Stamford. The center of Darien is located approximately 2 miles east of Holly Pond and Stamford center is 2 miles west. U.S. 1 intersects the Noroton River at the head of the cove and curves south following the northeastern shore of the pond. Noroton Neck and Brush Island form the eastern side of the cove, and Stamford's Weed Avenue and Cove Island Park form the western side. Cove Harbor is located at the mouth of Holly Pond.

Site Orientation and Configuration

The pond has an irregular shoreline, particularly on the Darien (east) side. A 500 foot wide spillway spans the mouth of the cove from Brush Island to Cove Island. The Noroton River enters the embayment in the northwest corner. The pond is approximately 1.1 miles long and 0.5 miles wide.

Tidal Data

Mean tidal range -	7.2 ft.
Spring tidal range -	8.3 ft.
Mean tide level -	3.6 ft.

Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth:	Unknown
Channel Depth:	Unknown

Additional Comments: The Channel is privately maintained and controlling depths are not shown on NOAA National Ocean Survey maps. The Pond is presumed to range from 1 to 5 feet deep at mean low water.

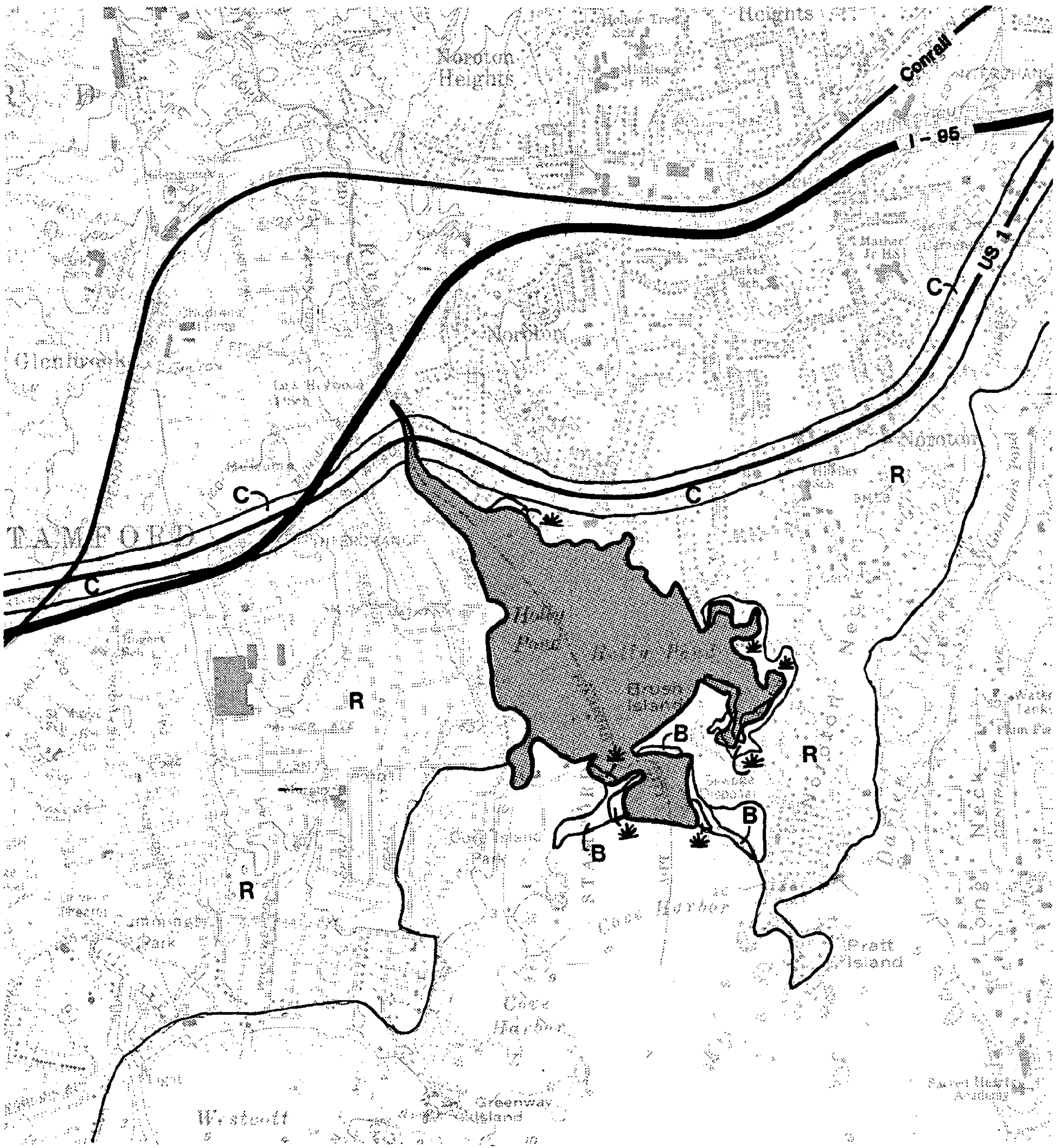
Source: NOAA National Ocean Survey Maps

Basin Hydrology

Regional Drainage Basin: Western Connecticut Coastal Basin
Embayment Basin Area: 11.7 square miles

Tributaries to Embayment: Noroton River

Other Sources of Freshwater Inflow: Some stormwater runoff from surrounding residential property, such as driveways, rooftops and nieghborhood streets.



Scale: 1" = 2000'

FIG 19.1 HOLLY POND
ENVIRONMENTAL LAND USE

Legend:

- wetlands
- **A** agriculture
- **R** residential
- **C** commercial/industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Basin Hydrology (con't)

Constrictions to Tidal Flow and Circulation:

Structure	% Constriction	Distance from Mouth
Brush Island Causeway	75-100	At Mouth
Holly Pond Spillway	75-100	At Mouth
Cove Road Bridge	75-100	At Mouth

Sources: U.S. Geological Survey, Connecticut Drainage Basin Gazeteer, 1981; Conn. Dept. of Environmental Protection

Water Quality Conditions

Upstream Water Quality Classification: B/A

Embayment Water Quality Classification: SB/SA

Direct Discharges: None

Sewer Service Area and Discharge Point: All of the land around the embayment is sewered, except for Cove Island and a small problem area on Brush Island. The sewer pump station, located on Brush Island, conveys collected waste to the regional plant in Stamford.

Storm Sewer Outfalls: There are numerous storm sewer outfalls discharging to both the pond and the Noroton River.

Significant Non-Point Pollution Sources: Coastal drainage from streets, rooftops, and parking lots flows directly to the embayment from many points, particularly street ends and drainage centers.

Shoreline and Bottom Conditions

Extent of Shoreline Modification: Approximately 80 percent of the shoreline has been filled and stabilized with seawalls and bulkheads for residential development. The Stamford side of the pond currently has seawalls running almost the entire length, while the Darien side has about one-third of the shore remaining in its natural state as coastal wetlands. Some wetlands have colonized shallow intertidal areas seaward of the seawalls on the Darien side. A spillway controls tidal flow at the mouth and prevents the exposure of tidal flats at low tide.

Shoreline and Bottom Conditions (con't)

Significant Areas of Erosion: The sandy shoreline on both sides of the mouth of the pond show signs of erosion and littoral transport from west to east. Groins have been built on both sides of the mouth in an effort to stem sand loss.

Shoaling and Sedimentation: Town officials indicate that the entire pond area is silting-in, making boat access at low tide difficult. Probable sources of this sediment include deposition from the Noroton River, erosion of surrounding property by runoff and waves, and resuspended bottom sediment from Long Island Sound.

Bottom Sediment Characteristics: The bottom sediment is generally silty, with some sand and gravel and a very high organic content. Residents are opposed to removing the spillway at the mouth of Holly Pond, for fear that the tidal flats would create obnoxious odors. This appears to indicate that the organic loading is severe and has caused anaerobic conditions in the bottom sediment.

Surrounding Lands

Maximum Basin Elevation:

Location	Height
Hindley School (near U.S. 1)	50 feet
Noroton Neck	40 feet
Noroton Heights(Christie Hill Rd)	200 feet
Western Shore (Stamford)	130 feet

Topography: The area around Holly Pond is generally flat, however, sections of the western shoreline of Holly Pond and the Noroton River have steep slopes, particularly near Cove Road and Hamilton Road, respectively (See Figure 19.1).

General Vegetation Characteristics: The eastern shore is moderately developed with some mature trees and shrubs interspersed between houses. The westernside of the pond (Stamford) is more densely developed with fewer trees and other vegetation. Brush Island is partially developed as a recreation area, with the remainder covered by a stand of trees.

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Agawam	fine sandy loam	0-3	very poor
Agawam	fine sandy loam	3-8	very poor

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Beaches	-	-	-
Charlton	fine sandy loam	3-8	very good
Charlton	fine sandy loam	8-15	very good
Charlton	fine sandy loam	15-25	poor
Charlton-Hollis	fine sandy loam	3-15	poor
Charlton-Hollis	fine sandy loam	15-40	very poor
Haven	silt loam	3-8	very poor
Hinckley	gravelly sandy loam	0-3	very poor
Hinckley	gravelly sandy loam	3-15	very poor
Hollis-Rock Outcrop	complex	3-15	very poor
Leicester	fine sandy loam	3-8	very poor
Paxton	fine sandy loam	3-8	poor
Paxton	fine sandy loam	8-15	poor
Paxton	fine sandy loam	15-25	poor
Ridgebury, Whitman and Leicester	extremely stony fine sandy loams	-	very poor
Sutton	extremely stony fine sandy loam	3-15	poor
Typic Udorthents	cut and fill	-	variable
Woodbridge	fine sandy loam	0-3	poor
Woodbridge	fine sandy loam	3-8	poor

Shellfish and Finfish Resources

There may be some shellfish in Holly Pond; however, the harbormarster and other town officials could not verify it. All of Holly Pond is closed to shellfishing.

