Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS & SCIENTISTS

Town of Falmouth, Massachusetts

Final
Needs Assessment Report
for
Wastewater Facilities Planning Study

MAY, 1999

Recycled Paper

Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS & SCIENTISTS

May 18, 1999

Mr. Raymond A. Jack, Utilities Manager
Department of Public Works
59 Town Hall Square
Falmouth, Massachusetts 02540

Re: Wastewater Facilities Planning Project
Final Needs Assessment Report
Stearns & Wheler No. 80284.0

Dear Mr. Jack:

In accordance with the approved Wastewater Facilities Plan Scope of Work, Stearns & Wheler has prepared the attached Final Needs Assessment Report for your review. The Needs Assessment Report documents the existing and future conditions for the centralized wastewater facilities in the planning areas. The report summarizes the wastewater needs to be addressed in the next two phases of the Wastewater Facilities Planning Project.

This report is being sent to the agencies indicated on the attached distribution list. These agencies are requested to review the report and send any questions or comments on the report to Stearns & Wheler at our Hyannis Office.

A public hearing has been planned by the Cape Cod Commission, on this portion of the Wastewater Facilities Planning Project, for June 10, 1999 at 3:00 p.m. in the Falmouth Town Hall, Selectmen's Meeting Room.

Please feel free to contact us if you have any questions about this report or any part of the Wastewater Facilities Planning Study.

Very truly yours,

Stearns & Wheler, LLC

Nathan C. Weeks

Nathan C. Weeks, P.E.
Senior Project Manager

Wayne C. Perry

Wayne C. Perry, P.E.
Associate

CC: Distribution List

100 West Main Street
Post Office Box 975
Hyannis, Massachusetts 02601
(508)790-1707 Fax (508)790-2707

WASTEWATER FACILITIES PLANNING STUDY
TOWN OF FALMOUTH, MASSACHUSETTS

Needs Assessment Report

Distribution List

A copy of the Needs Assessment Report has been sent to the following:

Secretary of Environmental Affairs
100 Cambridge Street - 20th floor
Boston, MA 02202
Attention: MEPA Unit

Department of Environmental Protection
One Winter Street
Boston, MA 02108
Attention: R. Lyberger

DEP/Southeastern Regional Office
20 Riverside Drive
Lakeville, MA 02347
Attention: B. Dudley

Massachusetts Historical Commission
Achieve Building
220 Morrissey Blvd.
Boston, Massachusetts 02125

Cape Cod Commission (six copies)
3225 Main Street
Barnstable, MA 02630
Attention S. Korjeff

Falmouth Utilities Department (seven copies)
59 Town Hall Square
Falmouth, MA 02540
Attention: R. Jack

Buzzards Bay Project
2870 Cranberry Highway
East Wareham, MA 02538
Attention: J. Costa

Coastal Management
100 Cambridge Street - 20th Floor
Boston, MA 02202

DEP/Southeastern Regional Office
20 Riverside Drive
Lakeville, MA 02347
Attention: MEPA Unit

USEPA, Region One
JFK Federal Building, CMA
Boston, MA 02203
Attention: B. Rosinoff

Division of Marine Fisheries
50A Portside Drive
Pocasset, MA 02559
Attention: J. Mendes

Falmouth Pond Watchers
Center for Marine Science and Technology
University of Massachusetts - Dartmouth
New Bedford, Massachusetts 02744

Falmouth Planning Office
59 Town Hall Square
Falmouth, MA 02540
Attention: B. Currie

Falmouth Natural Resources Department
59 Town Hall Square
Falmouth, MA 02540

Falmouth Public Library
750 Main Street
Falmouth, MA 02540
Attention: Reference Department

Falmouth Administrator's and Selectmen's Office
59 Town Hall Square
Falmouth, MA 02540
Attention: P. Boyer

Falmouth Health Department
59 Town Hall Square
Falmouth MA 02540
Attention: D. Carignan

J:\80284fal\Reports\Needs Assessment Report\DISTRIB3.doc

WASTEWATER FACILITIES PLANNING STUDY
NEEDS ASSESSMENT REPORT
TOWN OF FALMOUTH, MASSACHUSETTS

Prepared for

TOWN OF FALMOUTH, MASSACHUSETTS

Prepared by

Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS & SCIENTISTS
100 West Main Street, P.O. Box 975
Hyannis, Massachusetts 02601

April 1999

Project No. 80284

ACKNOWLEDGEMENTS

This Needs Assessment Report was produced through the joint efforts of Stearns & Wheler and the Town of Falmouth. Stearns & Wheler appreciates the assistance and valuable contributions made by the staff of the Town of Falmouth Department of Public Works, Utilities Division, Engineering Division, Wastewater Treatment Facility, Planning Department, Health Department, Natural Resources Department and Data Processing Department. We would like to acknowledge the following individuals who contributed to this report and study.

Raymond Jack and Kenneth Ventura of the Utilities Division who answered many questions and provided background on the Town's water and wastewater system.

George Calise and Saeed Kashi of the Engineering Division who provided insight and documents on previous engineering studies.

William Owen of the Department of Public Works who provided insight and construction costs for the existing wastewater facilities.

Robert White of the Falmouth Wastewater Treatment Facilities who provided insight, operations data, previous reports, site visits to the wastewater facilities, and much operational information.

Brian Currie and Wayne Dick of the Planning Department who provided GIS data and mapping, reports on previous planning efforts, and insight into future conditions in the Town and the planning areas.

David Carignan and Robyn Hendricks of the Health Department who provided data, background and insight on wastewater related health problems in the Town and in the planning areas.

Paul Montague of the Natural Resources Department, who provided data, records and details on shellfish closures and water quality in the Town's harbors and embayments.

George Trudeau of the Data Processing Department who created computerized data on the Town's properties, assessments, water consumption, land use, etc.

We would also like to acknowledge the following agencies that provided valuable data and insight for this report and study.

Cape Cod Commission who provided GIS data and mapping, technical information on the West Falmouth Harbor Watershed and assistance on the overall review process.

University of Massachusetts at Dartmouth, CMAST who provided documents of previous research in Falmouth and gave details for on-going research in the West Falmouth Watershed.

United States Geologic Survey who supplied documents and maps of groundwater modeling and groundwater elevation measurements in western Cape Cod.

Massachusetts DEP who provided file documents on Falmouth and assistance on the overall review process.

TABLE OF CONTENTS

Wastewater Facilities Planning Study
Needs Assessment Report
Town of Falmouth, Massachusetts

CHAPTER 4 TOWN-WIDE EXISTING CONDITIONS

CHAPTER 5 EXISTING CENTRALIZED FACILITIES

CHAPTER 6 EXISTING AND FUTURE CONDITIONS IN PLANNING AREAS

CHAPTER 7 NEEDS ASSESSMENT SUMMARY

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Appendix

EXECUTIVE SUMMARY
WASTEWATER FACILITIES PLANNING STUDY
NEEDS ASSESSMENT REPORT
TOWN OF FALMOUTH, MASSACHUSETTS

BACKGROUND

The Town of Falmouth is performing this Wastewater Facilities Planning Study (Study) to provide a comprehensive strategy for wastewater treatment and disposal issues for the next 20 years. The Study is meant to be consistent with the Town's Local Comprehensive Plan, which demonstrates a consistent goal that the Town protect its natural resources and provide a year-round economic base for its residents.

This Needs Assessment Report completes the first of three phases of the Wastewater Facilities Planning Study. The Needs Assessment provides the framework and necessary background information to complete the second phase of the Study where alternatives to remedy wastewater problems will be developed and evaluated (screened) for overall feasibility. The last phase of the Study will consist of detailed cost evaluation and environmental impact analysis of feasible alternatives, and a recommended plan of action.

The Needs Assessment Report utilized existing information and future estimations of land use, populations, and water usage to project future wastewater flows and loadings for the design year 2023. Wastewater issues and specific problem areas of the Town were identified and evaluated. Regulatory requirements and the Town's goals relating to wastewater management and growth management were incorporated into the Study.

A joint regulatory review process with the Massachusetts Executive Office of Environmental Affairs, MEPA Unit and the Cape Cod Commission has been initiated for the Study. An Environmental Notification Form and a Development of Regional Impact document were prepared and submitted to these two regulatory agencies for their review and comment. A public hearing was held at the Falmouth Town Hall on February 2, 1999 to discuss the Study and receive public comment on these two documents. This review resulted in the February 22, 1999 Certificate of the Secretary of Environmental Affairs, which accepted the project scope with few comments.

WASTEWATER PLANNING HISTORY

A Wastewater Facilities Plan was last completed for Falmouth in August 1981 focusing on an aging wastewater collection and discharge system in Woods Hole, including an ocean outfall at Woods Hole, and wastewater problems in densely developed portions of Falmouth Center, Falmouth Beach, Falmouth Heights, and the Maravista area. Recommendations of the 1981 Wastewater Facilities Plan were approved by the Town, and the following centralized wastewater facilities were implemented.

- Construction of the Falmouth Wastewater Treatment Facility (WWTF) located off Blacksmith Shop Road in West Falmouth.

- Construction of the Jones Palmer Pumping Station to collect wastewater from several areas of Town and pump it to the Falmouth WWTF.

- Elimination of the Woods Hole ocean outfall and construction of the Woods Hole Pumping Station to pump the collected wastewater to the Jones Palmer Pumping Station and ultimately to the Falmouth WWTF.

- Expansion of the Woods Hole wastewater collection system to collect wastewater from portions of Gardner and Park Roads, and construction of the Gardner Road Pumping Station to pump the collected wastewater to the Woods Hole Pumping Station, and ultimately to the Falmouth WWTF.

- Repairs to the Woods Hole collection system to reduce groundwater infiltration to the system.

- Construction of sewers along Main Street and the Shivericks Pond Pumping Station to collect wastewater and discharge it to Jones Palmer Pumping Station, and ultimately to the Falmouth WWTF.

- Construction of sewers in the Falmouth Beach Area and the Falmouth Beach Pumping Station to collect wastewater and discharge it to Shivericks Pond Pumping Station, and ultimately to the Falmouth WWTF.

- Construction of sewers along East Main Street, Davis Straits Road, and Scranton Avenue, and construction of the Falmouth Inner Harbor Pumping Station.

The Town's collection system has been slightly extended in past years to collect additional wastewater flow since implementation of these facilities.

The 1981 Wastewater Facilities Plan also recommended that portions of Falmouth Heights and Maravista be sewered approximately ten years after Falmouth Center was sewered. These areas are densely developed. Portions of these two areas are in the 100-year flood zone and at low elevations where the groundwater is close to the surface. The Maravista area is adjacent to Little Pond and Great Pond. Both of these ponds have water quality problems that have been attributed to wastewater impacts.

FALMOUTH WASTEWATER TREATMENT FACILITY (WWTF)

The Falmouth WWTF is located in West Falmouth off Blacksmith Shop Road east of Route 6. On average, it receives and treats 433,000 gallons per day (gpd) of wastewater from the centralized collection system and 28,000 gpd of septage from all of Falmouth. It utilizes an aerated pond treatment system, and effluent sand beds and spray irrigation fields for effluent disposal into the ground. The treatment system works well, and it has consistently met its effluent discharge permit from the Massachusetts Department of Environmental Protection (DEP). The treatment system was not designed to provide advanced nitrogen removal (treatment to less than 10 parts per million total nitrogen), which is typically required for all treatment plants that have groundwater discharge permits.

The effluent discharge beds have performed poorly ever since they were built. The original five beds were designed at a hydraulic loading rate of 3 gallons per day per square foot (gpd/ft.^{2}). Several investigations since construction have indicated actual infiltration rates of 0.7 to 1.4 gpd/ft.^{2}. Three additional discharge beds were constructed in 1995. The total capacity of the discharge beds has been assessed at 0.41 mgd based on an average infiltration rate of 1.1 gpd/ft.^{2}.

An average capacity of the spray irrigation area has been assessed at 0.5 mgd based on the design spray irrigation loading of 2 inches per acre per week.

The combined discharge capacity of the discharge beds and spray irrigation areas is 0.91 mgd. This capacity may need to be increased, especially in the winter when the spray irrigation system is not operated, if the Falmouth WWTF is expanded to treat additional flow from the areas of Town that need to connect to the centralized collection system.

CENTRALIZED WASTEWATER COLLECTION SYSTEM.

The centralized wastewater collection system (collection system) is comprised of approximately seven miles of gravity collection pipe, six municipally operated pumping stations, and approximately 8.8 miles of force main, which is a pressurized sewer that delivers wastewater from a pumping station to the Falmouth WWTF or another point in the collection system. The collection system collects wastewater from the following areas:

- Woods Hole,
- Main Street,
- Falmouth Beach, and
- Davis Straits and Inner Harbor Area.

Most of the collection system was constructed in 1986 though most portions of Woods Hole were sewered in 1949.

The collection system operates well, and has sufficient capacity for the existing wastewater flows.

Analysis of water consumption in the sewered areas and analysis of the wastewater flows to the Falmouth WWTF indicates there is some extraneous flow in the collection system. This flow is groundwater infiltration into gravity collection pipes and manholes, and/or inflow to the gravity collection system from building sump pumps, catch basins, or roof leaders and is collectively called infiltration and inflow (I/I). Most of this I/I is suspected to be entering the system in Woods Hole through the older gravity collection pipes. It is noted that this quantity of I/I is not considered excessive by Massachusetts DEP criteria for a collection system of this size. Never the less, the Town should take efforts to inspect the sewers regularly and prevent I/I from occurring. Also, sewered users should

be notified that basement sump pumps and roof leaders should not be connected to the sewer.

WASTEWATER PROBLEMS IN TOWN PLANNING AREAS

Several planning areas have been identified for this Study, and the wastewater problems have been prioritized for these areas.

A. Falmouth High School. Falmouth High School is considered in this Wastewater Facilities Planning Project as a Planning Area because of its location in the Long Pond Watershed Protection District and its high wastewater design flow. It is located north of Brick Kiln Road and approximately one-half mile northeast of Long Pond.

The High School has a current Title 5 flow of 25,000 gpd based on a current student population of 1,250. This flow exceeds the Title 5 regulation limit of 10,000 gpd for septic systems designed after 1995 and 15,000 gpd for all other systems. Because this system exceeds this threshold and is located inside the Long Pond Watershed Protection District, DEP may require that the property apply for a groundwater discharge permit or connect to the Falmouth Wastewater Treatment Facility.

B. West Falmouth Harbor Watershed Planning Area. As the name implies, this Planning Area is the watershed area to West Falmouth Harbor that contributes groundwater into the Harbor. Nitrogen loading in the watershed from the Falmouth WWTF, Falmouth Landfill, old septage lagoons located at the landfill, individual septic systems, lawn fertilizer, and storm runoff have caused water quality impacts to Snug Harbor and Oyster Pond. Nitrogen removal and other remediation alternatives will be evaluated in the next two phases of this Project to reduce nitrogen loading to these two areas of West Falmouth Harbor.

C. Woods Hole Planning Area. The Woods Hole Planning Area is made up mostly of sewered properties. The main focus of future evaluations in this area will be a potential sewer extension to allow properties on Juniper Point to connect to a sewer. The collection system has capacity to handle existing wastewater flows in this area, and is working well.