The town indicates that Holly Pond has no fish runs. The embayment has experienced only minor fish loss over the past 20 years.

Wetlands

Nearly the entire shoreline of Holly Pond has been filled and stabilized with bulkheads or stone walls (See Figure 19.1). Increased siltation of the embayment, however, has allowed Salt marsh cord-grass (Spartina alterniflora) an opportunity to establish itself seaward of the stabilized shoreline. This trend is most prominent along the eastern and particularly the southeastern shoreline.

The newly colonized marsh has formed a narrow fringe seaward of the ponds and stabilized shoreline. It primarily serves as a food source for birds and habitat for aquatic organisms.

Aerial photographs show that the wetlands of Holly Pond have been filled for over 50 years. It was not until the 1950's and the 1960's that most of the shoreline was stabilized with seawalls and bulkheads.

At present, almost all of the Holly Pond shoreline has been filled and stabilized. If siltation continues, additional colonization of wetlands can be expected in shallow areas along the perimeter of the embayment.

Environmentally Sensitive Areas

The tidal marshes of the Holly Pond estuary are comprised of Spartina alterniflora near the waters edge, Salt-meadow cord-grass (Spartina patens) in the higher marsh areas, and (Phragmites communis) at the edge of the marsh. Juvenile fish depend on Spartina alterniflora for shelter from predators, and birds derive nutrition from the plants' seeds and leaf tips. The mudflats, which are exposed at low tide, provide essential feeding area for shorebirds and some mammals.

B: Land Use Analysis

Current Shoreline and Water Use

Shallow depths, particularly along the embayment waterfront, combined with eutrophic conditions make the embayment less than desirable for swimming. Its water quality classification (SB), however, indicates that swimming is a suitable use.

Current Shoreline and Water Use (con't)

Many homeowners have private docks or at least store boats in their yards. Shallow draft boats are ideal for use on the embayment, but deeper draft vessels can navigate the pond at high tide without a problem.

Aside from active recreation, the pond provides passive recreation. Waterfront views are highly prized by residents living along the Holly Pond shoreline.

Current Upland Use

Almost all of the Darien side (east) of the embayment is residential. Exceptions include such buildings as the YMCA facility on the north shore. The Stamford side is more heterogeneous and includes an office building at the head of the pond, houses, a green strip park, observation points along Weed Avenue, and a large public park on Cove Island. The Darien side has a beach and other recreational facilities on the other side of the mouth of Holly Pond, just south of Brush Pond.

Historical and Significant Land Use Change

Fifty years ago the land surrounding Holly Pond consisted of large undeveloped lots. They were either used for limited agriculture or were associated with large estates. The shoreline at this time was not intensively developed, but most of the tidal wetlands had been filled to the water's edge. The spillway at the mouth of the pond had already been constructed seventy years earlier to create water power for a textile industry that started during the Civil War years.

By 1951, a dramatic increase in residential units had occurred around the pond, particularly on the Stamford side. Darien's housing growth, though significant, was not nearly as great as Stamford's. One of the most obvious differences was that Stamford made a transition to small lot subdivisions while Darien retained its low density character. As recently as 1951, most of the Darien housing growth around Holly Pond had concentrated along U.S. 1, while little new growth had occurred further south toward Noroton Neck and Pratt Island (See Figure 19.1). Some of the roads in this area had been built, however, in anticipation of rapid residential infilling.

The aerial photographs of 1970 show the signficant impact of suburbanization on Darien from the preceeding two decades. Most of the very large lots had been subdivided and developed with housing.

Historical and Significant Land Use Changes (con't)

Noroton Neck has now been almost completely developed along with Pratt Island. Many of the waterfront homes have now included docks, both on the Long Island Sound shore and Holly Pond. By 1970, Stamford had been intensively subdivided with small lot housing.

The period from 1970 to 1980 showed little additional change except for some new commercial office space development near the head of Holly Pond.

Public Access and Recreational Opportunities

The three public access points on Holly Pond include Weed Park (Darien side), the waterfront walkway with roadside observation points along Weed Avenue, and Stamford's public park on Cove Island. Use of Stamford's and Darien's public park is reserved for residents only.

C: Problem Identification

Local Departments and Offices Consulted

Darien Public Works Department
Darien Inland Wetlands Commission
Darien Planning and Zoning Commission Staff
Darien Conservation Commission
Darien Flood and Erosion Control Board

Response from Questionnaires and Local Meetings

Town officials cite pollution and poor circulation as the two major problems with the embayment. Both problems are believed to have existed for at least 75 years and have become more severe over time. The town has found it difficult to control the sewage pollution entering the system, but the general consensus is that most of the point source and non-point source contamination is coming from upstream sources along the Noroton River. They also believe there are some natural sources of pollution that are causing problems.

Response from Questionnaires and Local Meetings (con't)

Officials also emphasized their concern about the poor circulation in Holly Pond. Residents enjoy the aesthetics and convenience of having water in the pond even at low tide, but at the same time recognize that this may be affecting its tidal exchange with Long Island Sound. Though town officials see the existing pollution problems improving in the future, they see no prospective improvements in circulation.

Salt marsh loss is indicated by town officials as a long-term, historical problem of moderate concern. Erosion, siltation and fish loss are regarded as only minor problems.

Results of Field Survey and Research

Field surveys confirmed the poor circulation and pollution problems of the embayment. The perimeter of Holly Pond has grown progressively shallower with siltation, and Saltmarsh cord-grass (Spartina alternaflora) is now vegetating the shallows. Sea lettuce, which proliferates under nutrient rich or eutrophic conditions, was all along the shoreline and cast up in the tidal marshes where it was rotting. Though sea lettuce is a popular food source for fish and shore birds, bloom conditions have a significant impact on water quality. For example, at night when the plant must respire, the large mass of vegetation consumes dissolved oxygen and significantly depresses D.O. levels. Excessive growth of plants can lead to die off, which sinks to the bottom and forms an anaerobic mat of decaying material. This creates an oxygen debt, and chronic conditions can suffocate shellfish in the bottom sediment.

The specific origin of the pollution problem is difficult to determine from merely a field survey, because of the large area of the Noroton River basin. Most of the basin is moderately to heavily urbanized, and stormwater runoff alone probably constitutes amajor portion of the BOD and nutrient loading. In addition, it is difficult to tell whether there are still houses that have not connected to the sewer system, or houses that have connected but are still discharging somehow to the river. It should be noted, however, that most of the Noroton River basin is sewered.

The circulation problem of the pond is controlled by several factors, such as the spillway at the mouth, the volume of Noroton River discharge, the general depth of the embayment and its relationship to physical factors such as wind and waves.

Results of Field Survey and Research (con't)

The relative importance of these different factors on embayment water quality will be discussed in Subsection D below, but it is important to point out here that there are visual indications of stagnation, a symptom of poor circulation. It is also important to note that pollution and circulation are interrelated, as poor circulation localizes contaminated effluent and magnifies its polluting effect. Were there better mixing with Long Island Sound, for example, dilution would minimize or eliminate the impact of water pollution.

Based on survey observations and reviews of aerial photos, saltmarsh loss has not been nearly as significant during the past 10 years as it has been in previous decades. Most of Holly Pond's tidal wetlands were filled during the last century and the early part of this century. Filling activity since then has been limited to two small pockets of remaining marsh and the stabilization of partially filled shoreline. If anything, the acreage of tidal wetlands has increased over the past ten years from pioneer growth in silted shallows of the pond. Most of the perimeter of the embayment now has a five foot wide fringe marsh of Spartina alterniflora growing at the water's edge.

D: Problem Analysis

Pollution

A significant portion of Holly Pond's pollution comes from the Noroton River drainage basin. Though the highly developed residential areas of Glenbrook, Noroton Heights and Springdale are sewered, the dense suburbanization generates non-point source pollution that is difficult to control. For example, the cumulative impacts of lawn fertilizer, pesticides, soil erosion, dog feces, oil spills, and auto exhaust particulates have a major effect on receiving waters. Suburbanization magnifies these problems by increasing the amount of impervious surface in the basin and boosting stormwater runoff volumes. The end result is increasing direct discharge of surface area pollution.

In addition to surface runoff, several industries discharge wastes directly to the Noroton River. The river valley historically has been an industrial area because of its close proximity to the New Canann spur of the Conrail line. Most of these companies are located on the Stamford side of the river from Camp Avenue south to Pine Hill Road. The impact of discharges to the river is potentially signficant, but ultimately must be viewed in the context of the dilution effect of the receiving basin, Holly Pond.

Scale: 1" = 2000'

FIG 19.2 HOLLY POND ENVIRONMENTAL PROBLEMS

Problem Areas

1. Bridge constricts tidal flushing
2. Spillway limits tidal flushing
3. Closed to shellfishing

Pollution (con't)

The surface area of Holly Pond is roughly 182 acres, which is equal to approximately 65 million square feet. If one assumes the average depth of the pond is 6 feet (conservative estimate), there are approximately 390 million cubic feet of water in the embayment. The Noroton River's mean annual flow of 18 cfs translates to a daily discharge of 1.6 million cubic feet of water. A crude calculation shows that it would take the Noroton River almost 245 days to completely flush the embayment. Though these are crude calculations that do not take into account tidal exchange from Long Island Sound, they do highlight the relatively minor contribution of the river relative to the size of the embayment. It also points to the even greater significance of tidal circulation and exchange in flushing pollution out of the embayment.