D. Main Street and Falmouth Beach Planning Areas. These Planning Areas are made up of mostly sewered properties. A few properties in each area are not connected and are expected to connect during the next 20 years. The collection system has sufficient capacity to handle the existing wastewater flows and the future flows that will occur from connecting these unsewered properties.

E. Davis Straits/Inner Harbor Planning Area. This Planning Area extends from the intersection of Davis Straits and Maravista Avenue south to Clinton Avenue. It extends west along Jones Street to the Quality Inn and east to the commercially zoned properties of Worcester Court.

The non-sewered area along Davis Straits and Worcester Court is included in the Planning Area because this area is zoned commercial and has a high concentration of commercial properties that have high wastewater flows. Also, based on Board of Health records, two properties, Tataket Square and Admiralty Inn have frequent septic system pumping and have experienced problems with their septic systems. The Admiralty Inn has expressed an interest to connect to the collection system, and may be forced by DEP to install its own advanced treatment system if it can not connect. The Falmouth Mall is located in this area, and has expressed desire to be connected to the Collection System. The Falmouth Housing Authority, James Conley Apartments, has a high Title 5 design flow, and may need to connect to the collection system in the future if it plans to expand. This area is where much of the Town's commercial activity occurs and is promoted through the existing zoning. Centralized collection facilities are needed to support this commercial activity.

The Planning Area extends west along Jones Street to include the Lawrence School that was recently connected to the collection system. The next property to the west is the Quality Inn, which has a high water consumption and had its septic system pumped frequently. The property has significant wetland area, and groundwater is expected to be close to the ground surface.

Several of the commercial properties at the middle and southern end of Scranton Avenue have connected to the Collection System via a gravity sewer extension, and with individual pumping stations connected to a force main in the road. A commercial property located at the east end of Clinton Avenue has investigated connection to the centralized collection system.

The properties along Clinton Avenue are large and generally have sufficient space to construct Title 5 systems, as their existing systems need to be upgraded. Only one property on this street is suspected of septic system problems, and this is a commercial property at the east end of the avenue that has minimal land for a Title 5 system.

F. Falmouth Heights and Maravista Planning Areas. These two Planning Areas are evaluated in this Project because they were designated as Phase 2 sewer areas in 1981 as part of the previous Wastewater Facilities Plan, and scheduled for sewering approximately ten years after the Phase 1 sewering of Davis Straits, Inner Harbor, Main Street, Falmouth Beach and Woods Hole. These areas have not been sewered, yet.

These areas are located a long distance from the existing collection system, and would contribute a large wastewater flow to the Falmouth WWTF if they were sewered. Sewering these areas would be expensive. These areas have high usage in the summer and minimal usage in the winter.

The highest priority areas in these areas are the low elevation areas along the Vineyard Sound coast, Inner Harbor, and Little Pond. These areas are in the 100-year flood zone.

G. Prioritization of Planning Areas. The following list prioritizes the planning areas (and subareas of planning areas) with respect to wastewater needs. The highest priority areas are listed first.

1. Falmouth High School, which is located in the Long Pond Water Protection Area, and has a high Title 5 design flow.

2. West Falmouth Harbor Watershed Planning Area and the Falmouth WWTF discharge, which is impacting water quality in Snug Harbor.

3. Unsewered portions of Davis Straits and Jones Road where commercial properties have high wastewater flows and Town Zoning has been established to site commercial development.

4. Unsewered areas of Scranton Avenue, which have commercial properties that need to connect to the collection system.

5. Unsewered areas of Woods Hole on Juniper Point.

6. Low elevation areas in Falmouth Heights and Maravista.

7. Other areas in Falmouth Heights and Maravista.

8. Existing portions of the centralized collection system at Main Street, Davis Straits, and Inner Harbor that may need to convey additional wastewater to the Falmouth WWTF if the collection system is extended.

9. Falmouth Beach Planning Area, which may need an inspection for properties with sump pumps contributing to I/I.

10. Clinton Street Planning Area, which is at low elevations but has large properties that can accommodate new Title 5 systems when their existing systems need to be updated.

NO ACTION ALTERNATIVE

Under the "No Action Alternative" future wastewater treatment and disposal would continue at the Falmouth WWTF with an approximate 15 percent flow increase due to unsewered properties connecting to the collection system (infilling) and increased land use in the sewered areas. Snug Harbor and Oyster Pond would continue to have impacted water quality due to high nitrogen loading in their respective watersheds.

Existing substandard on-site systems would be upgraded to the standards of Title 5 and local Board of Health regulations. The Falmouth High School and several commercial properties would need to obtain groundwater discharge permits because their wastewater flows exceed the flow limits specified in the Title 5 Regulations. This means that they would need to construct their own advanced treatment systems.

NEXT STEPS TO IDENTIFY SOLUTIONS FOR WASTEWATER NEEDS.

The Needs Assessment Report documents the first third of the Project. The next phase of the Project will identify and screen centralized, decentralized, and on-site wastewater technologies and solutions for the planning areas and centralized facilities. These technologies and solutions will be described, and advantages and disadvantages will be summarized. Infeasible technologies and solutions will then be eliminated from further evaluation. The third phase will evaluate the feasible technologies and solutions in detail, and present the Recommended Wastewater Facilities Plan.

GLOSSARY OF COMMON ACRONYMS

ACEC	Areas of Critical Environmental Concern
ANGB	Air National Guard Base
A-Zones	Floodway areas designated by FEMA
BOD	Biochemical Oxygen Demand
BOH	Board of Health
CCC	Cape Cod Commission
CDM	Camp Dresser & McKee
CFR	Code of Federal Regulations
CMR	Code of Massachusetts Regulations
CMAST	Center for Marine Science and Technology
COD	Chemical Oxygen Demand
CZM	Coastal Zone Management
DCPC	District of Critical Planning Concern
DEIR	Draft Environmental Impact Report
DEM	Department of Environmental Management
DEP	Department of Environmental Protection
DMF	Division of Marine Fisheries
DO	Dissolved Oxygen
DPW	Department of Public Works
DRI	Developments of Regional Impact
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
ENF	Environmental Notification Form
EOEA	Executive Office of Environmental Affairs
FEIR	Final Environmental Impact Report
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
JRP	Joint Review Process
LCP	Local Comprehensive Plan
MBE	Minority Business Enterprise
MCL	Maximum Contaminant Level
MEPA Unit	Massachusetts Environmental Policy Act Unit
MGD	Million Gallons Day
mg/l	milligram per liter
MGL	Massachusetts General Law
MISER	Massachusetts Institute for Social and Economic Research
MMR	Massachusetts Military Reservation
MSL	Mean Seal Level

NH_4-N	Ammonia Nitrogen
NEPA	National Environmental Policy Act
NO_3-N	Nitrate Nitrogen
POTW	Publicly-Owned Treatment Works
ppm	parts per million
PSTF	Privately-Owned Sewage Treatment Facility
RBC	Rotating Biological Contactor
RPP	Regional Policy Plan
S&W	Stearns and Wheler
SMCL	Secondary Maximum Contaminant Level
SRF	State Revolving Fund
TDS	Total Dissolved Solids
THM	Trihalomethane
TKN	Total Kjeldahl Nitrogen
Total N	Total Nitrogen
TSS	Total Suspended Solids
USDA	United States Department of Agriculture
USGS	United States Geologic Survey
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
V-Zones	Velocity Zones designated by FEMA
WBE	Women's Business Enterprise
WWTF	Wastewater Treatment Facility
ZOC	Zones of Contribution

Chapter 1

Introduction

CHAPTER 1

INTRODUCTION

1.1 PROJECT IDENTIFICATION AND PURPOSE

The purpose of the Wastewater Facilities Planning Project (Project) is to provide an environmentally and economically sound plan for wastewater treatment and disposal in Falmouth for the next 20 years. The Project will evaluate the Town's existing wastewater treatment facility and collection system, address nitrogen loading impacts to West Falmouth Harbor, and identify and evaluate several planning areas in Falmouth.

The Town of Falmouth is located in the southwestern portion of Cape Cod as shown in Figure 1-1. This figure also locates the planning areas that are the focus of this project:

1.2 PROJECT BACKGROUND, ISSUES, AND PLANNING AREAS

A Wastewater Facilities Plan was last completed for Falmouth in August 1981 focusing on an aging wastewater collection and discharge system in Woods Hole, including an ocean outfall at Woods Hole, and wastewater problems in densely developed portions of Falmouth Center, Falmouth Beach, Falmouth Heights, and the Maravista area. Recommendations of the 1981 Wastewater Facilities Plan were approved by the Town, and the following centralized wastewater facilities were implemented as shown on Figure 1-2.

- Construction of the Falmouth Wastewater Treatment Facility (WWTF) located off Blacksmith Shop Road in West Falmouth.

- Construction of the Jones Palmer Pumping Station to collect wastewater from several areas of Town and pump it to the Falmouth WWTF.

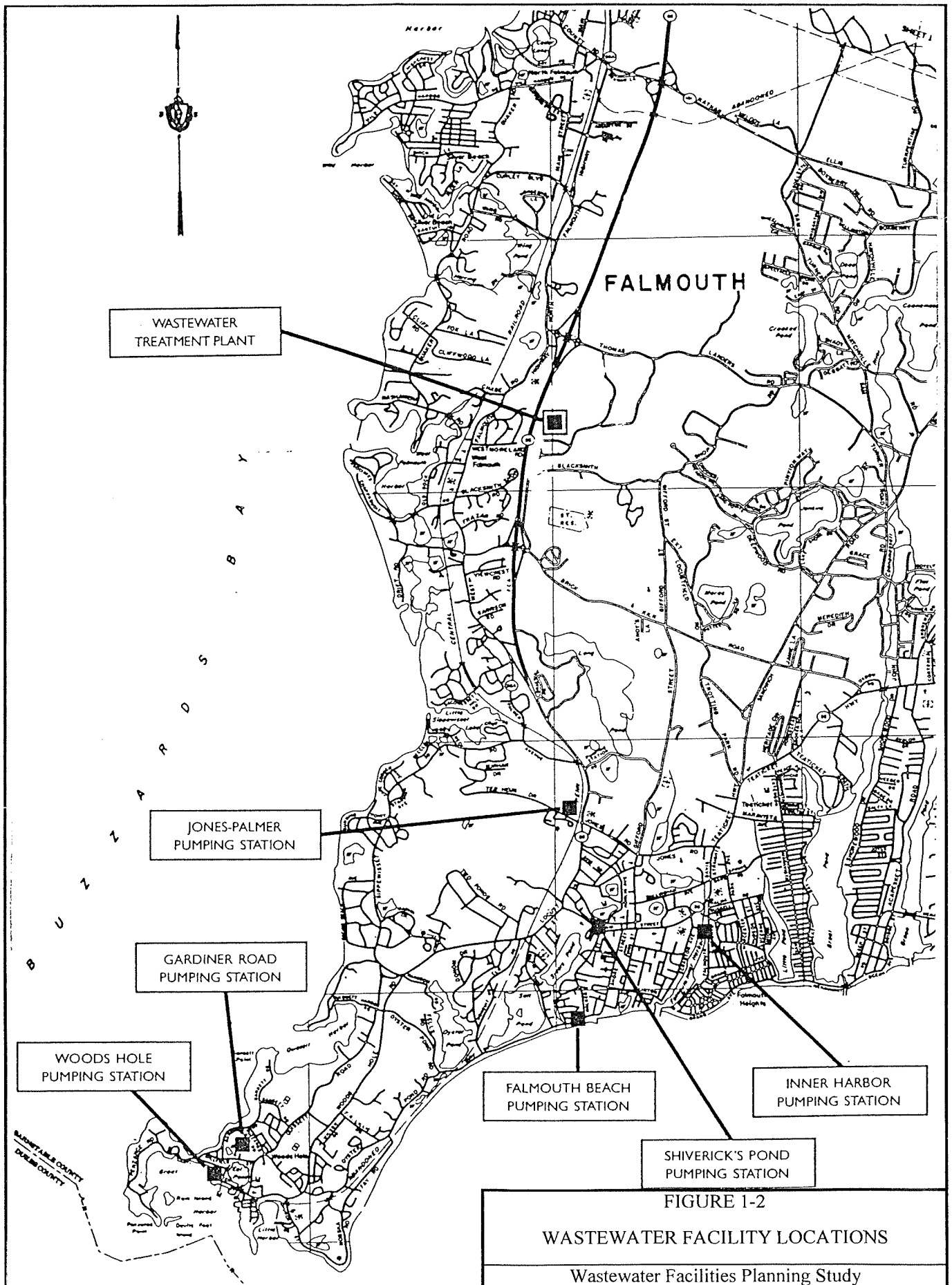


FIGURE 1-2

WASTEWATER FACILITY LOCATIONS

Wastewater Facilities Planning Study
Town of Falmouth, MA

Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS AND SCIENTISTS

Source: Town of Falmouth WWTF O&M Manual

WWfacilitiesloc-fig1-2.xls Figure 1.jjg

- Elimination of the Woods Hole ocean outfall and construction of the Woods Hole Pump Station to pump the collected wastewater to the Jones Palmer Pumping Station and ultimately to the Falmouth WWTF.

- Expansion of the Woods Hole wastewater collection system to collect wastewater from portions of Gardner and Park Roads; and construction of the Gardner Road Pumping Station to pump the collected wastewater to the Woods Hole Pumping Station, and ultimately to the Falmouth WWTF.

- Repairs to the Woods Hole collection system to reduce groundwater infiltration to the system.

- Construction of sewers along Main Street and the Shivericks Pond Pumping Station to collect wastewater and discharge it to Jones Palmer Pumping Station and ultimately to the Falmouth WWTF.

- Construction of sewers in the Falmouth Beach Area and the Falmouth Beach Pumping Station to collect wastewater and discharge it to Shivericks Pond Pumping Station, and ultimately to the Falmouth WWTF.

- Construction of sewers along East Main Street, Davis Straits Road, and Scranton Avenue; and construction of the Falmouth Inner Harbor Pumping Station.

The Town's collection system has been slightly extended in past years to collect additional wastewater flow since implementation of these facilities.

The 1981 Wastewater Facilities Plan also recommended that portions of Falmouth Heights and Maravista be sewered approximately ten years after Falmouth Center was sewered. These areas are densely developed, and some of the properties do not have sufficient space for fully compliant Title 5 systems. Portions of these two areas are in the 100-year flood zone and at low elevations where the groundwater is close to the surface.

The Maravista area is adjacent to Little Pond and Great Pond. Both of these ponds have water quality problems that have been attributed to wastewater impacts.

The Falmouth WWTF utilizes an aerated pond treatment system for removal of suspended and dissolved solids, and partial removal of nitrogen. The system was not designed for advanced nitrogen removal, and the groundwater between the Falmouth WWTF and West Falmouth Harbor was subsequently classified as a Class III groundwater as part of the plan to construct the Falmouth WWTF. The WWTF has performed well, and consistently meets its groundwater discharge permit. The existing groundwater discharge permit expires in 1999, and the Town wants to determine appropriate nitrogen effluent limits as part of this wastewater facilities planning process.

The planning area for the Wastewater Facility Planning Study is comprised of the following areas, which are illustrated on Figure 1-1.

- West Falmouth Watershed Area.

- Existing sewered areas of Falmouth which could receive additional flow from sewer extensions or infilling. These include the Woods Hole Planning Area, Main Street Planning Area, Falmouth Beach Planning Area and the Davis Straits/Inner Harbor Planning Area.

- Falmouth Heights and Maravista Planning Areas, which were identified to be sewered as the second phase of sewer construction in Falmouth.

- Falmouth High School, which has a large Title 5 design flow, and will need a groundwater discharge permit or connection to the Falmouth WWTF to remain in compliance with state regulations.

1.3 PROJECT SCOPE

The Falmouth Wastewater Facilities Planning Project has been divided into five phases. A brief listing of the tasks associated with the five phases of this project follows:

- Phase 1: Establishment of Planning Area and Brief Assessment of Current Conditions.

  - Collect and review available data pertinent to the Project.
  - Identify the Planning Areas for the Project.
  - Prepare a summary Report of the findings.

- Phase 2: Project Scoping and Environmental Documents Preparation.

  - Collect and review data, and compile an inventory of the existing Wastewater Treatment Facilities (WWTF) and collection system.
  - Assess future conditions.
  - Develop a Detailed Scope of Work.
  - Prepare and file the Environmental Notification Form and the Development of Regional Impact Documents.

- Phase 3: Needs Assessment.

  - Review and evaluate the existing conditions in the Planning Areas including land uses, population growth patterns, wastewater collection and disposal practices, groundwater conditions, surface water conditions, geologic conditions and environmentally sensitive areas.
  - Develop future wastewater projections and needs for the Town including population, land use, water consumption and wastewater disposal.

- Identify and prioritize service areas in need of corrective actions with respect to wastewater treatment.
- Prepare a Needs Assessment Report, which includes the "No Action Alternative".

- Phase 4: Development and Screening of Alternatives.

  - Identify and develop decentralized treatment options.
  - Identify and develop centralized treatment options.
  - Identify and develop collection system alternatives.
  - Identify and develop flow and loading reduction alternatives.
  - Identify and develop alternative technologies (both conventional and innovative), solutions, and plans to meet the Town's wastewater needs.
  - Screen the alternative technologies, solutions, and plans to select the alternatives that provide the greatest environmental and cost benefit.
  - Prepare Screening Analysis Report.

- Phase 5: Detailed Evaluation of Alternatives.

  - Prepare a detailed evaluation of screened alternatives.
  - Develop additional considerations for evaluation of alternatives.
  - Develop nitrogen management plan and plume delineation for West Falmouth Harbor.
  - Prepare a recommended plan and a schedule for its implementation.
  - Summarize Phase 5 work in a Wastewater Management Facilities Plan, and Draft and Final Environmental Impact Reports.

The full Project Scope was included in the Environmental Notification Form and Development of Regional Impact documents, which is available at the Town Library.

The following documents will be prepared as part of the project.

- Phase 1 Report. This report was completed in December 1998, and provided a brief summary of the Phase I tasks. The findings of that report have been expanded and included in the Needs Assessment Report.

- Environmental Notification Form and Development of Regional Impact documents. These documents have been prepared as described in Phase 2, and were submitted for environmental review on January 15, 1999. The full environmental review process is described in the following section of this chapter.

- Needs Assessment Report. This report will be prepared as described in Phase 3.

- Alternatives Screening Analysis Report. This report will be prepared as described in Phase 4.

- Recommended Plan and Draft Environmental Impact Report (DEIR). This report will be prepared as described in Phase 5.

- Recommended Plan and Final Environmental Impact Report. This report will finalize the recommended plan as described in Phase 5 and as part of the environmental review process.

1.4 ENVIRONMENTAL REVIEW PROCESS

A joint review process with the Massachusetts Executive Office of Environmental Affairs MEPA Unit and the Cape Cod Commission has been initiated for the project. An Environmental Notification Form and a Development of Regional Impact document were prepared and submitted to these two regulatory agencies for their review and comment. A public hearing was held at the Falmouth Town Hall on February 2, 1999 to discuss the

project and receive public comment on these two documents. This review resulted in the February 22, 1999 Certificate of the Secretary of Environmental Affairs, which accepted the project scope with few comments. The Secretary's Certificate is attached as Appendix A.

The most substantial change to the Project Scope that resulted from the review of the Environmental Notification Form and Development of Regional Impact documents was the request to move portions of the Phase 5 Scope to Phase 3, and report on these items in the Needs Assessment Report. Many of the detailed tasks in that portion of the Project Scope have been completed and are reported in Section 6.3 of this report. The other items will require more time before they are complete. These items will be performed during Phase 4 and 5.

The Secretary's Certificate requires the preparation of a Draft Environmental Impact Report and Final Environmental Impact Report as identified in the Project Scope. Two additional documents (Needs Assessment Report, and Alternatives Screening Analysis Report) will be prepared for environmental review to obtain regulatory and public input as the project proceeds. These two documents do not require formal MEPA review but may receive formal Cape Cod Commission review as part of their Development of Regional Impact review process.

1.5 PLANNING PERIOD

The Final Wastewater Facilities Plan and Environmental Impact Report will provide a Recommended Plan for wastewater facilities in the planning areas for the 20-year planning period of 2003 to 2023, which is the period that would start following any newly constructed wastewater treatment facilities.

1.6 PURPOSE AND ORGANIZATION OF THE NEEDS ASSESSMENT REPORT

The Needs Assessment Report is written to summarize the tasks identified in Phase 3 of the Project Scope. This work includes the research and description of existing conditions in the planning areas related to wastewater treatment and disposal; the Town's centralized treatment and disposal facilities; projected wastewater flows and loadings; and prioritization of the planning areas.

This Needs Assessment Report is divided into eight chapters. Chapter One presents the general introductory information about the Wastewater Facilities Planning Study. Chapter Two describes the technical documents reviewed along with Town and regional data, and identifies regional and Town personnel contacted with regard to this project. Chapter Three identifies the regulatory issues (local, regional, state, and federal) that must be considered during the Project. Chapter Four describes the Town-wide existing conditions. Chapter Five describes the existing centralized wastewater collection, treatment, and discharge facilities. Chapter Six identifies existing and future conditions in the planning areas. Chapter Seven provides a summary of the wastewater needs in the planning areas, and describes the results of the No Action Alternative, which is the expected out come in the planning areas if no changes are made to the existing facilities.

Chapter 2

Data Review and On-Going Projects

CHAPTER 2

DATA REVIEW

2.1 INTRODUCTION

This chapter provides an overview of information used in preparing the Needs Assessment Report for the Town of Falmouth. It also identifies on-going projects, which are developing information that could be used by the Wastewater Facilities Planning Project as it proceeds.

2.2 TECHNICAL REPORTS AND DATA

The following technical reports and data were reviewed for the Needs Assessment Report, and are presented in chronological order.

A. Falmouth Wastewater Collection and Treatment Facility Studies.

1. "Draft and Final Environmental Impact Statements: Wastewater Collection and Treatment Facilities", May and August 1981, USEPA.
2. "Final Wastewater Facilities Plan", August 1981, Camp Dresser & McKee (CDM).
3. "Falmouth WWTF Operation and Maintenance Manual, 1985 and 1998, CDM and Wright-Pierce.
4. "Draft Water Quality Projections for Wastewater Treatment and Irrigation Land Treatment System", December 1986, CDM.
5. "Draft Summary of Groundwater Investigations in Support of Land Disposal of Treated Wastewater from the Falmouth Wastewater Treatment Facility", January 1987, CDM.
6. "Wastewater Treatment Facility Final Performance Report", June 1988, CDM.

7. "Evaluation of the Rapid Infiltration Basins at the Falmouth Wastewater Treatment Facility", November 1990, Wright-Pierce.

8. "Evaluation of the Pond Aeration System at the Falmouth Wastewater Treatment Facility", November 1990, Wright-Pierce.

9. "Irrigation of Vegetation with Treated Municipal Wastewater", February 1991, Jordan and Marine Biological Laboratory.

10. "Otis ANG WWTP Construction Cost Information and Design Information", September 1993, Compiled by Stearns & Wheler.

11. "Sludge Removal Contract", February 1994, Falmouth DPW.

12. "Draft Report: An Evaluation of Effluent Disposal Alternatives", April 1994, CDM.

13. "WWTF Groundwater Discharge Permit, SE #1-168", August 1994, MA DEP.

14. "New Silver Beach Wastewater Management Plan", March 1997, Weston & Sampson.

15. "Initial Year Performance Report: Town of Falmouth, MA, Aeration System Improvements", April 1998, Wright-Pierce.

16. "WWTF Operating Data", on going, Falmouth DPW.

17. "Falmouth High School Design Drawings".

B. Falmouth Groundwater and Water Supply Studies.

1. "Water Supply Investigation: Zone of Contribution Study", May 1986, CDM.

2. "Water Supply Investigation: Joint Zone of Contribution Study", July 1987, CDM.

3. "Final Report on Groundwater Management/Water Supply Planning", July 1987, CDM.

4. Groundwater Contour Map entitled "Altitude and Configuration of the Water Table, Western Cape Cod Aquifer, Massachusetts, March 1993, USGS Open-File Report 94-462".

5. "Use of Particle Tracking to Improve Numerical Model Calibration and to Analyze Groundwater Flow and Contaminant Migration, MMR, Western Cape Cod, Massachusetts, USGS Open File Report, 96-214," 1996, Masterson et al.

6. "Delineation of Contributing Areas to Selected Public Supply Wells, Western Cape Cod, Massachusetts, Water Resources Investigations Report 98-4237", 1998, Masterson et al.

7. "Regional Water Supply Study and Development of Massachusetts Military Reservation and Upper Cape Cod, Massachusetts ", November 1998, Earth Tech, Inc.

C. Falmouth Surface Water Studies.

1. "Falmouth Technology Park Nitrogen Loading Assessment, July 1992, Howes et al.

2. "Culvert Design and Beach/Inlet Management Plan for Little Pond, Falmouth, Massachusetts", September 1993, Aubrey Consulting.

3. "A Study of the Fresh Water Input to and Other Characteristics of Oyster Pond, West Falmouth", November 1993, Alan P. Fleer.

4. "Nutrient Balance of a Shallow Coastal Embayment: Patterns of Groundwater Discharge: November 1994, Millham & Howes, Marine Ecology Progress Series, 112:155-167.

5. "Freshwater Flow into a Coastal Embayment (Little Pond): Groundwater and Surface Water Inputs", Millham & Howes, Limnol. Oceanogr, 39 (8), 1994, 1928-1944.

6. "Hydrodynamic and Water Quality Study of West Falmouth Harbor, MA." March 1995, Aubrey Consulting, Inc.

7. "Nitrogen management issues and options for West Falmouth Harbor: Progress Reports", 1996 - 1998, Buzzards Bay Project.

8. "Water Quality Monitoring of Falmouth's Coastal Ponds: Results from the 1997 Season", June 1998, Falmouth Pond Watchers, Howes and Goehringer.

9. "West Falmouth Harbor Nitrogen Loading Evaluation from Draft Coastal Embayment Report", September 1998, Cape Cod Commission.

D. Falmouth Sanitary Landfill Studies.

1. "Initial Site Assessment for Town of Falmouth Sanitary Landfill", January 1993, Town of Falmouth Engineering Division.

2. Comprehensive Site Assessment, Town of Falmouth Sanitary Landfill, November 1995, Woodard & Curran, Inc.

E. Falmouth Town Planning Documents.

1. "Open Space and Recreation Plan", May 1996, Town of Falmouth.
2. "Town of Falmouth Undeveloped Land Study (A component of the Local Comprehensive Plan)", May 1997, Falmouth Planning Office.
3. "Falmouth Local Comprehensive Plan", February 1998, Town of Falmouth.

2.3 MAPPING

The following maps and plans were reviewed for this Needs Assessment Report:

- Falmouth Quadrangle Topographical Map.
- Woods Hole Quadrangle Topographical Map.
- Pocasset Quadrangle Topographical Map.
- USGS Groundwater Contour Map.
- Town Assessor Maps for the Study Areas.
- CCC & MASS GIS Regional Maps for Falmouth.
- Falmouth Wastewater Treatment Facility: Sewage Works Improvements, 1983, CDM.
- Main Street Interceptor and Falmouth Inner Harbor Sewers and Force Main Record Drawings, 1983.
- Falmouth Beach and Gardiner Road Interceptor, Lateral Sewers and Force Main Record Drawings, 1983, CDM.
- Falmouth WWTF: Aeration System Improvements, 1994, Wright-Pierce.
- Falmouth WWTF: Construction of Infiltration Basins, 1994, CDM.

- Falmouth Sewage System: Woods Hole District Sewers; Ejector Station & Outfall, 1949, Haley & Ward.

2.4 TOWN AND REGIONAL DATA

Additional technical data from Town and regional sources has been received and reviewed as identified below:

- Town of Falmouth 1998 Assessor's Data including: land use, zoning, water users, 1997 and 1998 water consumption, sewer users, property and structure information and valuation.
- Cape Cod Commission Geographic Information System (GIS) data including: ACECs, Falmouth parcels, wetlands, flood plains, historic districts, existing and planned public well sites, marine water recharge areas, and water supply zones of contribution.
- List of approved subdivisions since 1994.
- Groundwater monitoring data from the WWTF and landfill.
- Soil logs from the monitoring wells installed at the WWTF and at the landfill.
- 1990 US Census data.
- "Cape Trends Demographic and Economic Characteristics and Trends", 1996, Cape Cod Commission.

2.5 MEETINGS AND TELEPHONE CONTACTS

Several meetings and telephone conversations were undertaken to research project information. These meetings and telephone contacts are briefly identified below.

- Peter Boyer, Town Administrator, regarding project organization goals.

- Raymond Jack and Ken Ventura of Utilities Department regarding project goals and management, existing information on water and wastewater systems, and Town regulations.
- Wayne Dick and Brian Currie of Planning Department regarding Town planning documents, GIS information, and Town regulations.
- Gregg Frasier, Harbormaster, regarding marine pumpout facilities.
- Marc DuPuis and Marcel Sanchez of Falmouth School Department regarding the high school wastewater facilities.
- Mary Pat Flynn of Economic Development Industrial Corporation regarding Falmouth Technology Park.
- Paul Montague, Shellfish Constable, regarding shellfish closures.
- Saad Kashi, P.E. of Engineering Department regarding water quality and soils information at the landfill.
- George Trudeau and Lynn Grant of the Data Processing Department regarding Town data.
- William Owen, P.E., Director of Public Works, regarding construction costs of Falmouth WWTF and collection system.
- David Carignan, Health Agent, regarding septic system failures, wastewater problem areas, "SepTrac" septic system tracking program, and Class III groundwater areas.
- Joseph Costa, Ph.D., Buzzards Bay Project, regarding West Falmouth Harbor Studies and "SepTrac" program.
- Brian L. Howes, Ph.D., Center for Marine Science and Technology (CMST) Laboratory at University of Massachusetts-Dartmouth regarding on-going research in West Falmouth Harbor Area.
- George Heufelder, BOH member, regarding coastal ponds and Class III groundwater designation.
- Fran Craighton, Chief Operator of ANGB WWTP, regarding system capacity of that treatment plant.
- Ed Eichner, Cape Cod Commission Water Resource Planner, regarding nitrogen issues at West Falmouth Harbor.

- John Masterson, USGS, regarding groundwater modeling in Western cape Cod.