Constricted Circulation and Tidal Flushing

The spillway across the mouth of Holly Pond is 550 feet long. Its function was once to provide water power to industry, but today it regulates the water level of the pond such that the pond never empties, even at low tide. This feature keeps the pond navigable and odorous tidal flats covered at low tide, but severely restricts the tidal flushing of the embayment. Reduction of the mean tidal range from 7.2 feet to less than 3 feet dramatically alters the tidal dynamics and subjects the embayment to significant forms of environmental degradation.

The foremost problem is that there is only limited daily turnover of surface water in the embayment. Estuaries are typically a highly productive system, but require large amounts of dissolved oxygen. Normally, most dissolved oxygen comes from Long Island Sound, but the spillway signficiantly reduces this impact.

The shallow depth of Holly Pond generally makes it a warmer water body than Long Island Sound in the summer, and further exacerbates the low D.O. problem. Oxygen consuming bacterial action and decay accelerates with rising water temperature and can lead to anoxia which, in turn, causes fish kills and decimates shellfish beds. Bottom sediment loaded with decaying organics can also become anoxic. Normally, low tide exposure of mud flats replenishes the oxygen debt, but this natural action is not possible with the action of the spillway.

Circulation is another factor which affects the health of the Holly Pond ecosystem. Under windy conditions there is considerable circulation within the pond, but during quiet summer days the water body becomes sluggish and highly stratified. Under stratified conditions, there can be dramatic differences between bottom and top temperatures, D.O.'s and salinity. It also sets up an entrainment mechanism that establishes a lens of freshwater overlying a wedge of saltwater.

Constricted Circulation and Tidal Flushing (con't)

Incoming tides drive the wedge toward the freshwater source, bringing with it nutrients and higher D.O. levels. The problem with entrainment is that it can isolate the upper reaches of the water column, such that there is a significant localizing effect of water pollution.

In summary, Holly Pond has more attributes of a pond than a coastal estuary. The freshwater impact of the Noroton River is minor considering the volume of the pond and that tidal exchange with Long Island Sound is restricted by the spillway. The resultant effect, particularly during the summer, is stratification of the water column, depressed dissolved oxygen levels, higher bacteria levels, and accelerated decomposition. All factors point to increased stress on the ecosystem and a greater chance for environmental degradation.

GORHAM'S POND

A: Physical Description

Location

The embayment is located in the Noroton Heights section of Darien about 1 mile from the center of town. The center of Norwalk is located 5.0 miles east and Stamford is 4 miles west. Long Neck forms the eastern bank of Gorham's Pond, while Noroton Neck forms the western bank. For purposes of this report, the study area is defined as the section of the pond from the Rings End Road bridge north 0.95 miles to the lower reaches of the Goodwives River (See Figure 19.3).

Site Orientation and Configuration

The embayment is 0.95 miles long and quite narrow in places, ranging from 30 feet wide to 500 feet. The pond is roughly linear with its axis oriented from NNE to SSW. Cummings Brook enters the embayment on the west bank, 2000 feet north of the Rings End Road bridge.

Tidal Data

Mean tidal range -	7.2 ft.
Spring tidal range -	8.3 ft.
Mean tide level -	3.6 ft.

Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth:	Unknown
Channel Depth:	None

Additional Comments: Depths are not recorded on NOAA National Area Survey Maps, above Rings End Road dam. Pond is presumed to range from 1 to 3 feet at mean low water.

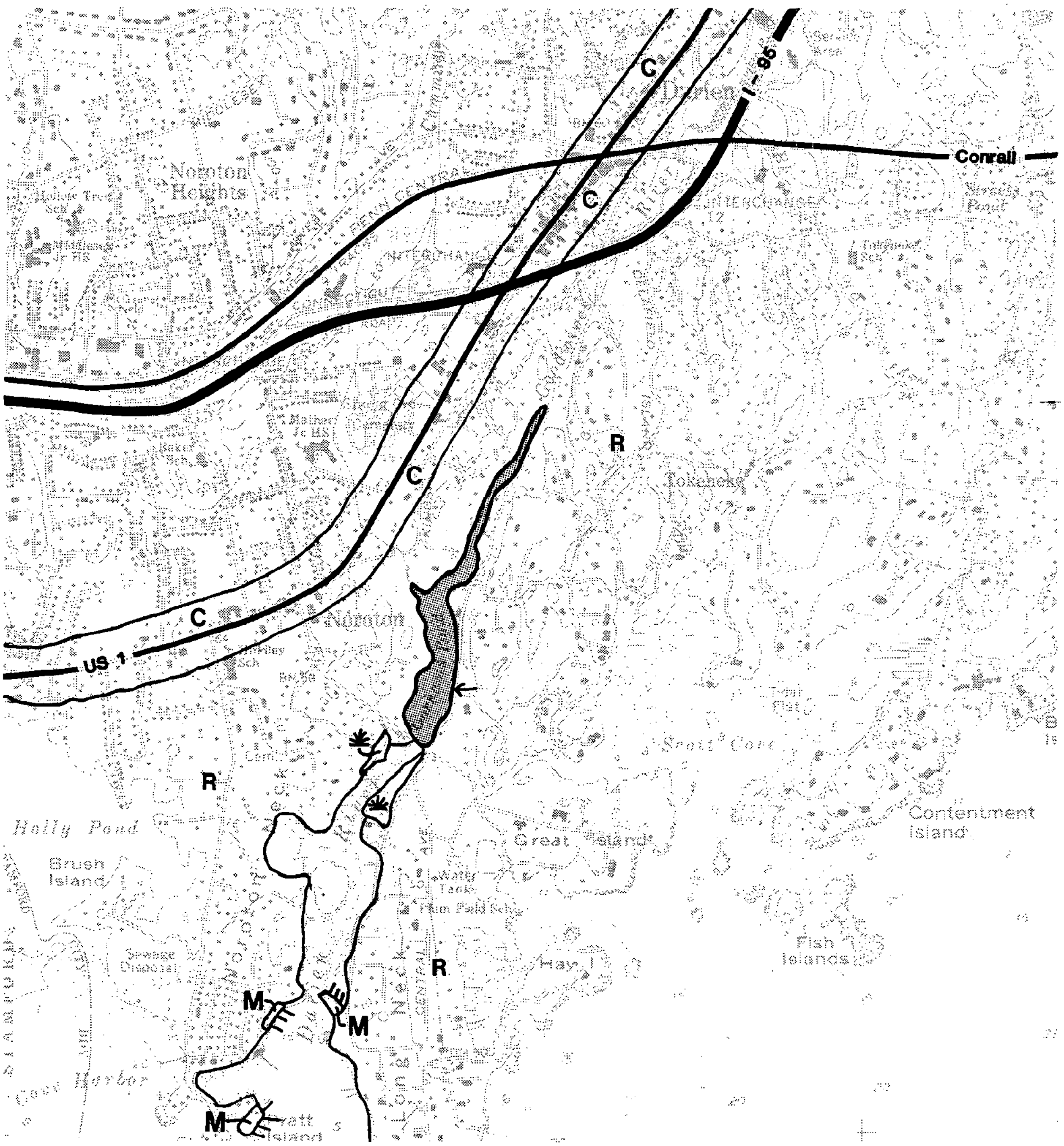
Source: NOAA National Ocean Survey Maps

Basin Hydrology

Regional Drainage Basin: Western Connecticut Coastal Basin
Embayment Basin Area: 6.2 square miles

Tributaries to Embayment: Goodwives River
Cummings Brook
Stony Brook

Additional Significant Sources of Fresh Water Inflow: Some surface runoff enters the embayment from street sewers and residential drainpipes.



Scale: 1" = 2000'

FIG 19.3 GORHAM'S POND ENVIRONMENTAL LAND USE

Legend:

- (wetlands symbol) wetlands
- **A** agriculture
- **R** residential
- **C** commercial/industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Constrictions to Tidal Flow and Circulation:

Structure	% Constriction	Distance from Mouth
Rings End Rd Dam	75-100	1.2 mile
Goodwives River Rd bridge	25-50	2.0 miles
Andrews Drive bridge	25-50	2.4 miles
Locust Hill Rd bridge	0-25	2.6 miles
I-95 bridge	0-25	2.7 miles
Tokeneke Rd bridge	25-50	3.0 miles
Conrail RR bridge	25-50	3.1 miles

Sources: U.S. Geological Survey, Connecticut Drainage Basin Gazeteer, 1981; Conn. Dept. of Environmental Protection

Water Quality Conditions

Embayment Water Quality Classification: B/A

Direct Discharges:

Source	NPDES Permit #	Waste Characteristics
Wee Burn Country Club	CT0100846	B.O.D. loading, suspended solids, variable pH, chlorine

Future Status of Discharges: The Wee Burn Country Club NPDES permit is currently expired. The future status is uncertain until the state takes action.

Sewer Service Area and Discharge Point: Very little of the Gorham's Pond drainage basin above Rings End Road is sewered. Several neighborhoods off Rings End Road have been identified as problem areas.

Storm Sewer Outfalls: There are numerous storm sewer outfalls located along the river bank.

Significant Non-Point Pollution Sources: Fertilizers and pesticides from residential lawns and gardens may drain with stormwater runoff to the embayment.