2.6 ON-GOING PROJECTS

The following projects and research efforts are on-going in Falmouth, developing information that could be used in the Wastewater Facilities Planning Project. Efforts have been made by Stearns & Wheler to coordinate our work with these on-going projects.

A. Ashumet Plume Nitrogen Offset Program. This project was initiated by the Town of Falmouth in September 1998 to study portions of Falmouth down gradient of the Ashumet Valley Plume emanating from the old Otis ANG Wastewater Treatment Facility. This area includes the Coonamesset River/Great Pond, Bachus River/Mill Pond/Green Pond, and the Bournes Pond systems, and the watersheds to these surface waters. The objectives of this project include:

- Evaluate all nitrogen and other possible limiting nutrient loadings into the ponds including inputs from the Ashumet Valley Plume.
- Quantify the current state of the surface water quality in this area and the magnitude of deterioration that is likely to occur without corrective measures.
- Develop flushing rates for each embayment.
- Identify, evaluate, and estimate the investment to adopt all feasible and reasonably effective measures to improve water quality in the ponds without regard to financial constraints.
- Recommend a strategy to optimize water quality benefits within specific investment budget of $8.5M.

This project is expected to be complete in the fall of 1999, and is expected to recommend nitrogen and wastewater remediation facilities for this area.

B. CMAST Research in the West Falmouth Area. Brian Howes, Ph.D., of the Center for Marine Science and Technology (CMAST) at the University of Massachusetts – Dartmouth has on-going research in the West Falmouth Harbor area. Dr. Howes and a graduate student are studying the ability of the salt marsh system in Snug Harbor to intercept nitrogen loading discharging from the groundwater system into the harbor. As part of that research, a graduate studies thesis will be produced. This thesis may be available in late summer of 1999. Dr. Howes is also pursuing funding for water quality sampling of several embayments on Cape Cod and Buzzards Bay. Some of the sampling could be in West Falmouth Harbor.

C. New Silver Beach Wastewater Evaluations. The October 1995 Town Meeting authorized funding for a wastewater management plan for the New Silver Beach area. The planning effort evaluated the following wastewater management alternatives for the properties in the study area.

- Treatment and discharge through individual on-site (Title 5) systems.
- Treatment and discharge through individual on-site with innovative/alternative technology.
- Construction of tight tanks to allow transportation of the wastewater to the Falmouth WWTF for treatment and discharge.
- Construction of a collection system to convey the wastewater to the Falmouth WWTF for treatment and discharge.
- Construction of a collection system to convey the wastewater to a new treatment and disposal facility near the New Silver Beach Area.

The New Silver Beach Wastewater Management Plan was finished in March 1997, and recommended the following components.

- Wastewater collection system.
- Tertiary treatment at new wastewater treatment plant located at 40 William Road.
- Effluent discharge through subsurface leaching structures at a new athletic field located adjacent to the North Falmouth Elementary School.

The Town is proceeding with hydrogeologic investigations and modeling to determine environmental impacts of the effluent discharge at the proposed location.

D. Watershed Protection Plan for Long Pond Water Supply. The Town of Falmouth is developing a watershed protection plan for the Long Pond water supply watershed and recharge area, and has retained the consulting firm of Haley & Ward to develop the plan. The plan will identify potential hazards to the water supply and will recommend management steps to protect the water supply. The plan is expected to be complete in April 1999.

E. USGS Modeling of Western Cape Cod. The United States Geologic Survey (USGS) has performed several groundwater monitoring and modeling efforts in the western Cape Cod area, and continues to perform these efforts. The following documents have been published by USGS since 1993.

- Groundwater contour map of western Cape Cod showing five-foot contours (Open File Report 94-462).
- "Use of Particle Tracking to Improve Numerical Model Calibration and To analyze Groundwater Flow and Contaminant Migration, MMR, Western Cape Cod, Massachusetts, Open File Report 96-214".
- Delineation of Contributing Areas to Selected Public Supply Wells, Western Cape Cod, Massachusetts, Water Resources Investigation Report 98-4237".

USGS is continuing with modeling in western Cape Cod and plans to delineate contributing areas to ponds and embayments in this area. This effort is planned to be complete in late 1999.

Chapter 3

Regulatory Issues

The MEPA process, as described in 301 CMR 11.00, establishes thresholds, procedures, and timetables for a multi-level review process. If a project exceeds review thresholds or if state funding is requested for a project, the project proponent begins the review process by preparing and filing an Environmental Notification Form (ENF) with the Secretary of Environmental Affairs (Secretary). A 30-day review period follows, during which the Secretary receives agency and public comments and holds a site visit and consultation session. At the close of the ENF review period, the Secretary determines whether an Environmental Impact Report (EIR) is necessary (see Appendix A). If an EIR is required, it is prepared by the proponent and submitted to the Secretary. The EIR is reviewed at both draft and final stages, by agencies, and the public. After completion of the Secretary's review, state agencies may act on the project.

The Town of Falmouth has entered the MEPA process as part of the Wastewater Facilities Planning Project because state funding is expected to be requested for the Project. This state funding is low-interest rate loans provided by Massachusetts DEP State Revolving Fund (SRF) loan Program. An ENF was filed on January 15, 1999, and a certificate dated February 22, 1999 (contained in Appendix A) was issued stating that an EIR is required. The Scope of the Wastewater Management Facilities Planning Study will be used as the scope of the EIR.

B. On-Site Treatment and Discharge. Title 5 of the Massachusetts State Environmental Code provides minimum standards for the "...protection of public health, safety, welfare and the environment by requiring the proper siting, construction, upgrade, and maintenance of on-site sewage disposal systems and appropriate means for the transport and disposal of septage". The regulations contained in 310 CMR 15.00 come under the jurisdiction of the Massachusetts DEP and are enforced in conjunction with local health departments through permits, inspections, and financial penalties.

As defined by the regulations, an individual sewage disposal system is "... A system or series of systems for the treatment and disposal of sanitary sewage below the ground surface". Systems typically consist of a septic tank, distribution box and a soil absorption system. These systems may

also contain a tight tank, shared system or alternative system. The following is a list of design considerations for Title 5 systems as described by 310 CMR 15.000:

1. No individual sewage disposal system shall be constructed, upgraded or expanded unless it receives less than 10,000 gpd. Exceptions are made for flows greater than 10,000 but less than 15,000 gpd which were approved and permitted for construction prior to March 31, 1995 and are designed according to the 1978 Title 5 Code (15.004(2)).

2. No system shall be used by more than one lot, with the exception of properties, which are divided after system construction or combined into single ownership (15.004(3)).

3. No new system shall be constructed, upgraded, or expanded if access to a local sewer system is available and feasible, except the case of alternative systems which can demonstrate the ability to provide the same or greater treatment level of the sewer, or by variance (15.004(4)).

4. System design flows shall be based upon design flow criteria listed in 310 CMR 15.203. Actual water meter data shall not be substituted for the design flow criteria except in the case of school or university systems (15.203).

5. System design flows for facilities not listed in 310 CMR 15.203 shall be established by actual meter readings based on 200 percent of average water meter reading, subject to approval by DEP and the BOH (15.203 (6)).

6. Setbacks for septic tanks and soil absorption systems are laid out in 310 CMR 15.211, with setbacks from water bodies measured from the bank or most landward boundary.

7. Four feet of vertical separation is required between the bottom of the soil absorption system and the groundwater for percolation rates more than two minutes per inch, and five feet of separation for percolation rates of two minutes per inch or less (15.212).

8. No septic tanks can be constructed in a Velocity Zone (V-Zone) unless to replace one already in existence before March 31, 1995, where placement of the tank outside the V-Zones is not feasible either horizontally or vertically (15.213 (1)). A V-Zone is an area designated by the Federal Emergency Management Authority (FEMA) that will periodically be flooded and have high velocity wave action that could cause damage to property.

9. No soil absorption system can be constructed in a V-Zone unless to serve a building in existence before March 31, 1995. If the system existed prior to March 31, 1995, it can remain in a V-Zone only if there is no increase in design flow from such buildings, no sewer connection available, no other available sites, no septic tank or humus/composting toilet located in the V-Zone, or the system has the required separation from high groundwater (15.213 (2)).

10. No system in nitrogen sensitive areas shall be designed to receive more than 440 gallons of design flow per day per acre except for enhanced nitrogen removal systems (15.214).

11. Soil absorption systems must be located in areas where there is 4-feet of naturally occurring material, and which contain no impervious layers occurring within the four feet (15.240). Systems must also be located at least 4 to 5 feet above the groundwater surface elevation depending on the percolation rate of the soil.

12. Effluent from any component of an on-site system requires a permit to be discharged to a surface water or groundwater if the discharge is over 10,000 gpd (15.240 (2)).

13. Use of garbage grinders requires an additional 50% in leaching area (15.240 (4)).

14. Effluent loading rates are dependent on soil class and percolation rates (15.242).

15. Leaching trenches are the preferred method of effluent disposal, but other methods may be used including (but not limited to) leaching pits, fields, and chambers (15.240 (6)).

16. Use of alternative systems is subject to approval by DEP and the town BOH.

Local health departments generally enforce the regulations summarized above. The local Board of Health may impose more stringent requirements due to specific problems or concerns.

In order for an individual or community to receive a variance from state requirements, it must be the written opinion of the Board of Health that: (1) the enforcement thereof would do manifest injustice; and (2) the applicant has proved that the same degree of environmental protection required under Title 5 can be achieved without strict application of the particular provision (310 CMR 15.10). For new construction, Title 5 does not allow variances to the requirement of 4-feet of naturally occurring material below the soil absorption system (15.415(1)). For repairs and upgrades to existing systems, a variance may be allowed providing the owner demonstrates that resiting the system or connecting to a sewer are not feasible alternatives.

C. Privately-Owned Sewage Treatment Facilities and Publicly-Owned Treatment Works. Privately-owned sewage treatment facilities (PSTFs) are the private version of the Publicly-Owned Treatment Works (POTWs). POTWs are defined in 314 CMR 12.02, as "... any device or system used in the treatment (including recycling and reclamation) of municipal sewage or industrial waste of a liquid nature which is owned by a public entity. A POTW can include any sewers, pipes, or other conveyances if they convey wastewater to a POTW providing treatment." In Massachusetts, there are detailed requirements at the state level, which apply stringent requirements on the siting and operation of POTWs and PSTFs.

Current DEP regulations require a groundwater discharge permit for any residential or commercial discharge greater than 10,000 gallons per day (gpd). The groundwater discharge permit requirements are typically met through the use of a PSTF or POTW. DEP reviews the performance of these facilities under its Groundwater Discharge Permit Program (314 CMR 5.00). The Town of Falmouth's Wastewater Treatment Facility (WWTF) is a POTW. Falmouth currently has two

PSTFs; one at the Coonamessett Inn, and one at Sea Crest. A new POTW is currently planned for the New Silver Beach area.

D. Effluent Discharge at an Ocean Outfall. The Massachusetts Ocean Sanctuaries Act (M.G.L. c132A) regulations establish state environmental policy to be enforced in the five Massachusetts Ocean Sanctuary areas including the Cape Cod Ocean Sanctuary, the Cape Cod Bay Sanctuary, the Cape and Islands Ocean Sanctuary, the North Shore Ocean Sanctuary, and the South Essex Ocean Sanctuary. These areas, as designated by the Massachusetts Department of Environmental Management (DEM), are special resources and it is the DEM's responsibility to protect them "from any exploitation, development, or activity that would seriously alter or otherwise endanger their ecology or appearance".

Falmouth is located in the Cape and Islands Ocean Sanctuary. Municipal wastewater discharges into ocean sanctuaries are specifically precluded under these regulations, unless the discharge is approved and licensed prior to December 1971. A variance from these policies would require the Secretary of Environmental Affairs, DEM, and the Division of Water Pollution Control (DWPC) to agree that a special variance was needed to protect the public health due to a limited number of feasible wastewater discharge alternatives.

E. Groundwater Quality Standards. The Groundwater Quality Standards of 314 CMR 6.00 define three groundwater classes and their designated uses, and specify the minimum groundwater quality criteria for each class. Class I groundwaters are fresh groundwaters designated as a potential source of potable water. Class II groundwaters are saline waters and are designated as a potential source of potable mineral waters. Class III groundwaters are fresh or saline waters and are designated for uses other than potable water. At a minimum, Class III groundwaters can be used as a potential source of non-potable water and are suitable for human contact but not ingestion. The majority of Falmouth's groundwaters are classified as Class I, and any permitted discharges to this groundwater must meet the following requirements:

- Pathogenic organisms shall not render the groundwater detrimental to public health or impair the groundwater for use as a source of potable water.

- Coliform bacteria shall not exceed maximum contaminant levels, as stated in National Interim Primary Drinking Water Standards. The current limits are 20 fecal coliforms per 100 ml and 100 total coliforms per 100 ml.

- Nitrate nitrogen and total nitrogen shall not exceed 10 mg/l.

- Total trihalomethanes shall not exceed 0.1 mg/l.

A portion of Falmouth's groundwater between West Falmouth Harbor and the WWTF has been classified as Class III. This class was designated as part of the 1981 Facilities Plan based on 314 CMR 6.05 (3)(c), and the Groundwater Discharge Permit #0-168. Groundwaters classified as Class III must meet the following requirements:

- Pathogenic organisms shall not render the groundwater detrimental to public health.
- Radioactivity shall not exceed levels as stated in the National Interim Primary Drinking Water Standard.
- All other pollutants shall exist in concentrations or in combination such that any human exposure will not result in "death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions or physical deformations or cause any significant adverse effects to the environment, or which would exceed the recommended limits on the most sensitive groundwater use".

Discharges to groundwater of 10,000 gpd or greater must meet requirements of the Groundwater Quality Standards, as well as the Groundwater Discharge Permitting Program described below.

F. Groundwater Discharge Permitting. The Massachusetts Groundwater Discharge Permit Program is contained in 314 CMR 5.00, and is the regulation which governs wastewater discharges to the groundwater of 10,000 gpd or greater. Facilities designed or constructed prior to March 1995 are allowed to discharge up to 15,000 gpd without a discharge permit.

The groundwater discharge regulations cover several types of discharge to groundwater, including discharges through infiltration beds, spray irrigation fields, percolation fields, lagoons, or injection wells. The effluent quality of permitted discharges must meet the requirements for the groundwater class. These requirements are quite strict and cannot be met with a typical on-site septic system. Advanced wastewater treatment plants are used to meet the requirements. Application for a discharge permit requires a hydrogeologic evaluation, as well as an engineered design for the treatment and discharge facility.

G. Reclaimed Water Use. The use of reclaimed water must meet guidelines developed by DEP (Draft 6, October 1998) in addition to the requirement of the Groundwater Discharge Permitting Program. Reclaimed water use includes use of treated wastewater for irrigation at a golf course, and discharges into approved Zone II areas.

H. Surface Water Quality Standards. In addition to the limitations on ocean disposal of wastewater imposed by the Ocean Sanctuary regulations, the Massachusetts Surface Water Quality Standards define the activities that are prohibited in various class-designated surface water bodies. The water in Waquoit Bay and its tributaries are designated SA and Outstanding Resource Water, the highest State designations for ocean water. The water in Nantucket Sound and Buzzards Bay are also designated SA. Any actions that would prevent swimming, fishing, or other recreational activities in these waters are strictly prohibited. The water in Inner Harbor is designated SB, suitable for aquatic life and primary and secondary recreational contact.

In addition to the designations of the marine waters identified above, Long Pond in Falmouth is designated a Class A water according to 314 CMR 4.00, because it is a public water supply source

and has been designated as an Outstanding Resource Water. Other fresh water ponds in Falmouth have been designated as Class B waters according to 314 CMR 4.00. This is the highest ranking for a freshwater not used as a potable water supply. Dissolved oxygen, temperature, pH, fecal coliforms, solids, color, turbidity, oil, grease, taste and odor are all regulated for both Class A and B waters and can not exceed levels which degrade these waters as set by 314 CMR 4.05.

I. Surface Water Discharge Permitting. The Massachusetts Surface Water Discharge Permit Program described in 314 CMR 3.00 regulates all discharges of pollutants to surface waters located in Massachusetts. These include point sources for public and privately owned treatment works and stormwater discharges.

Discharge of treated wastewater to surface waters in Falmouth would not be allowed due to the Ocean Sanctuaries Act, the Outstanding Resource Water designation of Waquoit Bay and the Class A and B designation of Falmouth's ponds.

J. Wetlands Protection. The Wetland Protection Act (M.G.L. ch. 131, s. 40) and parallel State regulations (310 CMR 10.00) were enacted to safeguard wetlands, associated resource areas, and floodplains from impacts of over development.

The Wetland Protection Act covers any wet area where the groundwater level is at or near the surface of the ground for a long enough period during the year to support a community of wetland-type vegetation. Wet areas include any salt or fresh-water marsh, meadow, swamp, or bog.

Areas subject to protection under the Wetlands Protection Act include banks, dunes, beaches and flats. All of these protected areas are referred to as resource areas. Resource areas are protected by a surrounding 100-foot buffer zone in which landscape alterations are regulated. The Wetlands Protection Act also covers construction on land subject to flooding as well as land subject to coastal

storm flowage. Generally, the regulations apply to two types of floodplain: those lands bordering directly on bodies of water, and those lands subject to flooding (called "Isolated Land Subject to Flooding") which do not border bodies of water.

The state regulates activities that involve filling, dredging, or excavating in or near a wetland or water body. The regulations govern additional construction activities, including site preparation, the removal of trees or bushes, vista pruning, and the changing of land contours.

A Notice of Intent must be filed for work in any resource area. This Notice requires a detailed description of the planned activity, and the applicant must show that if the resource area will be altered, the benefits will outweigh the damage. For work outside the resource areas but within a 100-foot buffer zone around a bordering vegetated wetland, bank, dune, or beach, the owner has the option of filing a "Request for Determination" in order to show that the work will not impact a resource area. If the Conservation Commission agrees, it will issue a "Negative Determination," permitting the work as presented. If the Conservation Commission decides that the work will impact a resource area, it will issue a "Positive Determination" and require a full hearing and the filing of a Notice of Intent.

K. Governor Kings Executive Order No. 181 on Barrier Beach Areas and Velocity Zones. This Executive Order defines barrier beach areas and sets several State policies to restrict and discourage development in these areas. One policy states that no State funds and Federal grants for construction projects shall be used to encourage growth and development in hazard-prone barrier beach areas. This policy has been used by the State to restrict government funded projects in hazard-prone areas such as Velocity Zones.

Discussion with members of Massachusetts Coastal Zone Management indicates that the State will discourage development in a Velocity Zone and withhold State funding for such a project. This development would include the construction of a treatment facility or collection system in a Velocity

Zone. This policy could affect Falmouth if a sewer is proposed to collect wastewater in southern areas of the Town that have Velocity Zones.

L. Toxic/Incompatible Discharges to Wastewater Collection Systems. In the early 1980s, the USEPA established nation wide industrial pretreatment standards contained in 40 CFR 403, General Pretreatment Regulations, to regulate the discharge of industrial pollutants to publicly owned treatment works (POTWs). The general goals of this program are to limit those toxic/incompatible discharges, which could:

- Pass through a plant inadequately treated.
- Harm a plant's treatment processes, thereby preventing the plant from complying with its permit.
- Accumulate in the plant's sludge in concentrations that would limit sludge disposal options.
- Cause a risk to the health and safety of treatment plant workers or the general public.

When these regulations were established, all communities with POTW flows greater than 5 mgd were required to establish local industrial pretreatment programs. Because flow at the Town of Falmouth's WWTF is less than 5 mgd, no pretreatment program was required at that time.

Massachusetts's pretreatment regulations (314 CMR 12.00) parallel the federal regulations. Paragraph 12.09.2 of the Massachusetts regulation states that the Director of the DEP may require a POTW with a design flow of 5 mgd or less to establish a pretreatment program in order to meet the goals listed above.

M. Regulations for the Land Application of Sludge and Septage. The land application of sludge and septage, as well as the distribution of compost material made form WPCF sludge, are regulated by DEP in 310 CMR 32 and the March 1993 federal standards contained in 40CFR Part 503. The State regulations are the more stringent of these two regulations.

Under the DEP regulations, sludges, septage, and compost (collectively called "material") are classified as Type I, II, or III, depending upon chemical, pathogen, and organic content and sludge stabilization process used. The sludge classification determines how the material is ultimately used or disposed. Type I material can be used on any site and requires no further DEP regulation; while Type II and III materials require additional regulation on the ultimate use, the application site, and allowable application rates. A compost must be classified as Type I to be sold or otherwise distributed to the public.

N. Water Resources, Treatment and Supply of Potable Water. The Safe Drinking Water Act (SDWA) of 1974 is federal legislation that dictates the regulation of potable water in the United States. Major amendments were made to the SDWA in 1986, and mandate that 25 additional contaminants come under regulation every three years. This legislation is incorporated into the regulations of 40 CFR 141, 142, and 143, which are maintained and enforced by USEPA.

Massachusetts is a primacy state for the regulation of potable water, which means that Massachusetts DEP is the primary agency for maintaining and enforcing the drinking water regulations. Massachusetts regulations contained in 310 CMR 27.00 closely parallel the federal regulations and establish the maximum contaminant level (MCL) of the regulated contaminants in drinking water. The groundwater quality standards discussed in a previous section and contained in 314 CMR 6.00 have been determined by the drinking water MCLs.

The SDWA provides guidelines on the establishment of wellhead protection programs, which Massachusetts has established in Section 310 CMR 22.21. The program delineates three zones around each public water supply. The Zone I delineation is the area immediately around the well or wellfield which must be owned by, or in the control of, the water purveyor. The Zone I for a well producing 100,000 gpd or greater has a minimum diameter of 800 feet. The Zone II delineation is the area of an aquifer which contributes water to a well under the "...most severe pumping and recharge conditions that can be realistically anticipated". The regulations define these conditions as 180 days of pumping at safe yield with no recharge from precipitation. Zone II areas are typically

material. The Zone III delineation is the area beyond the Zone II from which surface water and groundwater drain into Zone II.

The wellhead protection program regulates the allowed land use within each zone. Land use activities within Zone I areas must be related to the water supply or have no significant adverse impact on water quality. The following land uses are prohibited from being sited in a Zone II area.

- Landfills or open dumps.
- Landfilling of sludge or septage.
- Automobile grave yards and junk yards.
- Stockpiling of contaminated snow or ice.
- Individual sewage disposal systems designed to receive more than 110 gallons of sewage per quarter acre under ownership per day.
- Wastewater treatment plants that are required to obtain groundwater discharge permits.
- Facilities that generate, treat, store, or dispose of hazardous materials.

There are exceptions to the prohibition of wastewater treatment plants listed above. These exceptions are reviewed by DEP on a case-by-case basis.

3.3 REGIONAL REGULATORY ISSUES

A. Development of Regional Impact (DRI) Review Process. In accordance with the Cape Cod Commission Act, Chapter 716, the Cape Cod Commission (Commission) has the authority to review and regulate Developments of Regional Impact (DRIs). This review is carried out by the Commissioners and the Commission staff, in accordance with Administrative and Enabling regulations.

As stated earlier, Falmouth's Wastewater Facilities Planning Study includes an environmental review process that is governed by the Massachusetts Environmental Policy Act (MEPA) and the Commission's DRI procedures. This review process is a joint review process as identified by the

- The maximum loading standard for Nitrate Nitrogen impact on groundwater shall be 5 ppm.

- In order to limit Phosphorus inputs, no subsurface disposal systems shall be permitted within 300 feet of mean high water of fresh water ponds.

- Development and redevelopment shall not exceed identified critical Nitrate Nitrogen loading standards for Nitrogen impact on marine ecosystems.

- Conversion from seasonal to year-round uses in FEMA flood zones or within 100 feet of wetlands shall not be permitted unless the proponent installs a DEP approved alternative system with enhanced Nitrogen removal.

- New direct discharge of untreated stormwater, parking lot runoff and/or wastewater into marine and freshwater surface water and wetland shall not be permitted. Development and redevelopment shall use best management practices such as vegetated swales to runoff and maximize water quality treatment.

b. **Goal.** To encourage the use of public and private sewage treatment facilities in appropriate areas where they provide environmental or other public benefits and where they can be adequately managed and maintained. The following selected minimum performance standards are indicated:

- Private treatment facilities may be constructed only if the are no feasible public treatment facility options available or planed.

2. **Coastal Resources.**

a. **Goal.** To protect the public interests in the coast and rights for fishing, fowling, and navigation, to preserve and manage coastal areas so as to safeguard and perpetuate their biological, economic, historic, maritime, and aesthetic values, and to preserve and where appropriate expand public access to the shoreline.

b. **Goal.** To limit development in areas subject to coastal storm flowage, particularly high hazard areas in order to minimize the loss of life and structures and the environmental damage resulting from storms, flooding, erosion and relative sea level rise. The following selected minimum performance standards are indicated:

- No development or redevelopment shall be permitted within FEMA V-Zones. Existing structures may be reconstructed or renovated provided there is no increase in floor area or intensity of use. As an exception, where there is no feasible alternative, water-dependent structures and uses may be permitted subject to the approval of all permitting authorities.

- In order to accommodate possible relative sea level rise and possible increased storm intensity, ensure human health and safety, and protect the integrity of coastal landforms and natural resources, all new buildings, including replacements, or substantial improvements to existing structures within FEMA A-Zones shall be designed to accommodate the documented relative seal level rise rate in Massachusetts of at least one foot per 100 years, and in V-Zones shall be designed to accommodate a relative sea level rise rate of two feet per 100 years.

The Town of Falmouth has a Local Comprehensive Plan (LCP), which has been approved by the Cape Cod Commission. The LCP is structured in accordance with the "Guidelines" adopted by the Cape Cod Commission.

3.4 FEDERAL REGULATORY ISSUES

A. NEPA. The National Environmental Policy Act of 1970 (NEPA) provides the basis for the protection of the environment. This act ensures that environmental information is provided to the public for use in the decision making process for projects which might affect the environment. According to regulations the "...NEPA process is intended to help public officials make decisions that are based on an understanding of environmental consequences; and take actions that protect, restore, and enhance the environment" This policy has been established to eliminate redundancy and combine NEPA requirements with other concerned agency's requirements. The NEPA process is the fore runner of similar environmental review processes adopted by State and regional agencies; it allows for the assessment and identification of alternatives for projects concerning the environment. The Town of Falmouth is not expected to enter into the NEPA process as the Wastewater Facilities Planning Study is regulated by the Massachusetts Environmental Policy Act (MEPA) and the Cape Cod Commission's Development of Regional Impact (DRI) review process as described in earlier sections.

B. Stormwater Discharges. Certain stormwater discharges to surface waters are regulated by the USEPA through the Stormwater Rule contained in 40 CFR 122. These regulations specify the types of facilities and the types of stormwater discharges that require stormwater discharge permits.

Industrial facilities are required to file permit applications with USEPA depending on their Standard Industrial Classification code. Small municipalities with populations less than 100,000 are not required to file permit applications, except for municipally owned or operated "industrial activities" such as landfills, power plants, and airports. Small municipalities may need to file a permit

2. **Falmouth Health Regulations, FHR 15.00: Title 5 Modifications.** These requirements identify several provisions that are stricter than the revised Title 5 (March 31, 1995) and are in effect in Falmouth. They cover the following main issues.

- Variances to Title 5.
- Septic Systems near Wetlands.
- Septic systems shall be constructed on the same lot as the structure or structures that they serve.
- Septic tank, leaching pit and cesspool covers.
- Construction materials.
- Criteria for determining a septic system repair or replacement.

3. **Article XXI of the Zoning Regulations: Coastal Pond Overlay District**. These regulations establish and delineate Coastal Pond Overlay Districts and their restrictions. Three different classifications are identified: high quality areas, stabilization areas, and intensive water activity areas. Each area has specific zoning requirements and nitrogen concentration standards. The "Critical" eutrophic levels are:

- 0.32 mg/L total nitrogen for high quality areas;
- 0.52 mg/L total nitrogen for stabilization areas;
- and 0.75 mg/L total nitrogen for intensive water activity areas.

Chapter 4

Town-Wide Existing Conditions

CHAPTER 4

TOWN-WIDE EXISTING CONDITIONS

4.1 INTRODUCTION

This chapter provides a description of the Town of Falmouth's Town-wide natural resources, demographics, water supply, and failing on-site septic systems. The Town's natural resources are defined by the Town's topography, geology, soils, groundwater, surface waters, coastal embayments, wetlands, flood plains, and protected natural areas. Town demographics include zoning; land use; cultural resources; population; age distribution; income; and tax burden. The Town's existing water supply facilities, usage and conservation programs are summarized. Also, failing on-site septic systems are briefly discussed for the planning areas. Each of these existing conditions has been identified through review of Town documents and records, interviews, and site evaluations made by the Project Team.

4.2 NATURAL RESOURCES

A. Topography. Falmouth, like most towns on Cape Cod, is comprised mostly of glacial deposits. Falmouth consists of hilly areas along the western quarter of Town, parallel to Buzzards Bay. This is identified as the Buzzards Bay Moraine, a terminal ridge marking what was once the edge of a glacier (Open Space, 1996). The eastern three-quarters of the Town consist of flat terrain with the beaches making up the southern boundaries.

Falmouth has numerous kettle hole ponds, salt-water pond estuaries, beaches and wetlands. Ground elevations in Town vary from Mean Sea Level (MSL) to an elevation of 206 ft, on a hill west of the Falmouth WWTF. The Town is bordered to the north by the Town of Bourne and the Massachusetts Military Reservation (MMR), to the south by the Vineyard Sound, to the East by Buzzards Bay, and to the West by the Town of

The Town of Falmouth receives its drinking water from the Sagamore Lens of the Cape Cod Sole Source Aquifer. The following section reviews aspects of the Sagamore Lens including its flow direction, elevation and impacts from the Massachusetts Military Reservation. It also identifies public water supplies and existing Zone IIs.

2. **Flow Direction and Elevation.** Several studies have been prepared regarding the groundwater flow direction and elevation as listed in Chapter 2. Previous water supply and modeling studies in the West Falmouth Harbor area have characterized the groundwater system at that area. The United States Geologic Survey has prepared regional groundwater contour maps and flow models for western Cape Cod, which covers Falmouth. Generally, the groundwater system (Sagamore Lens) is at its highest elevation north of Falmouth in the MMR and flows under Falmouth's surface area to Buzzards Bay and Vineyard Sound. Ten-foot groundwater contours are shown on Figure 4-2.