Shoreline and Bottom Conditions

Extent of Shoreline Modifications: Approximately 80 percent of the embayment shoreline has been filled, stabilized or altered. Almost half of the eastern shore has been filled to provide a suitable roadbed for Goodwives River Road. Property along the western shore has been filled, primarily to provide waterfront yard for homes. The northern half of Gorham's Pond is where natural segments of the shoreline remain intact. A spillway at the End Road bridge limits tidal access to the pond.

Significant Areas of Erosion: None reported or observed.

Shoaling and Sedimentation Problems: The bottom sediment above the spillway is a very fine silt with a significant organic component. During heavy flow periods, some of the trapped sediment is flushed into the lower reaches.

Bottom Sediment Conditions: Sediment from upland erosion in the Goodwives River drainage basin is being deposited in Gorham's Pond. Minimal flow conditions, combined with the wide bed of the river just above Rings End Road, make the pond an ideal settling basin for suspended sediment. The problem is compounded by the effect of the Rings End Road spillway, which acts to make settling more effective.

Surrounding Lands

Maximum Basin Elevation:

Location	Height
Long Neck	60 feet
Delafield Island Drive	80 feet
Kings Highway	70 feet
Brookside Road (near Cherry Lawn School)	130 feet

Topography - The area surrounding the pond is generally quite hilly. The east and west shores of Gorham's Pond have moderately steep slopes, particularly near the Goodwives River Road bridge and along the upper reaches of the pond.

General Vegetation Characteristics - The shore area is moderately developed, with many neighborhoods retaining an almost rural forested environment (particularly near the upper reaches of the pond and along the Goodwives River). The upper reaches of the Goodwives River is more densely developed with houses and has fewer trees and shrubs.

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Agawam	fine sandy loam	0-3	very poor
Agawam	fine sandy loam	3-8	very poor
Beaches	-	-	-
Charlton	fine sandy loam	3-8	very good
Charlton	fine sandy loam	8-15	very good
Charlton-Hollis	fine sandy loam	3-15	poor
Charlton-Hollis	fine sandy loam	15-40	very poor
Hinckley	gravelly sandy loam	0-3	very poor
Hollis-Rock Outcrop	complex	3-15	very poor
Hollis-Rock Outcrop	complex	15-35	very poor
Paxton	fine sandy loam	0-3	poor
Paxton	fine sandy loam	3-8	poor
Paxton	fine sandy loam	8-15	poor
Paxton	fine sandy loam	15-25	poor
Raynham	silt loam	-	very poor
Ridgebury	fine sandy loam	-	very poor
Ridgebury, Whitman, and Leicester	extremely stony fine sandy loams		very poor
Sutton	fine sandy loam	3-8	poor
Tisbury	silt loam	0-3	very poor
Typic Udorthents	cut and fill	-	variable
Walpole	sandy loam		very poor
Westbrook	mucky peat	-	very poor
Woodbridge	fine sandy loam	0-3	poor

Shellfish and Finfish Resources

There are no known clam or oyster beds in Gorham's Pond. Nor are there any fish runs up the Goodwives River through Gorham's Pond.

Wetlands

There are no tidal wetlands within Gorham's Pond (See Figure 19.3). All tidal wetlands of the Goodwives River are located along the shores below Rings End Road. There is a small pocket of inland wetlands reed (Phragmites communis) dominated at the head of the pond.

Aerial photos from the 1930's show the Rings End Road dam in place and most of the Gorham's Pond shoreline already filled. Development along basin shoreline goes back at least 150 years, as there are several millponds on the Goodwives River that were constructed to harness water power.

At present, the embayment conditions is anticipated to stay essentially the same over the next ten years.

Environmentally Sensitive Areas

The lower reaches of the Goodwives River, south of Rings End Road, are an important feeding and nesting habitat for birds and a productive habitat for aquatic organisms.

The tidal marshes of the estuarine system are comprised of Salt-marsh cord-grass (Spartina alterniflora) near the waters edge, Salt-meadow cord-grass (Spartina patens) in the higher marsh area and Reed grass (Phragmites communis) at the edge of the marsh. Juvenile fish depend on Spartina alterniflora for shelter from predators, and birds derive nutrition from the plants' seeds and leaf tips. The mudflats, which are exposed at low tide, provide feeding area for shore birds and some mammals.

B: Land Use Analysis

Current Shoreline and Water Use

The embayment is used for some boating, but mostly for passive recreational enjoyment. Local residents thoroughly enjoy living on the pond and view it as an asset to their quality of life.

Current Upland Use

The area surrounding the embayment is completely residential, consisting of single family detached units on large lots (See Figure 19.3). Under current zoning, the minimum lot size is one acre per family. Many of the lots, however, are much larger than one acre, with a large percentage of the land forested with mature trees.

Historical and Significant Land Use Changes

The major change since the early nineteenth century has been the abandonment of water-powered mills in the Goodwives River Valley. Gorham's Pond itself was dammed to provide low head hydropower for mill use. As a result of this early-period industrial development, much of the shoreline has been filled and altered for well over 100 years. Land use in the valley has traditionally remained of low density with large lot development. Most of the houses along the pond are at least 100 years old and relatively little residential infilling has occurred over the past 30 years.

Public Access and Recreational Opportunities

Visual access to the pond may be gained from the Rings End Road bridge. Some visual access is available from the Goodwives River Road bridge, but the line of sight is very limited. There are no public recreational sites located on Gorhams Pond.

C: Problem Identification

Local Departments and Offices Consulted

Darien Public Works Department
Darien Inland Wetlands Commission
Darien Planning and Zoning Commission Staff
Darien Conservation Commission
Darien Flood and Erosion Control Board

Response from Questionnaires and Local Meetings

The strong consensus among town officials is that Gorham's Pond has a severe siltation problem. They also believe the embayment has a minor to moderate pollution problem.

Officials believe the siltation problem has existed for at least 35 years and has grown particularly bad during the past 10 to 12 years. The situation is expected to become more severe in the future.

The cause of the problem apparently is a combination of natural factors, and local and upstream man-made factors. Town officals are currently considering dredging the embayment as a solution but recognize that this would be an expensive alternative.

No other problems with Gorham's Pond were cited by the town.

Results of Field Survey and Research

A field survey of the embayment confirmed a siltation problem not only in Gorham's Pond, but at other sites further upstream on the Goodwives River. The source of the problem is not readily apparent, but there are several possible explanations. These would include natural erosion, biomass, and earlier development.

First, the embayment valley has moderate to steep slopes. This encourages erosion from overland drainage. In addition, houses are built on some of these steep slopes and any residential activities such as construction or even landscaping or gardening makes land subject to erosion.

Second, over three-quarters of a mile of stream bed above the pond has a thick forest cover hanging over it. The trees contribute considerable organic material to the embayment, which then settles in the pond. The decayed material forms an organic silt which is eventually transported downstream to Gorhams Pond.

Third, the development of new retail space and business office space along the Goodwives River off U.S. 1 was encouraged in the 1967 Plan of Development. Though not all of this development has since been built, the new construction has significantly increased both erosion and stormwater runoff in the basin. Parking lots and streets are the major generators of surface runoff, and have led to increased BOD loading and particulate discharge. The construction phase itself was a major contributor of soil erosion and probably accounts for the observed significant increase in sedimentation over the past 10 to 12 years.

The fourth and most obvious factor is simply the design and configuration of Gorham's Pond. The dam severely restricts river flow and eventually eliminates tidal influence. These two factors alone make the pond an ideal settling pond for sediment.

The narrow spillway at the end of the wide pond presents little opportunity for the embayment basin to experience flow velocities of sufficient speed to disturb the bottom. In addition, the spillway design makes no provision for periodic drawdown to discharge accumulated silt. The same problem applies to other millponds further up the river. Currently they function as large reservoirs of silt, and during each major rainstorm they discharge but a fraction of their stored sediment.

D: Problem Analysis

Siltation

Siltation was the only significant environmental problem identified by the town. The problem was also subsequently confirmed during a field survey that covered the embayment study area from the southern limit at the Rings End Road bridge north to the Goodwives River Road bridge. Analysis of both field observations and research material indicates that the embayment experiences excessive siltation for several reasons.

First, the pond and river bed are subject to relatively little scouring and agitation of sediment. The spillway at Rings End Road effectively cuts off the pond from most tidal flushing and nearly eliminates a major mechanism of sediment transport. In addition, impoundment of drainage behind the dam provides a quiet environment for the settling of suspended sediment transported from upriver sources. The spillway is also an impediment to transport downstream and tends to trap sediment in the pond basin behind the rock structure.

Second, the series of dams on the river tends to dampen the peaks in stream flow, providing shorter and less frequent opportunities for river and basin bottom scouring and large-scale transport of sediment. Mean annual flow (See A-5 of this section) during normal conditions is only 18.5 cfs (based on 11.7 square mile basin and 1.58 cfs/sq. mi. multiplier), and the presence of the dams tends to limit increases in flow during peak rainfall periods. A dampened transport mechanism slows the movement of sediment from its source to Long Island Sound and favors accumulation of even light, silty material, particularly in millpond impoundments.

Third, the volume of eroded sediment entering the embayment system is significant due to steep slopes, construction projects and the large volumes of stormwater runoff generated by impervious surface (rooftops, parking lots, sidewalks, streets). Steep slopes historically have been a source of eroded sediment. New sources have been added by the accelerated commercial and residential development of the past 20 years. This recent commercial development within the basin has been focused near the intersection of I-95 and U.S. 1, while housing development has been particularly active off Mansfield Avenue. Both types of development are strongly suspected as contributing significant sources of sediment to the embayment.

Scale: 1" = 2000'

FIG 19.4 GORHAM'S POND ENVIRONMENTAL PROBLEMS

Problem Areas

1. Closed to shellfishing
2. Spillway limits tidal mixing
3. Pond is silting in

Siltation
(con't)

The fourth reason the embayment is particularly subject to siltation relates to the vegetated character of the lower reaches (below I-95) of the Goodwives River. Though land along that river segment is zoned for 1 acre lots, most of the lots in this area are substantially larger. Property along the river is densely vegetated, with both thick ground cover and an overhang of mature trees. The field survey of this segment of the river revealed a large mass of decaying material in the river bed. The mean flow of the river and dampened peak flows keep these organics from being flushed down the river to the harbor. Decayed organic material forms a fine silt which typically settles in the quiet millpond environments.

Of the four general factors that encourage siltation of Gorham's Pond, two factors relate to the altered dynamics of the embayment sediment transport and the other two relate to the sources and accelerated loading of the material. Though Gorham's Pond and the Goodwives River may experience significant sediment loading from natural and man-made sources, the loading is not unusually high in the context of other Connecticut river systems analyzed in this report. Rather, the more likely critical factors leading to excessive siltation are those man-made alterations of the stream mentioned above that have significantly limited the natural transport mechanisms and flushing of the embayment.

PROBLEM SUMMARY

Holly Pond

1.	Pollution	Moderate	(a)
2.	Constricted Circulation and Tidal Flushing	Severe	(b)

Gorham's Pond

1.	Constricted Tidal Flushing	Moderate	(b)
2.	Sedimentation	Moderate	(a)

KEY: (a) Conditions becoming worse (b) No change (c) Conditions improving

CHAPTER 20 Greenwich Embayments

INTRODUCTION

The Town of Greenwich is located in Fairfield County and is the western-most community along the Connecticut shore of Long Island Sound. Greenwich is also the largest coastal town or city, with an area of 47.3 square miles. All of that area drains to the Western Connecticut Coastal Basin. During 1970 to 1978, the population increased 7.1 percent (1970 - 59,755; 1978 - 64,000), or roughly 50 percent faster than the average state increase for that same period. The number of Greenwich housing units increased by 11.1 percent, close to the Fairfield County average of 12.1 percent. The discrepancy between the growth rate in population and housing stock might be explained by a possible decrease in average household size.

The density of the town is 1,353 persons per square mile, almost identical to the county average of 1,333 persons per square mile. The population is divided into seven villages and the town center. These include Greenwich, Cos Cob, Riverside, Old Greenwich, Byram, Glenville, and Round Hill. Areas of the town south of U.S. 1 are most heavily populated and include Greenwich's central business district. Additional commercial strip development and office buildings are located along the rest of U.S. 1.

Areas north of U.S. 1 are the least populated parts of town, as minimum lot sizes in Greenwich range from 2 to 4 acres under current zoning. Other major transportation routes linking the town to the region include the Merrit Parkway serving the northern part of town, Interstate 95, which runs along the coast, and the local Conrail line providing connections to New Haven and New York.

The geology of Greenwich has been greatly influenced by glacial processes. As is the general case for western Connecticut, any ridges of bedrock, oriented in north-south direction, are overlain with glacial till and stratified drift. Early road development in the town followed these ridges. Examples include Stanwick Road, North Street, Lake Avenue, and parts of Riverside Road. Most of the town's inland wetlands exist in small pockets between the ridges and are linked together by small streams and a few rivers, such as the Mianus and Byram Rivers.

The Greenwich coast is highly irregular and consists of drowned river valleys divided by bedrock ridges in the form of necks of land. The shoreline itself is rocky, and bedrock outcroppings are particularly visible at the water's edge. Sand is much less common along the far western Connecticut shore and forms a few isolated beaches in rocky coves. The largest sandy formation along the coast is Todd's Point, which has been reworked in the form of a sand spit by littoral currents.

Of the six major coves and harbors in the town, Greenwich Harbor is the focal point of commercial and recreational boating activity, while the Byram River and Mianus River are the more industrialized waterways. Greenwich Cove and Byram Harbor are used primarily for recreation because of their close proximity to town recreation areas.

Greenwich Cove, Tomac Cove and Byram Harbor were originally considered for inclusion in this study. The first two embayments were deleted, however, because their environmental problems are relatively minor or have existed for a long period of time. Byram Harbor was ultimately chosen because of a growing concern over urban runoff and drainage from a tributary that flows through the town landfill, in addition to the unusual number of public beach closings, presumably caused by failing local septic systems.

BYRAM HARBOR

A: Physical Description

Location

The embayment is located in the western section of Greenwich, between the neighborhoods of Belle Haven and Byram (See Figure 20.1). The harbor is located 1.5 miles from the center of Greenwich and 1.0 miles from the New York border. For purposes of this study, the harbor mouth is defined by a transect running from the end of Game Cock Island to the Belle Haven Point (near Otter Rocks) (See Figure 20.1). Byram Park is on the western shore of the embayment and includes a protected harbor enclosed by Rich and Farwells Islands. The Conrail line and Interstate 95 pass behind Byram Park, and I-95 is sited less than 150 feet from the head of the harbor.

Site Orientation and Configuration

The harbor is 2200 feet wide at the north and gradually tapers down to 100 feet in width at the head. The axis of the harbor is oriented approximately from north to south and is about 3000 feet in length. The shoreline is irregular, with wetlands and bedrock outcroppings protruding from the shoreline.

Tidal Data

Mean tidal range -	7.2 ft.
Spring tidal range -	8.5 ft.
Mean tide level -	3.6 ft.

Source: U.S. Department of Commerce, 1980 Tide Tables: East Coast of North and South America

Bathymetry

Range of Depth:	1-6 ft (MLW)
Channel Depth:	3-6 ft (MLW)

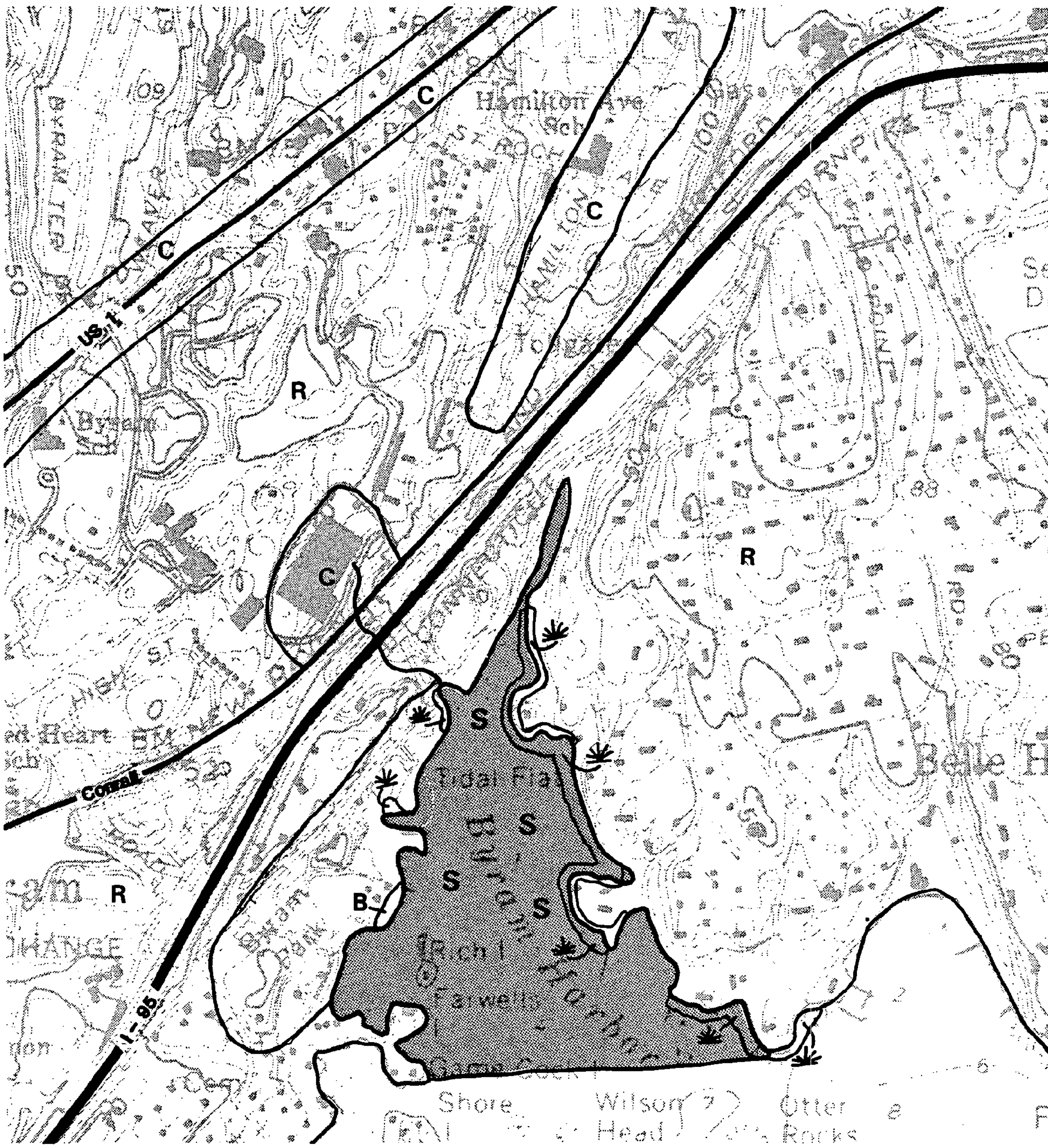
Additional Comments: Channel is both publicly and privately maintained. Minimum channel depth is reported to be 6 ft.(MLW), but is probably less than that now.