3. **Public Water Supplies.** The Town of Falmouth receives its drinking water from the Sagamore Lens. It has several drinking water wells and one surface water source, which draw water from this aquifer. The Town is also exploring possible future locations for wells to meet future demands and compensate for wells impacted from the MMR plumes. There are currently four wells in Town: Fresh Pond Well, Coonamessett Well, Mares Pond Well, and Ashumet Well. Of these only Fresh Pond, Coonamessett and Mares Pond are considered active wells. The Long Pond surface water supply is the main water supply for Falmouth.

Figure 4-2 indicates Water Resource Protection Districts which are the Zones of Contribution (ZOC) for each of the water supply sources. The public water supplies are discussed further in Section 4.4.

4. **Impacts from the MMR**. A large number of studies and reports have been produced to assess the impacts of the MMR on groundwater supplies. In 1986 as part of an Installation Restoration Program initiated for the MMR, a large number of these impacts were identified; in 1989, the MMR was declared a Super Fund Site by the

USEPA. As of 1996, five large plumes have been identified, several of which impact Falmouth (Open Space, 1996). These impacts are well documented and currently there are studies and remediation efforts associated with these impacts. These impacts are being evaluated in other projects, and are not addressed further in this study.

D. Coastal Embayments.

1. **Identification and Watershed Delineation.** The Town of Falmouth is bordered to the south by Vineyard Sound and the west by Buzzards Bay. Many coastal embayments open into these two large water bodies from Falmouth. The Cape Cod Commission has identified coastal embayment recharge areas for these embayments as identified in Figure 4-1 and 4-2.

The coastal embayment recharge areas have been developed due to concerns that nitrogen loading in these areas will surface in a coastal embayment. This nitrogen, acting as a fertilizer, can cause excessive plant growth, periodic changes in the dissolved oxygen content in the embayment, and create changes in the embayment ecosystem. This could affect shellfish and other marine animals. This over fertilization of a surface water (fresh or salt water) is called eutrophication.

Nitrogen is typically the limiting nutrient in salt-water environments; therefore, the nitrogen concentrations in these water bodies will be one of the major controlling factors on the level of eutrophication in these embayments. Nitrogen enters a coastal embayment through its recharge area. Unlike phosphorus, a limiting nutrient for freshwater systems, nitrogen is believed to travel in the groundwater system without being attenuated by the soils. Nitrogen can result from on-site septic systems, wastewater treatment facility discharges, landfill leachate, lawn fertilization, waterfowl, wetlands, atmospheric deposition, and stormwater runoff. The nitrogen loading and effects in the West Falmouth Harbor recharge area are discussed in great detail in Chapter 6.

and 39 additional vernal pools identified by the Falmouth Wetlands Action Committee (Open Space, 1993).

Falmouth also has numerous saltwater wetlands; one of the largest is Great Sippewisset Marsh. Great Sippewisset Marsh is approximately 100 to 150 acres and is located just south of West Falmouth Harbor along Buzzards Bay. Both salt and fresh water wetlands are identified on Figure 4-2.

F. Flood Plains and Velocity Zones. Floodplains are nature's way of buffering land from excessive storm events because they act to dissipate the wind and wave action generated during these storms. V- Zones are designated by the Federal Emergency Management Agency (FEMA) and are defined as areas susceptible to 100 year coastal flooding with high velocity wave action. The V-Zones are illustrated in Figure 4-1.

A-Zones are also designated by FEMA and are areas where flooding is predicted to occur once every 100 years. This flooding occurs with minimal associated wave action, and these areas are located land ward of the V-Zones, typically in salt marshes and low elevation areas of Falmouth. The surface elevations in these areas typically lie below ten feet MSL. The A-Zones are illustrated in Figure 4-1.

G. Protected Natural Areas.

1. **Areas of Critical Environmental Concern (ACECs).** The Town of Falmouth has one ACEC, designated in 1983, which is centered around the Waquoit Bay Area and includes: Waquoit Bay, Childs River, Moonakis River, Bourne Pond, and Quashnet River. This ACEC also extends into the Town of Mashpee. Regulations regarding stormwater discharges, flood control, and shell fishing have been instituted to help protect this area. A Town by-law regarding this ACEC also established a 50-foot buffer to protect against clear cutting and construction in this area (Falmouth LCP, 1997). These areas are shown on Figure 4-1.

approximately 28,000 people. The Census data also estimated that there were approximately 2.4 people per household year round. The Town of Falmouth Planning Department has compiled Town census data for 1970 through 1993, and has developed population projections through the year 2005.

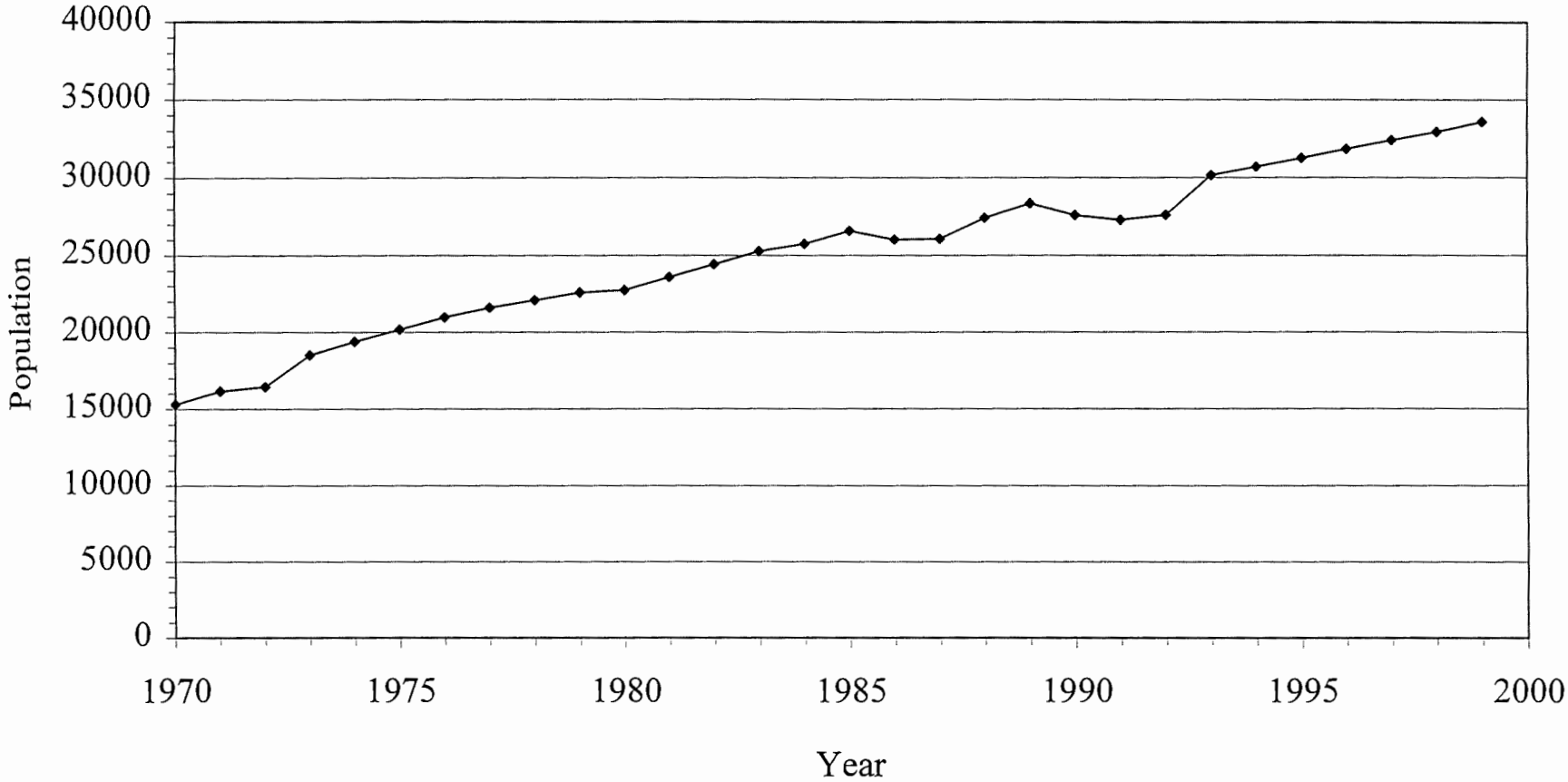
Figure 4-3 presents Falmouth's population trends from 1970 to 1999 based on Falmouth Town Census Data (1970 – 1993) and projected population data (1994-2005) developed by the Town Planning Office.

The Town of Falmouth Planning Department also used the 1990 Census information, and estimated that during summer months the number people per household increased to three, and developed a weighted average of 2.55 people per household in order to calculate the annualized average population for the Town (Falmouth Planning Office, 1997). This weighted average and 1994 assessors' data on existing dwellings were then used to develop annualized average populations for 1995 and buildout conditions. These projected population estimates for the Town are approximately 45,200 people in 1995, and 60,100 people at buildout. Discussions with the Planning Department also identified a 200 percent factor (approximately five people per household) to estimate peak summer populations.

Seasonal populations on Cape Cod are the most difficult to predict. These populations are usually a combination of five distinct groups: year round residents, second homeowners, visitors and guests of homeowners, vacationers, and day-trippers.

- Year round residents: This refers to the permanent populations indicated by the United States Census.

- Second homeowners: This is the population group that owns summer homes in Falmouth. These populations could be estimated through surveys of out of town property owners.



Notes:

1. Populations for 1970 through 1993 are from Falmouth census data

2. Populations from 1994 to 1999 are estimates from the Falmouth Planning Department

FIGURE 4-3

Existing and Projected Census Population Data

Wastewater Facilities Planning Study
Town of Falmouth, MA

Stearns & Wheler, LLC.

Environmental Engineers and Scientists

fig4_3.xls Population
4/8/99

- Visitors and guests of homeowners: This is the population group that are visitors or guests of year round or second homeowners. The number of these visitors is difficult to estimate and will vary from week to week and month to month.

- Vacationers: This group can be described as those who visit Falmouth and find lodging in hotels, motels, and rental cottages. Their numbers could be estimated by surveying the Town's hotels and motels rentals during summer months or through number of beds for these establishments

- Day-trippers: These are the people who travel to Falmouth, but do not stay overnight, and are the most difficult population group to estimate.

The Town of Falmouth Planning Department estimates the peak summer population to be approximately 2 times the annualized year round population. For Falmouth, using the projected 1998 year-round population of 33,000, an estimate of the 1998 summer populations would be 69,000. The Utilities Department also estimates the summer population for the Annual Statistical Report for Water Consumption, and in 1997 estimated this population to be 77,500.

B. Characteristics of Town Residents.

1. **Age Distribution.** In 1990, approximately 22-percent of the Town population was below the age of 17; 59-percent were between 18 and 64; and 19-percent were over the age of 65 (Open Space, 1996). The median age for Falmouth residents in 1990 was 38.5, which was the fifth youngest on the Cape behind Barnstable, Bourne, Mashpee and Sandwich (Cape Trends, 1996).

2. **Income and Tax Burden.** US Census and CapeTrends data estimate that the Median Household Income for Falmouth was between $34,000 and $37,000 per year. Property taxes for Falmouth in 1996 were $10.73 per thousand dollars of assessed property valuation. An average tax bill in 1996 for a single-family home was

section of the Falmouth Local Comprehensive Plan (1998) provides the most complete listing of existing and recommended historic sites.

4.4 WATER SUPPLY

A. Description of Existing Facilities. Currently, 85 percent of Falmouth is serviced by Public Water, which comes from the Sagamore Lens. There are currently four wells in Town, Fresh Pond Well, Coonamessett Well, Mares Pond Well, and Ashumet Well. Of these, only Fresh Pond, Coonamessett and Mares Pond are in use. These three active wells account for 44-percent of the water used in Town.

The Town also receives water from Long Pond, a surface water supply located between Route 28 and Buzzards Bay. This water supply provides for 56 percent of the Town's consumption. Figure 4-1 illustrates the locations of the water supply wells and Long Pond Reservoir.

B. Town-Wide Water Consumption. According to the 1997 Public Water Supply Annual Statistical Report for the Town of Falmouth, approximately 790 million gallons of water was pumped from the Long Pond Reservoir, 188 million gallons from Fresh Pond Well, 318 million gallons from Coonamessett Well, and 121 million gallons from Mares Pond Well for a total of approximately 1,420 million gallons in 1997.

Eighty-four percent of the 1,420 million gallons was consumed by residential, commercial, industrial, and agricultural properties, one-percent accounted for flushing the system, 13-percent was unaccounted for, and two-percent was identified for water system "bleeders", which are drains at dead ends of the water distribution system.

C. Water Conservation Program. The Town of Falmouth Utilities Department currently employs several means to conserve water in the Town. The department tracks leaks in the system during routine maintenance to minimize water losses. The

If a system fails due to frequent pumping, it usually indicates systems that are overloaded, out dated, located in unsuitable soils, or located in low elevation areas where high groundwater conditions occur. This data can be useful to indicate where endemic septic system problems occur or where overloaded systems may be causing a health threat.

Falmouth maintains records of septic system inspections and records on the date and frequency of system pumping. Also, the Health Department has a computerized database (SepTrac) developed by the Buzzards Bay Project to store and access this data. The inspection data has not been entered into the database yet. The septic system pumping data has been entered into the system through July 1, 1997.

Stearns & Wheler analyzed the septic system pumping data for the period of July 1996 through June 1997 to identify the septic systems that had been pumped two or more times during this period. This data helped refine the size of the planning areas. Maps of the planning areas are included in Appendix C, and show the properties that were pumped for the following frequencies:

- Two times
- Three to five times
- Six to ten times
- Greater than ten times

This information will be discussed during the evaluation of the planning areas in Chapter 6. Additional information on the SepTrac system is presented in Section 5.1, B1 of Chapter 5. Recommendations on entering the data into the computerized system are made in Chapter 7.

This information will be updated as more information is entered into the computer.

Chapter 5

Existing Centralized Facilities

CHAPTER 5

EXISTING CENTRALIZED FACILITES

5.1 FALMOUTH WASTEWATER TREATMENT FACILITY (WWTF)

A. History of Falmouth Wastewater Treatment Facilities. In 1949, a portion of Woods Hole was sewered and the effluent discharged into Great Harbor via an 8-inch ocean outfall pipe. As a result of the 1981 Facilities Plan, use of the outfall pipe was discontinued and the existing wastewater treatment facility was constructed. By October of 1986, the existing WWTF construction was completed and the facility was online. Effluent disposal through infiltration basins has been continuously used at this site since the facility's startup in 1986, and spray irrigation has been in use since 1988. Several additions and modifications have been made to the facility over the last 13 years. The majority of these facilities were constructed under three major construction projects, which are described below. Figure 5-1 illustrates the present site layout.

1. Wastewater treatment facility construction. The existing control building, headworks, pump gallery, aerated ponds, sludge drying beds, spray irrigation, and infiltration basins Nos. 1 through 5 were completed and placed in service in 1986.

2. New infiltration beds Nos. 6, 7, and 8. These three additional infiltration basins were completed and put online in 1995. Some modifications were made to the spray irrigation areas to accommodate final construction of these beds.

3. New aerated pond aeration system. This project replaced the existing flow diffusers and lateral piping in each of the three aerated ponds. These modifications were completed and online in 1996, and included the installation of 228 new plate diffusers and associated lateral piping.

B. Summary of Existing Centralized Wastewater Flows and Loadings.

1. Analysis of historical treatment facility records. Wastewater treatment facility staff regularly sample and record the flows of wastewater, and septage. Much of the recorded data is reported to the State in monthly reports, while other data is utilized by the WWTF staff as part of their monitoring and process control operations. As part of this project, four years of data (from 1995 through 1998) were analyzed to determine the flows and loadings to the Falmouth WWTF. Monthly averages were computed and are summarized in Appendix D. This data is the basis for evaluations of influent flows and loadings and plant performance.

a. Plant influent. Plant influent is a combination of wastewater from the collection system and septage. Wastewater is collected at the Jones Palmer Pumping Station where it is pumped to the Falmouth WWTF. The Jones Palmer Pumping Station is equipped with a Doppler flow meter, which measures and records the influent flow to the WWTF. The average day, maximum day, minimum day, and total flows are recorded and reported to DEP in the monthly report. A typical monthly report is attached in Appendix E. Septage is transported to the WWTF by septage haulers. The volume of septage is measured on a scale and record on the monthly report.

Table 5-1 summarizes the average annual, minimum month, maximum month, and peak day influent flows between 1995 and 1998. Table 5-2 summarizes these same flows for 1998, which will be used for the existing conditions.

A representative sample of the facility influent is analyzed weekly for five-day biochemical oxygen demand (BOD_5), and total suspended solids (TSS). The WWTF effluent is sampled weekly and analyzed for BOD_5, TTS, total Kjeldahl nitrogen (TKN), ammonia nitrogen (NH_4-N), and nitrate nitrogen (NO_3-N).

TABLE 5-1

FALMOUTH WWTF
INFLUENT FLOWS (1995 to 1998)
Wastewater Facilities Planning Study
Town of Falmouth, Massachusetts

Flow Average [1]	Flow (gallons per day)	Time of Occurrence
Average annual	463,000	1998
Minimum month	262,000	Jan-95
Maximum month	676,000	Jul-97
Peak day	794,000	29-Jul-97

Notes:

1. Flows include sewage, and septage.

TABLE 5-2

FALMOUTH WWTF
TOTAL 1998 INFLUENT FLOWS
Wastewater Facilities Planning Study
Town of Falmouth, Massachusetts

Flow Average	Sewage Flow (gallons per day)	Septage Flow[2] (gallons per day)	Total	Time of Occurrence
Average annual	435,000	28,000	463,000	1998
Minimum month	334,000	14,000	348,000	Dec-98
Maximum month	564,000	35,000	599,000	Aug-98
Peak day [1]	688,000	49,000	737,000	15-Jul-98

Notes:

1. Peak day consists of the peak day sewage and septage flows combined for that particular month.

2. Septage flows for maximum and minimum months are not necessarily the maximum or minimum values for the year. They are the values that correspond to the months that the maximum and minimum sewage flows occurred. Maximum and minimum septage flows are shown on a following Table.

BOD_5 is used to gauge the strength of wastewater, as it is a measure of the quantity of oxygen that will be required to biologically stabilize the organic matter present in the wastewater. The nitrogen analysis of the effluent provides a measure of the nitrogen loading to the groundwater system. The sum of TKN and NO_3-N represents the total nitrogen content of the effluent.

Influent BOD_5 sampling at the Falmouth WWTF indicates an average BOD_5 concentration between 375 and 411 mg/L for 1995 through 1998. These BOD_5 concentrations result in this wastewater being classified as high strength.

Influent TSS concentrations during the same period averaged between 354 to 469 mg/L, with a maximum concentration of 1175 mg/L in November 1998, and a minimum of 154 mg/L in January 1996. These TSS concentrations are typical of high strength wastewater. High TSS values, like the BOD_5 values, seen at the Falmouth WWTF, are likely due to the relatively high septage flows.

Influent nitrogen values were not available from historical data as these parameters were typically only sampled in the effluent flow. Additional sampling and nitrogen analysis was initiated in early 1999 to establish influent nitrogen characteristics of this wastewater. The early sample results are reported in a following section.

b. Septage. The Falmouth WWTF receives and treats septage and trap grease (all referred to as "septage") from haulers located in and around Falmouth. The WWTF tracks the number of septage loads discharged to the system, and the gallons of septage. The average annual flow, maximum month flow and the minimum month flow for 1998 were 27,900 gpd, 40,700 gpd and 14,000 gpd respectively. The peak day flow of 73,700 gallons was experienced during July of 1998. These flows are summarized in Table 5-3.

c. **Infiltration and inflow.** In 1977 and 1978 the existing Woods Hole sewer system was evaluated and the infiltration and inflow (I/I) was analyzed. The 1981 Facilities Plan indicated that 60 percent (or 0.3 mgd) of the 0.5 mgd wastewater flow could be attributed to groundwater intrusion (infiltration). The reports identified 1,600 feet of pipe in poor condition and requiring replacement, and another 9,500 feet requiring repair.

Based on these recommendations, repairs were made to this system in 1983. The WWTF staff believes that there may still be I/I entering the system. The brick manholes and the older pipe from the original the Woods Hole collection system could be the points of entry for the I/I in the Woods Hole System.

To roughly evaluate I/I in the collection system, Stearns & Wheler performed a water balance study. This study investigated the water consumption of all the sewered properties, and compared that average water flow to the average wastewater flow pumped to the WWTF. The average water consumption for these properties was 281,000 gpd and the average wastewater flow was 435,000 gpd. The water consumption is smaller than the wastewater flow pumped to the WWTF and indicates that extraneous water is entering the collection system as infiltration or inflow. A factor of 90 percent is often used to estimate wastewater flows resulting from water consumption, though this factor will vary from location to location. The 90 percent factor results in a sewage flow of 253,000 gpd from the sewered properties. When that sewage flow is subtracted from the wastewater flow pumped to the WWTF, it indicates an I/I average flow of 180,000 gpd, or 41 percent of the total WWTF influent flow (not counting septage flow).

To further investigate I/I at individual service areas, Stearns & Wheler performed a water balance at each collection system service area by comparing pumping

It is recognized that not all infiltration is cost effective to eliminate, and the DEP has established a cut off of 10,000 gpd/im for I/I to justify grant eligibility and for performing rehabilitative work. Falmouth's I/I falls below this criteria.

Recommendations for further study and correction of I/I in the system are provided in Chapter 7.

Inflow to the collection system during wet weather periods was also investigated by analyzing WWTF influent data before, during, and after storm events. The results indicate a small increase in flow after storm events for most months. The months of July, August, and September actually indicated higher flows prior to the storm events. The increases and decreases were small and wet weather inflow into the collection system through manholes or other entry points does not appear to be a problem.

d. Sludge (biosolids). The Falmouth WWTF operates three aerated ponds, which act as the physical and biological treatment process. Sludge has been removed from the ponds, twice since plant startup. During the first cleaning in 1994, a contractor was hired to remove the sludge using dredging equipment, belt filter presses, and trucks for ultimate sludge disposal. In 1996, as part of the installation of the new aeration equipment, the WWTF operational staff drained the ponds, and pumped the sludge to the three drying beds. The sludge was dried, removed from the beds and disposed of at the Falmouth Sanitary Landfill.

During the first sludge removal, approximately 185 dry tons were removed from Aeration Pond No. 1 with an average concentration of 24 percent solids. Approximately 190 dry tons were removed from Pond No. 2 and 213 dry tons from Pond No. 3, with an average concentrations of 19 and 17 percent solids, respectively. In 1997, following the second cleaning, a total of 1,302 cubic yards was disposed of at the sanitary landfill following the sludge removal from the drying beds.

TABLE 5-4

FALMOUTH WWTF
SUMMARY OF SLUDGE ANALYSIS
Wastewater Facilities Planning Study
Town of Falmouth, Massachusetts

Leachability Analysis (TCLP)							
Parameter	RCRA Limit	Pond 1		Pond 2		Pond 3	
		1994	1996	1994	1996 (1)	1994	1996 (1)
Semivolatiles (mg/kg)		BDL (2)	BDL	BDL	BDL	BDL	BDL
Volatiles (mg/kg)		BDL	BDL	BDL	15	BDL	15
Pesticides (mg/kg)		BDL	BDL	BDL	BDL	BDL	BDL
Herbicides (mg/kg)		BDL	BDL	BDL	BDL	BDL	BDL
PCBs (mg/kg)		NA (3)	BDL	NA	BDL	NA	BDL
Metals, (mg/L)							
Arsenic	5	0.006	BDL	0.003	BDL	0.002	BDL
Barium	100	0.98	2	1.5	2.2	1.3	2.2
Cadmium	1	0.007	BDL	BDL	0.015	BDL	0.015
Chromium	5	< 0.009	BDL	< 0.009	0.01	< 0.009	0.01
Lead	5	< 0.1	BDL	< 0.1	BDL	< 0.1	BDL
Mercury	0.2	< 0.0001	BDL	< .0001	BDL	< 0.0001	BDL
Selenium	1	0.051	BDL	0.035	BDL	0.024	BDL
Silver	5	< 0.01	BDL	< 0.01	0.01	< 0.01	0.01

Notes:
1. Samples from Ponds 2 and 3, during the 1996 sampling, were made into a composit sample prior to analysis.
2. BDL = Below detection limit
3. NA = Not Analyzed

Total Metals Analysis (mg/kg)										
Parameter	Regulartory Threshold				Location					
	USEPA Sludge Type		MADEP Sludge Type		Pond 1		Pond 2		Pond 3	
	A	B	I	II	1994	1996	1994	1996 (1)	1994	1996 (1)
Antimony					NA	BDL	NA	BDL	NA	BDL
Arsenic	41	75			10	BDL	1.4	BDL	4.9	BDL
Boron			300	300	< 0.25	NA	< 0.25	NA	< 0.25	NA
Barium					1100	NA	1800	NA	1700	NA
Beryllium					NA	BDL	NA	BDL	NA	BDL
Cadmium	39	85	14	25	< 4.3	BDL	14	BDL	12	BDL
Chromium	1200	3000	1000	1000	20	30	55	42	62	42
Copper	1500	4300	1000	1000	1900	1800	2900	2500	3100	2500
Lead	300	840	300	1000	210	150	240	BDL	260	BDL
Mercury	17	57	10	10	16	5.2	7.9	6.6	9.2	6.6
Molybdenum	18	75	10	10	20	NA	4.4	NA	11	NA
Nickel	420	420	200	200	< 14	BDL	32	BDL	65	BDL
Selenium	36	100			37	5.9	7.3	14	17	14
Silver					340	59	48	110	100	110
Thallium					NA	BDL	NA	BDL	NA	BDL
Zinc	2800	7500	2500	2500	1400	1500	2300	2100	2600	2100

Notes:
1. Samples from Ponds 2 and 3, during the 1996 sampling, were made into a composit sample prior to analysis.

The grit is also generated at the aerated grit chamber from septage pumped from the septage holding tanks. Typically, the grit screw is operated every other day, and empties into a 1-cubic yard dumpster. The dumpster is hoisted onto a truck periodically and the grit is landfilled. The dumpster is emptied approximately twice a month in the summer and once a month in the winter.

Grit which settles out in the septage holding tanks is removed by a vacuum truck periodically, and this material is discharged to the sludge drying beds. This material, like the pond sludge and the grit generated at the pumping stations, is periodically removed for disposal at the landfill.

C. Additional Wastewater and Septage Sampling. Review of the available data revealed some data gaps, and additional sampling and analysis was requested. The sample locations and the goals of the additional sampling are listed below:

- BOD and TSS analysis of the influent wastewater (without septage) to quantify septage and wastewater BOD and TSS loadings separately.

- Nitrogen analysis of the influent wastewater (without septage as well as from the composite wastewater/septage sample) was requested to quantify nitrogen loadings for the septage and wastewater.

The results of these additional analyses performed in early 1999 are summarized on Table 5-5.

D. Development of Total Flows and Loadings to the WWTF. The wastewater flow quantities at the Falmouth WWTF have been further evaluated by researching the land uses; and associated wastewater flows have been grouped into the following categories: residential, commercial, institutional and industrial. Wastewater loadings have been calculated for these flows using typical concentrations for each category. The

TABLE 5-5

SUMMARY OF ANALYTICAL DATA
ADDITIONAL WASTEWATER SAMPLING
Wastewater Facilities Planning Study
Town of Falmouth, Massachusetts

Parameter	Composite Influent (1)	Influent Wastewater (2)	Septage (5)
Liquid Analysis			
BOD_5 , mg/l (3)	350	236	2,600
TSS, mg/l (3)	346	105	5,000
TKN, mg/l (4)	38.3	30.1	58
NO3-N / NO_2-N, mg/l (4)	0.1	0.2	---
NH_4-N, mg/l (4)	20.7	19.2	---
Alkalinity, mg/l (4)	144	131	---

Notes:

1. Composit Influent Wastewater is comprised of wastewater and septage in volumes proportional to their respective flows into the WWTF.
2. Influent wastewater is wastewater from the Jones Palmer pump station only, no septage component.
3. BOD and TSS results are an average of six (6) samples taken in early 1999.
4. Results are an average of three (3) samples taken in early 1999.
5. Calculated from the other two analyses and the wastewater flows for the sample period.

wastewater flows and loadings for these categories, the septage, and the infiltration/inflow are summarized on Table 5-6.

Comparison of the total sewered flows and loadings (the flows and loadings to the WWTF without the I/I and septage flows) to the population for the sewered areas results in the following per capita loadings rates:

- BOD loading of 0.2 pound BOD/capita/day
- TSS loading of 0.2 pound TTS/capita/day
- TKN loading of 0.02 pound TKN/capita/day

These values are typical for a residential community like Falmouth.

E. Summary of Overall WWTF Performance. Overall facility performance is indicated by the quality of the treated effluent pumped to the infiltration basins and spray irrigation system. Monthly averages (from January 1995 to December 1998) of the WWTF influent, effluent, in addition to the permit limit, are plotted on Figure 5-2 for BOD_5, Figure 5-3 for TSS, and Figure 5-4 for Nitrogen.

Figure 5-2 indicates that the facility performs well at removing BOD with an average annual removal rate of 92 percent. The current groundwater discharge limit for Falmouth is 85 mg/L of BOD on a daily basis and the effluent monthly average BOD concentrations never exceeded this value. The daily average BOD concentration has exceeded the effluent limit only once in the past four year.

Figure 5-3 indicates that the facility performs well at removing TSS on a monthly basis, removing 96 percent as an average annual basis. The current groundwater discharge limit for the Falmouth WWTF is 85 mg/L of TSS on a daily basis, and the effluent TSS concentration has never exceeded this limit.