Source: NOAA National Ocean Survey Maps

Basin Hydrology

Regional Drainage Basin: Western Connecticut Coastal Basin
Embayment Basin Area: 1.6 square miles

Tributaries to Embayment: Tom's Brook



Scale: 1" = 1000'

FIG 20.1 BYRAM HARBOR ENVIRONMENTAL LAND USE

Legend:

- wetlands
- **A** agriculture
- **R** residential
- **C** commercial/ industrial
- **B** beach
- **M** marina
- **S** shellfish beds
- → public access

Constrictions to Tidal Flow and Circulation:

Structure	% Constriction	Distance from Mouth
Game Cock Rd. Causeway	75-100	At Mouth
Rich Island Seawall	-	At Mouth

Sources: U.S. Geological Survey, Connecticut Drainage Basin Gazeteer, 1981; Conn. Dept. of Environmental Protection

Water Quality Conditions

Upstream Water Quality Classification: B

Embayment Water Quality Classification: SB

Direct Discharges: None

Sewer Service Area and Discharge Point: The western side of Byram Harbor (Byram Shore) is sewered; however, the eastern shore (Belle Haven) is not. Treatment and discharge of sewage is at Grass Island in Greenwich Harbor.

Storm Sewer Outfalls: There are several storm sewer outfalls and residential drainpipes that discharge to the embayment.

Significant Non-Point Pollution Sources: Toms Brook drains through the town's sanitary landfill and then drains to Byram Harbor. There is a possibility that this surface water may become contaminated with landfill leachate as it passes through the landfill.

Shoreline and Bottom Conditions

Extent of Shoreline Modifications: Almost all of the western shore of the embayment has been filled and stabilized with seawalls. Seawalls line almost the entire length of Byram Park and continue north to the head of the harbor along residential shorefront. A filled causeway connects Game Cock Island to the mainland and constricts flow to and from Byram Harbor. The shorelines of Farwells Island and Rich Island are stabilized with seawalls. Large volumes of sand are dumped regularly on Byram Park beach. The eastern shoreline of the harbor is primarily bedrock, and low-lying segments have been filled and stabilized with heavy stone seawalls.

Significant Areas of Erosion: Byram Beach loses much of its sand to shoreline currents each year. The sand is transported out of the harbor and is believed to contribute to the sandy beaches and sandbars of the surrounding islands.

Shoreline and Bottom Conditions (con't)

Shoaling and Sedimentation Problems: The public marina in Byram Harbor is served with an estimated three to six foot channel (MLW), and the outer mooring area has at least six feet of water at low tide. The inner harbor area is quite susceptible to siltation and must be dredged periodically. Entrance to the Byram Harbor public marina can be difficult during unusually low tides.

Bottom Sediment Characteristics: The bottom sediment of Byram Harbor, except in the vicinity of the town beach, is predominately silty with a moderate organic content and some clay. This fine sediment is interspersed with small to medium sized rocks and some rock outcroppings.

Surrounding Lands

Maximum Basin Elevation:

Location	Height
Belle Haven (Field Point Rd.)	130 feet
Head of Byram Harbor (western shore)	50 feet
Byram Park	50 feet

Topography: The area exhibits moderately rolling terrain, becoming steeper towards the north.

The shore of Belle Haven has moderately steep slopes particularly toward the head of the harbor. Parts of Byram Park have very steep slopes, as these are almost sheer faces of ledge found in two areas of the park.

General Vegetation Characteristics: The eastern shore is moderately developed, with much of the natural vegetation replaced with landscaping. Most of the western side is a park with numerous trees, bushes and several ballfields.

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Charlton-Hollis	fine sandy loams	3-15	poor
Charlton-Hollis	fine sandy loams	15-40	very poor
Hollis-Rock Outcrop	complex	3-15	very poor
Hollis-Rock Outcrop	complex	15-35	very poor

Soils:

Name	Characteristics	Slope %	Developmental Drainage Suitability
Paxton	fine sandy loam	3-8	poor
Sutton	fine sandy loam	3-8	poor
Typic Udorthents	cut and fill	-	variable
Woodbridge	fine sandy loam	3-8	poor
Woodbridge	fine sandy loam	8-15	poor

Shellfish and Finfish Resources

There are no oyster beds in the harbor, but there are numerous clam beds, particularly near shore in the tidal and subtidal mud flats.

According to the town Conservation Commission staff, there are fish runs up the harbor in both spring and fall. Alewives are mentioned in particular, though it is generally known that winter flounder also run in the spring. Bluefish, striped bass, smelt, and porgies also frequent the area during the summer.

Wetlands

There are very few areas of tidal wetlands remaining in Byram Habor (See Figure 20.1). Most wetlands have been filled in the process of stabilizing the shoreline, or they have been eroded by increased wave reflection and refraction along the altered shoreline. Exceptions include small pockets of marsh along the Belle Haven shoreline; a few pockets in the public marina areas; and some larger wetland areas on the islands at the mouth of the harbor. The small pockets of marsh primarily function as habitat and a food source for birds and aquatic organisms.

Much of the development along the harbor is at least sixty years old. During the settlment of Belle Haven and Byram Shore, the glacial rocks of the areas were used to build extensive seawalls on former tidal flats and wetlands. These walls were then backfilled to reclaim land and expand property holdings. In several cases, islands were linked to the mainland with solid-fill causeways to permanently establish overland access.

Wetland filling in the Byram Harbor area has ceased since the late 1950's, and any subsequent loss has been the result of natural erosion. Natural erosion is expected to be the only cause of wetlands loss in the future.

Environmentally Sensitive Areas

The islands at the mouth of Byram Harbor constitute important habitat for birds, some mammals, and aquatic organisms. Those of particular value include Huckleberry Island, Shell Island, Calf Island and Bowers Island.

The islands near Byram Harbor are a special habitat because of their qualities of isolation from man and predators more commonly associated with the mainland. For example, birds nesting in the spring preceed the boating season and usually do not encounter much interference or competition for open space from man. The islands are also subject to less development pressure and still have their forests and coastal wetlands intact. Even several islands that were developed at one time have now been abandoned and are becoming partially or completely reforested.

B: Land Use Analysis

Current Shoreline and Water Use

Residents along the waterfront regularly use the water for swimming, boating, water skiing, and fishing. Many of the homes have docks and most of the homeowners have boats, either stored on their property or kept on moorings. The public marina, boatyard and beach in Byram Park expand these recreational opportunities to other Greenwich residents also (See Figure 20.1). Use of the park facilities is limited to town residents only.

Current Upland Use

Most of the land around Byram Harbor is residential, except for Byram Park and the conservation land of the surrounding islands. The houses along Belle Haven are typically very large, on lots of two acres or more. Byram Shore homes are more densely settled and range from quarter acre development up to two acres or more. The facilities of Byram Park are explained in greater detail in Subsection B-4.

Historical and Significant Land Use Changes

The Byram Harbor shoreline has been developed for at least 70 years, with some houses dating back to the mid-nineteenth century. Some residential infilling has occurred since then, primarily on the Byram Shore (west) side (See Figure 20.1). The most significant change in use has been the acquisition of property for Byram Park and its subsequent expansion in the 1970's. The other change has occurred on the islands. Both Huckleberry and Shell Islands used to have summer cottages and were actively used by a residential summer population. Today, all of the houses are abandoned, allowing the islands to partially or completely grow over with trees and dense ground cover. Birds and some mammals are now very dependent on this habitat for their survival.

Public Access and Recreational Opportunities

Byram Park, the most significant public access and recrea- tion area along the harbor, is part of the Greenwich Parks System and is available for use by all Greenwich residents. Aside from the marina, boatyard and beach, the park has tennis courts, softball and baseball fields, a swimming pool and a large cookout area. The marina consists of five long finger piers and is de- signed for small outboard boats. Large boats are typ- ically kept at the mouth of the harbor on moorings. The boatyard can handle all sizes of boats up to 50 feet, though most are under 30 feet. The beach is protected by lifeguards and offers changing rooms, showers, an outdoor pavillion, and a snack bar.

C: Problem Identification

Local Departments and Offices Consulted

Greenwich Inland Wetlands Agency
Greenwich Conservation Commission Staff
Greenwich Flood and Erosion Control Board
Greenwich Health Department

Response from Questionnaires and Local Meetings

Town officials indicated that saltmarsh loss was a major problem and fish loss was a moderate problem. Little was known about other potential problems such as pollution, siltation, erosion, eutrophication and circulation constriction.

The general consensus was that saltmarsh loss was a historic problem caused by man-made filling, and it is currently limited to loss from natural erosion. Fish loss is believed to be caused by man-made impacts from both upstream sources and local sources. Potential types of pollution that could be affecting finfish populations include surface runoff contaminated with pesticides and fertilizers, drainage from the town land fill, and chlorinators. Shellfish populations also appear to be on the decline. Changes are based on limited and in some cases conflicting information. The most significant impact to shellfish populations over the past 30 years has been the closing of town water to shellfishing in the late 1960's.

Results of Field Survey and Research

The field survey revealed very little in the way of major impacts to the environment or degradation of coast resources. Special effort was made to investigate the water quality of Tom's Brook, which flows through the town's sanitary landfill. The landfill has been closed down for the past several years, but there is a constant concern that leachate might be contaminating the brook.

Results of Field Survey and Research (con't)

The Greenwich Department of Health is responsible for testing the water quality of fresh and coastal waters. Laura Morrison of the Health Department indicated that Tom's Brook water quality has been sampled on several occasions for BOD, some nutrients and bacteria. In all cases, the testing results came out very low and did not warrant further concern by the town. She did admit, however, that to her knowledge the brook has never been sampled by the town for more sophisticated water quality parameters such as synthetic organic compounds and heavy metals. This type of sampling is conducted typically on drainage from landfills to determine whether the surface water is being contaminated by leachate. Without the more specific data described above, it is difficult to make any final conclusions on the brook water quality. Observation of the stream bed, however, did reveal the presence of an orange colored scum on rocks and gravel. No specific data is available on the components of this residue.

Recent wetlands loss in the embayment appears to be minor and is limited to the effects of erosion. According to surrounding residents, shellfish populations appear to have remained stable over recent years. Some residents believe that with the ban on shellfishing, populations may have actually increased over the past 10 years.

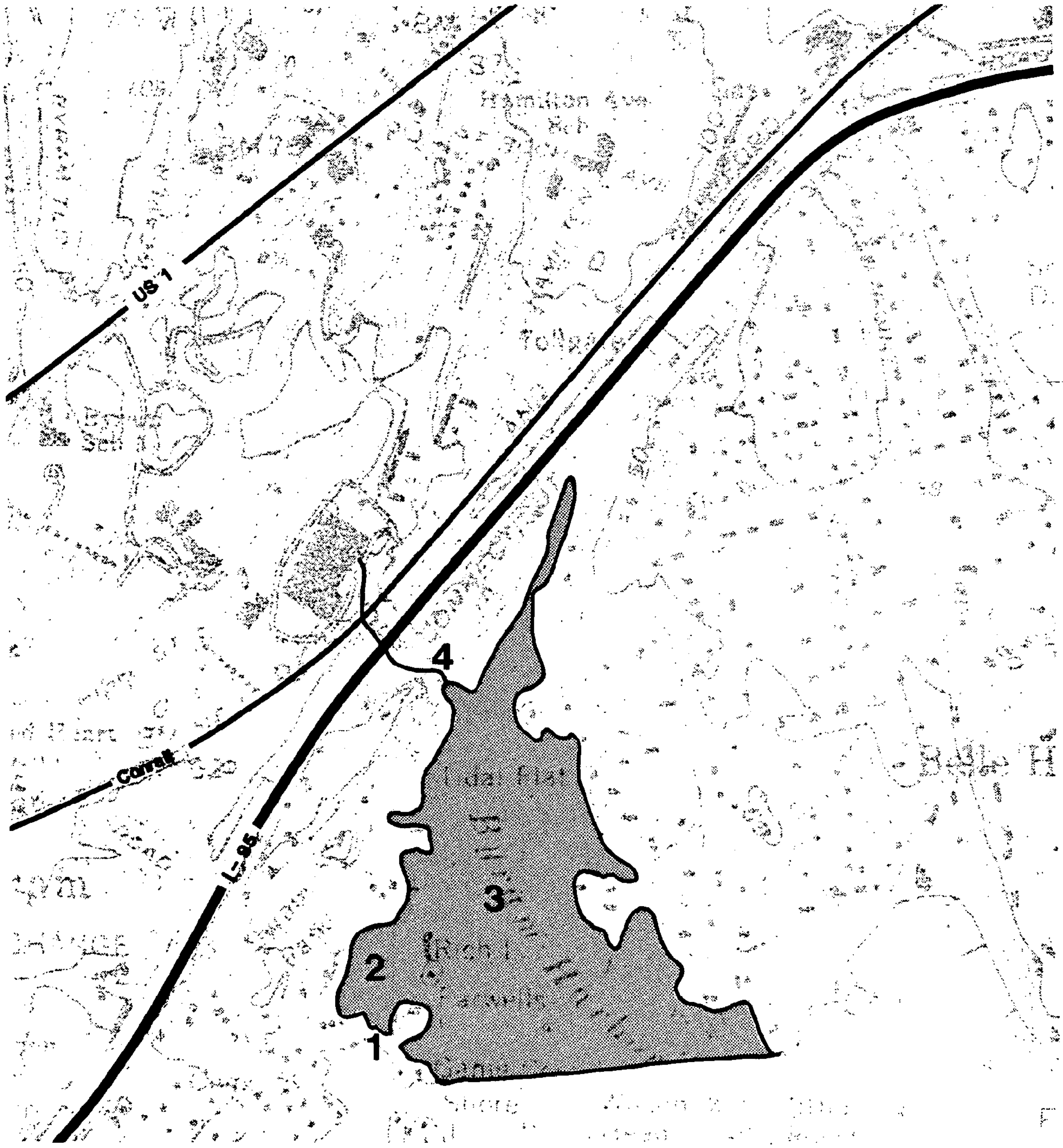
Wildlife habitat has certainly improved over the past 10 years. This is mainly due to the revegetation of islands that were formerly developed with houses. Several rare and declining species of birds that had never frequented the area before are now often seen. This trend is expected to continue as partially forested islands become completely reforested.

Water quality in Byram Harbor is expected to improve as houses along Byram Harbor Shore tie in to a new sewer that was just recently completed in that area. Many homes currently have faulty septic tanks, or, in some cases, antiquated chlorinators which signficantly degrade local water quality. Controlling these problem areas should decrease the BOD loading on nearshore waters and eliminate much of the bacterial contamination.

D: Problem Analysis

Water Pollution

The water quality of Tom's Brook, the largest tributary to Byram Harbor, has relatively low BOD, nutrient and bacterial levels. Little is known, however, about its quality with respect to heavy metals and synthetic organic compounds. These two parameters are of particular concern, because the brook flows through the town's former sanitary landfill. Leachate from the landfill may be contaminating surface waters with heavy metals and synthetic organic compounds.



Scale: 1" = 1000'

FIG 20.2 BYRAM HARBOR ENVIRONMENTAL PROBLEMS

Problem Areas

1. Filled land constricts tidal circulation
2. Moderate siltation of harbor
3. Closed to shellfishing
4. Drainage from town landfill

Water Pollution (con't)

According to the town Health Department, Byram Beach is periodically closed (1-4 days each summer) due to high bacterial levels, in part due to the area's failing septic tanks and chlorinators. Chlorinators are particularly damaging to the aquatic environment because the treated wastes generate high BOD and the chlorine kills marine life. A new sewer line has recently been installed along Byram Shore to tie in coastal homes. This should eliminate most of the substandard treatment that generates the bacterial contamination and chlorine wastes. Elimination of this pollution should result in improved water quality conditions in Byram Harbor.

Habitat

Wildlife habitat in the Byram Harbor area has steadily improved with the revegetation of formerly developed islands. These islands serve a special function by providing isolated habitat during most of the year. The islands are particularly valuable as shore bird nesting sites and as habitat for some mammals. The shoreline currently supports tidal wetlands which are a valuable food source to birds and protective habitat for juvenile fish and other marine organisms. The quality of the habitat is expected to improve over the next ten years as revegetation continues.

Saltmarsh Loss

The majority of saltmarsh loss around Byram Harbor is due to past shoreline filling and stabilization. Most of the activity dates back to before World War II. Saltmarsh loss since then has been primarily caused by natural coastal erosion. Little documentation is available on the extent of this loss over the past thirty years. It is generally believed that the two areas that have experienced significant loss are Calf Island and the head of Byram Harbor (See Figure 20.2).

Siltation

Most of the large scale shoreline modifications in Byram Harbor predate World War II, so current patterns have not changed significantly for at least the past 35 years. Prior to the 1950's, the most dramatic impact on current patterns was caused by the construction of a solid fill causeway to Game Cock Island and the fill and seawall construction around Farwells and Rich Islands. Tidal flushing of the Byram Park Marina area from the west was cut off by the Game Cock Island causeway, and fill and seawalls constricted the exchange through the remaining inlets.

The impact of increased tidal constriction has been to create a settling basin out of the marina area. the numerous pilings holding the floating finger piers in place also tend to slow down tidal flow, thus encouraging suspended solids to settle out. Consequently the town periodically dredges the marina to permit unobstructed navigation for small crafts (under 25 feet).

Siltation
(con't)

The remainder of the embayment outside of the enclosed marina area is subject to scouring and periodic re-suspension of bottom sediment. This more open area does not readily accumulate silt and is rarely dredged.

PROBLEM SUMMARY

Byram Harbor

1.	Water pollution	Minor	(b)
2.	Saltmarsh loss	Moderate	(b)
3.	Siltation	Moderate	(b)

KEY: (a) Conditions becoming worse (b) No change (c) Conditions improving

CHAPTER 21 EMBAYMENT PROBLEM CATEGORIES AND RANKINGS

INTRODUCTION

The preceeding chapters have presented the results of research and field work for 35 embayments along the coast of Connecticut. The environmental problems of each embayment have been identified, and their cause, severity, and trends identified. These data were summmarized at the end of each chapter, and will be reviewed in the following text. The discussion will include the development of problem categories, and the general character/distribution of coastal environmental problems.

Development of Problem Categories

Discussions with DEP/Planning and Coordination/Coastal Area Management staff and town environmental officials revealed a wide range of site-specific problems present in each embayment. Problems ranged from beach and marsh loss to water and shellfish contamination. The defined problems tended to be more use/development oriented at the community level, while at the state level, concerns tend to focus on more general environmental issues. Exposure to this range of concerns gave our staff an opportunity to categorize major problem types along the coast. These categories include the following:

- Erosion
- Siltation
- Eutrophication
- Wetlands Loss
- Fish and Shellfish Loss
- Water Pollution
- Flow Restriction

Although these categories may exclude a few peripheral issues, they cover virtually all of the serious environmental concerns identified in this study.

The Character and Distribution of Coastal Problems

The type, severity, trend and cause of all embayment problems has been listed on Tables 21.1 and 21.2. A review of these data leads to the following observations on problem character and distributions.

Erosion

Because of the protected/low velocity environments of most embayments, bank erosion and beach erosion are not major concerns. Where the problem does exist, it is most commonly caused by human activities and use impacts (wave reflection, boat wakes, dredging, etc.). There is no apparent distributional bias of erosion problems along the coast.

Table 21.1

EMBAYMENT PROBLEM TYPE, SEVERITY, AND TREND

Name	Problem Type						
	Erosion	Siltation	Eutrophication	Wetland Loss	Fin/Shellfish Loss	Pollution	Flow Constriction
Wequetequock	-	2a	-	-	-	2b	1b
Quiambog	-	2a	3b	-	-	3b	-
West Cove	-	1b	-	-	-	-	2b
Palmer's Cove	-	3b	-	-	-	2b	1b
Mill Cove	-	2b	-	-	-	2a	2b
Poquetanuck	-	1b	1c	-	-	-	2b
Smith Cove	2b	1a	--	-	-	2c	1b
Keeney Cove	-	2b	-	-	-	2b	-
Smith's Cove	-	2a	3b	-	-	2c	2b
Niantic River	-	2a	-	-	-	2c	2b
Fourmile River	-	2a	3b	-	-	2a	3b
Middle Cove	2b	2b	-	-	-	2b	2b
Indiantown	3b	2b	-	-	-	3b	3a
Menunketesuck	2a	2a	-	-	-	2a	3b
West River	1a	1a	-	-	-	2b	1a
Little Harbor	-	1a	-	-	-	-	2b
E. Haven River	3b	2a	-	2b	-	2c	2c
Pattaconck	-	1b	-	-	-	3b	1b
Mill River	-	1b	1b	-	-	1b	2b
Gulf Pond	-	3a	-	-	-	2b	1b
Wepawaug	-	2b	-	-	-	2b	-
Marine Basin	-	3b	-	-	-	2a	-
Lewis Gut	-	-	-	1a	-	2a	2b
Frash Pond	-	3b	-	2a	2b	3b	1b
Ash Creek	-	-	-	-	-	2b	2b
Mill River	-	-	-	-	2b	1b	3b
Horse Tavern	-	-	-	2a	-	-	1a

Table 21.1 (Continued)

EMBAYMENT PROBLEM TYPE, SEVERITY, AND TREND

Name	Problem Type						
	Erosion	Siltation	Eutrophication	Wetland Loss	Fin/Shellfish Loss	Pollution	Flow Constriction
Bermuda Lagoon	3a	-	-	-	2b	2b	-
Gray's Creek	-	2a	-	-	-	2b	-
Canfield Island	2a	2a	-	2a	-	-	-
Mill Pond	2a	1a	-	-	-	-	1b
Village Creek	-	2a	-	1a	-	-	-
Holly's Pond	-	-	-	-	-	2a	1b
Gorham's Pond	2a	-	-	-	-	-	2b
Byram Harbor	-	2b	-	3b	-	1c	-

Table Symbols

1 = Severe 2 = Moderate 3 = Minor

a = Conditions Worsening, b = Conditions Stable, c = Conditions Improving

Table 21.2

EMBAYMENT PROBLEM CAUSES

Embayment	Problem						
	Erosion	Siltation	Eutrophication	Wetland Loss	Fin/Shellfish Loss	Pollution	Flow Constriction
Wequetequock	-	7,8	-	-	-	25,26,29	36
Quiambog	-	8,10	-	20	-	25,26,29	-
West Cove	-	11	-	-	-	-	38
Palmer's Cove	-	8	-	-	-	25,26,30	36,37
Mill Cove	-	7,8-	-	-	-	25	36,37
Poquetanuck	-	8	15	-	-	-	36
Smith Cove	2	9,8	-	-	-	25,28,32,33	36,37
Keeney Cove	-	8	-	-	-	25,26,32	-
Smith's Cove	-	8,12	15	-	-	25	44
Niantic River	-	8,9	-	-	-	25,26,32	36,37
Fourmile River	-	11	15	-	-	32	36,37
Middle Cove	4,5,6	10	-	-	-	26	44
Indiantown	6	7	-	-	-	25,26	45
Menunketesuck	2,4	11	-	-	-	25,26,31	37
West River	1	10,11	-	-	-	25,28	39
Little Harbor	-	11	-	-	-	-	38
E. Haven River	-	8,11	-	18	-	25,31,35	40
Pattaconk	-	8,14	-	-	-	25,26	36,37
Mill River	-	8,9	15	-	-	27,29,34	39,41
Gulf Pond	-	7	-	-	-	29	36,37
Wepawaug	-	8	-	-	-	26,29	-
Marine Basin	-	8,11	-	-	-	26,29,32	-
Lewis Gut	-	-	-	18	-	29,35	39

Table 21.2 (continued)

EMBAYMENT PROBLEM CAUSES

Embayment	Problem						
	Erosion	Siltation	Eutrophication	Wetland Loss	Fin/Shellfish Loss	Pollution	Flow Constriction
Frash Pond	-	8	-	17	21,22	26	40
Ash Creek	-	-	-	-		27,29,30	39,40
Mill River	-	-	-	-	21	25,29,34	36,37,42
Horse Tavern	-	-	-	18	-	-	40
Bermuda Lagoon	-	-	-	16	23,24	25,26	-
Gray's Creek	-	8,9,10,11	-	-	-	27	-
Canfield Island	1	10,11	-	17,20	-	-	-
Mill Pond	1,2,3	7	-	-	-	-	43
Village Creek	-	8,11	-	17	-	-	-
Holly's Pond	-	-	-	-	-	26,29	42
Gorham's Pond	-	8,9	-	-	-	-	42
Byram Harbor	-	7,10	-	16,20	-	25,32	-

Table 21.2 (continued)

Problem Cause Categories

Erosion

1. Wave Attack
2. Bank Undermining; Natural
3. Bank Undermining; Man-caused
4. Boat Wakes
5. Dredging Impacts
6. Wave Reflection

Siltation

7. Constriction
8. Upland Erosion
9. Bank Erosion
10. Current Transport
11. Wave Transport
12. Earlier Land Use
13. Development
14. Deteriorating Bulkheads

Eutrophication

15. Water Pollution

Wetland Loss

16. Riverine Erosion
17. Filling
18. Tide Gates/Flushing Restrictions
19. Wake Erosion
20. Wave Attack

Fin/Shellfish Losses

21. Pollution
22. Tide Gates
23. Septic Failure
24. Natural Conditions

Pollution

25. Septic Failure
26. Residential Runoff
27. Urban Runoff
28. Agricultural Runoff
29. Point Discharge
30. Marina Spills
31. Boat Discharges
32. Leachate from Landfills
33. Fly Ash Erosion
34. Contaminated Bottom Sediment
35. Transport from Other Areas

Flow Constriction

36. Rail Road Causeway
37. Bridge
38. Jetty/Groin
39. Natural Bar Formation
40. Tide Gates
41. Marsh Filling
42. Dam
43. Culvert
44. Natural Form
45. Filling

Siltation

Siltation is a pervasive problem in most areas studied. The primary sources appear to be from wave/current transport out of Long Island Sound and erosion/riverine transport from upland areas. The frequency of problems tied to upland erosion suggests that developmental land use controls might be appropriate. Siltation is most common along the eastern half of the coastline, probably due to increased developmental activities over the past 20 years. There is also some tendency towards slightly lower local relief and lower Long Island Sound transport capabilities around the western embayments.

Eutrophication

Eutrophication problems are difficult to see and document, but do not appear to be as frequent as siltation problems. There is no apparent trend or bias in the frequency or location of problem sites.

Wetland Loss

Wetland losses are occurring in response to combinations of human activities and natural process, including wave attack, boat wakes, filling, etc. Virtually all of the impacted areas identified in the study occur in the western embayments (Stratford to Greenwich), suggesting that shorefront land development and water use pressures may be contributing to marsh losses.

Fin/Shellfish Loss

Large portions of the state shellfish beds have been closed because of contamination. Inspection of the pollution data indicates that most of the studied embayments have one or more significant sources of pollution that might impact both fin and shellfish populations. Population loss of fish indicated extremely poor environmental conditions for fish life, and appear to be present only in the western embyaments. This is probably due in part to heavier population and industry concentration leading to the kills.

Pollution

Water pollution problems are common to most of the studied embayments. Some of the more common problems include spetic tank leakage and non-point runoff. Although there are exceptions, the eastern embayments tend to exhibit development-related pollution problems, while the western embyaments exhibit more frequent urban-industrial pollution problems. In most cases, current pollutant sources are creating the problem, but in a few cases, past episodes have contaminated bottom sediments.

Flow Constriction/ Restriction

These are common throughout the coastline. The most common source of constriction/restriction is the Conrail System, which operates rail service over a large number of causeways. Various road and highway bridges also act to reduce flow and circulation. Other restrictions include dams, jetties, filling, and natural bar development. There is no apparent bias in the location of the various constrictions/restrictions to flow.

Summary

The general types of environmental problems have been identified for a range of embayments along the coast. The severity, trend, and cause(s) of each problem have also been identified, and the general condition of the coastal environment has been briefly summarized in the preceeding text. The next phase of the study (to be presented in a separate volume) will suggest various structural and non-structural measures that could be used to approach the problems. This presentation will consider approximate costs, benefits, and general impacts created by implementing recommended option.