TABLE 5-6

FALMOUTH WWTF
WASTEWATER FLOWS AND LOADINGS
Wastewater Facilities Planning Study
Town of Falmouth, Massachusetts

Source	Average Annual	Minimum Month	Maximum Month
Residential			
Flow, gpd	55,000	36,000	83,000
BOD_5, lb/day	180	110	350
TSS, lb/day	140	80	280
TKN lb/day	20	10	30
Commercial & Industrial (1)			
Flow, gpd	103,000	67,000	155,000
BOD_5, lb/day	470	250	780
TSS, lb/day	260	170	520
TKN, lb/day	40	10	60
Institutional			
Flow, gpd	95,000	62,000	143,000
BOD_5, lb/day	320	180	600
TSS, lb/day	240	130	480
TKN, lb/day	40	10	60
Total Sewered Areas			
Flow, gpd	253,000	165,000	382,000
BOD_5, lb/day	970	540	1,720
TSS, lb/day	630	370	1,280
TKN, lb/day	100	30	160
WWTF Infiltration/Inflow (gpd) (2)	180,000	180,000	180,000
Septage Flows (gpd)			
Flow, gpd	28,000	14,000	41,000
BOD_5, lb/day	600	300	1,200
TSS, lb/day	1,200	500	2,000
TKN, lb/day	10	10	20
Total WWTF Influent			
Flow, gpd	463,000	334,000	599,000
BOD_5, lb/day	1,580	770	2,900
TSS, lb/day	1,820	790	2,980
TKN, lb/day	120	60	200

Notes:
1. Industrial flows are very small (average annual flow of 300 gpd) and make up a small percentage of the total commercial and industrial category.
2. Infiltration and Inflow can occur any time of the year.

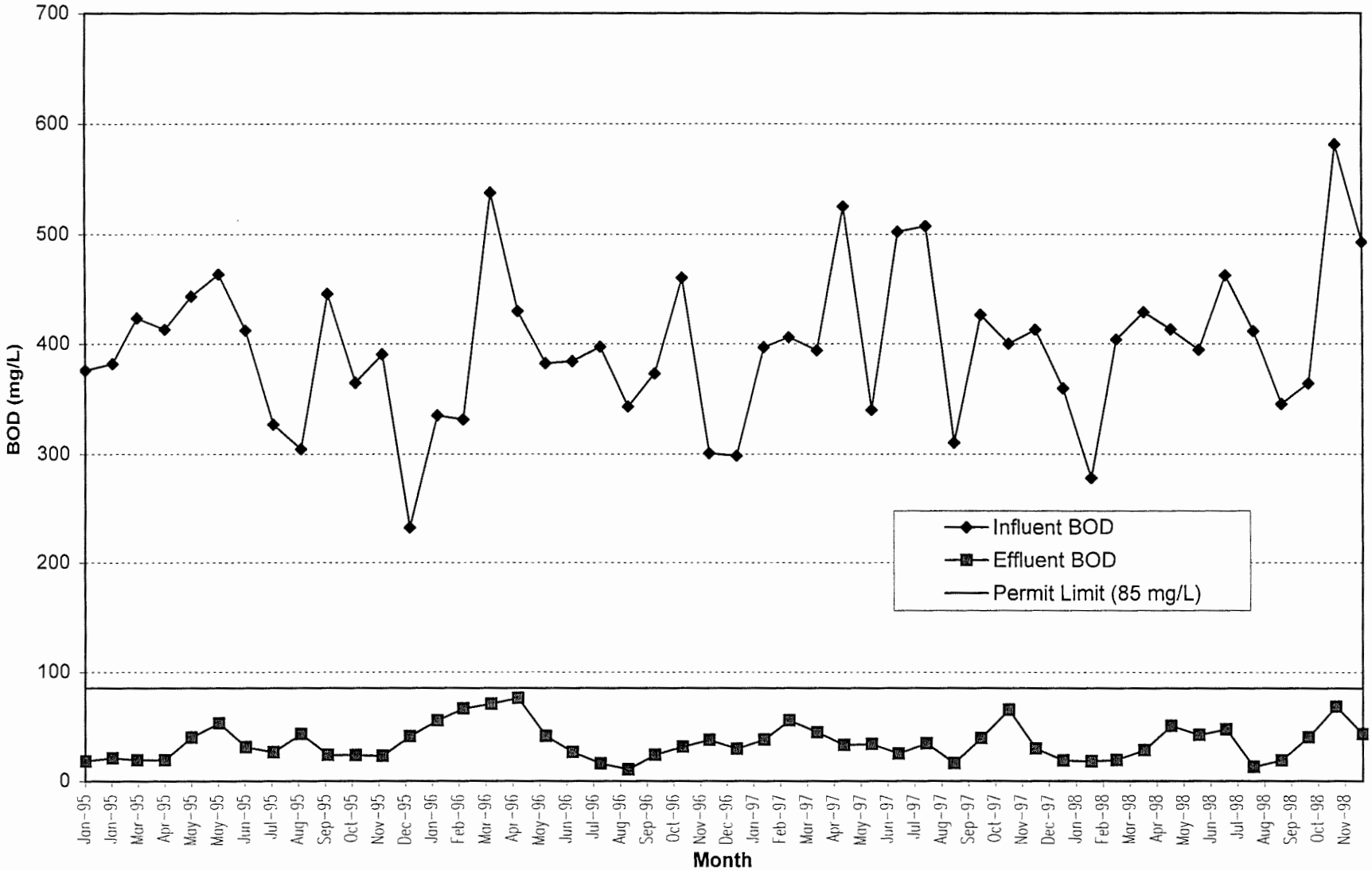


FIGURE 5-2
INFLUENT AND EFFLUENT BOD CONCENTRATIONS

Wastewater Facilities Planning Study
Town of Falmouth, MA

Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS & SCIENTISTS

Chap5figs.xls Fig 5-2 (BOD)
4/7/99

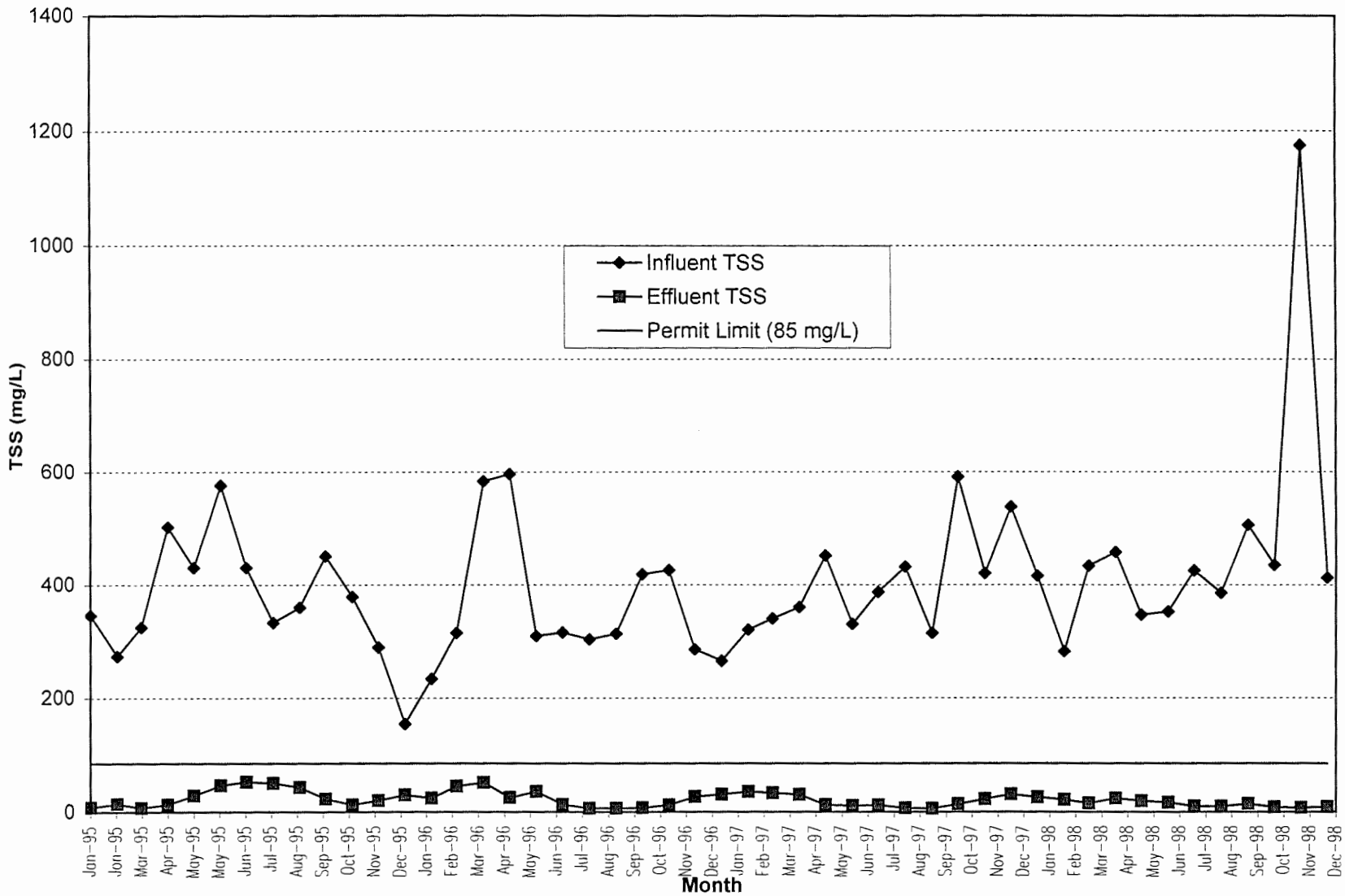
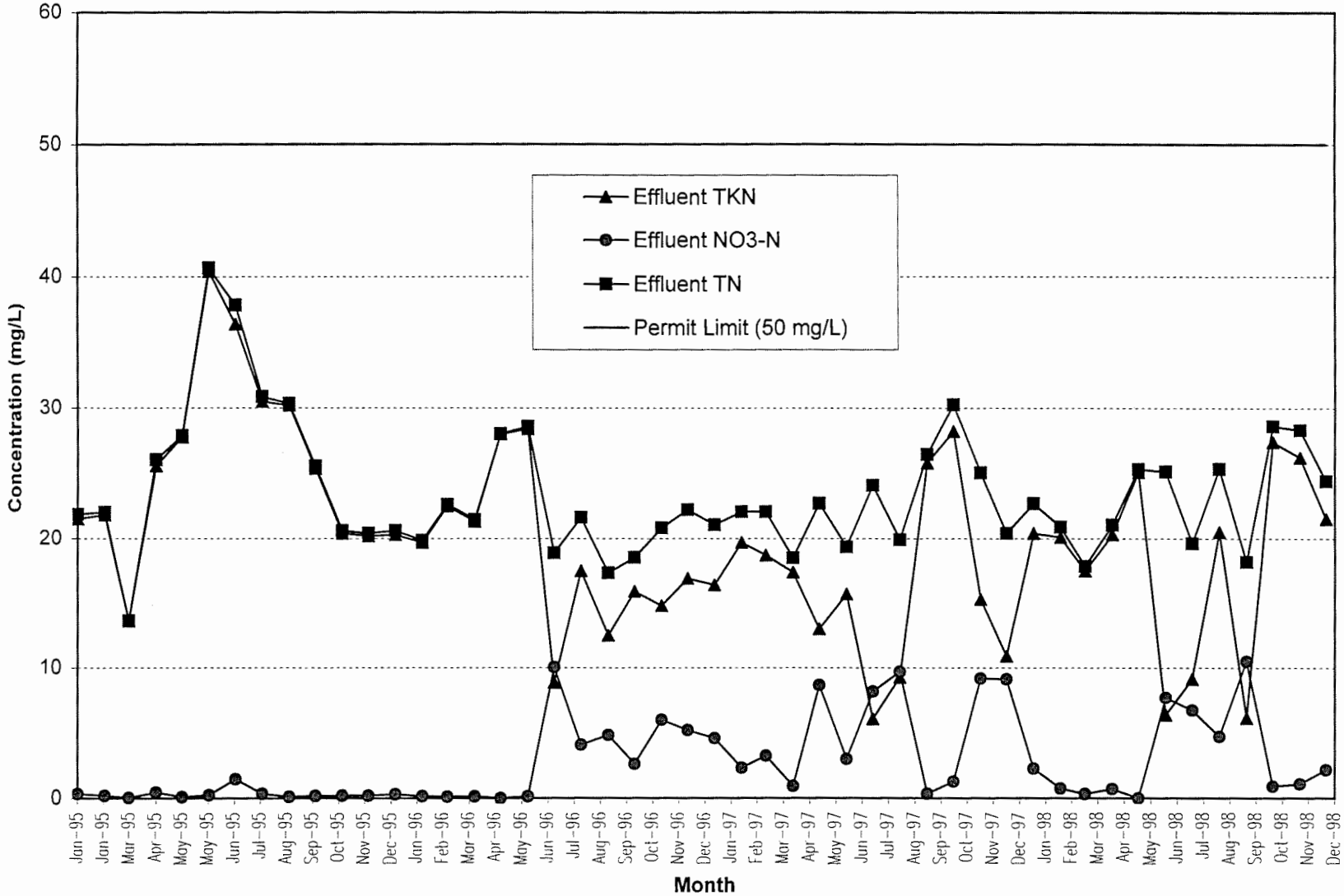


FIGURE 5-3
INFLUENT AND EFFLUENT TSS CONCENTRATIONS

Wastewater Facilities Planning Study
Town of Falmouth, MA

Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS & SCIENTISTS

Chap5figs.xls Fig 5-3 (TSS)
4/7/99



Notes:

1. Influent nitrogen analysis performed in early 1999 indicates total influent nitrogen of approximately 38 mg/l.

FIGURE 5-4

INFLUENT & EFFLUENT NITROGEN CONCENTRATIONS (1)

Wastewater Facilities Planning Study
Town of Falmouth, MA

Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS & SCIENTISTS

Chap5figs.xls Fig 5-4 (N-Plot)
4/7/99

Figure 5-4 shows the monthly average total nitrogen, TKN, and NO_3-N concentrations in the WWTF effluent, which have never exceeded the discharge limit of 50 mg/l. The figure also indicates that some nitrification (conversion of ammonia-nitrogen to nitrate nitrogen) began to occur in June 1996. Minimal denitrification is occurring.

F. Wastewater Treatment Facilities.

1. Description. The Falmouth WWTF is comprised of the pretreatment facilities and aerated ponds. The arrangement of these facilities on the Falmouth WWTF site is shown as Figure 5-1. The existing wastewater detailed flow schematic, Figure 5-5, and the general flow schematic, Figure 5-6, provide a graphic presentation of the wastewater treatment process and flow through the Falmouth WWTF. An inventory of the treatment facilities and process equipment has been developed and is contained in Appendix E.

a. Pretreatment facilities. The pretreatment facilities consist of an aerated grit chamber and grit screw. Currently the aerated grit chamber is only used for flow from the septage holding tanks, and the wastewater flow from the Jones Palmer pumping station by-passes the chamber. Grit from the aerated grit chamber is collected in a 1-cubic yard grit container and disposed of at the landfill.

b. Aerated ponds. This treatment process consists of three aerated ponds. Each pond is equipped with fine bubble diffused air, and flow is controlled with the use of knife gate valves located in structures between each pond. Currently only the diffused aeration systems in Pond Nos. 1 and 2 are in use; Pond No. 3 is not being aerated at this time. Pond No. 1 is the largest with a total volume of 940,000 cubic feet, with dimensions of 600 feet long, 210 feet wide and 12 feet deep. Ponds 2 and 3 are each 470,000 gallons, 290 feet long and 200 feet wide and 12.5 and 13 feet deep respectively. The total volume of these

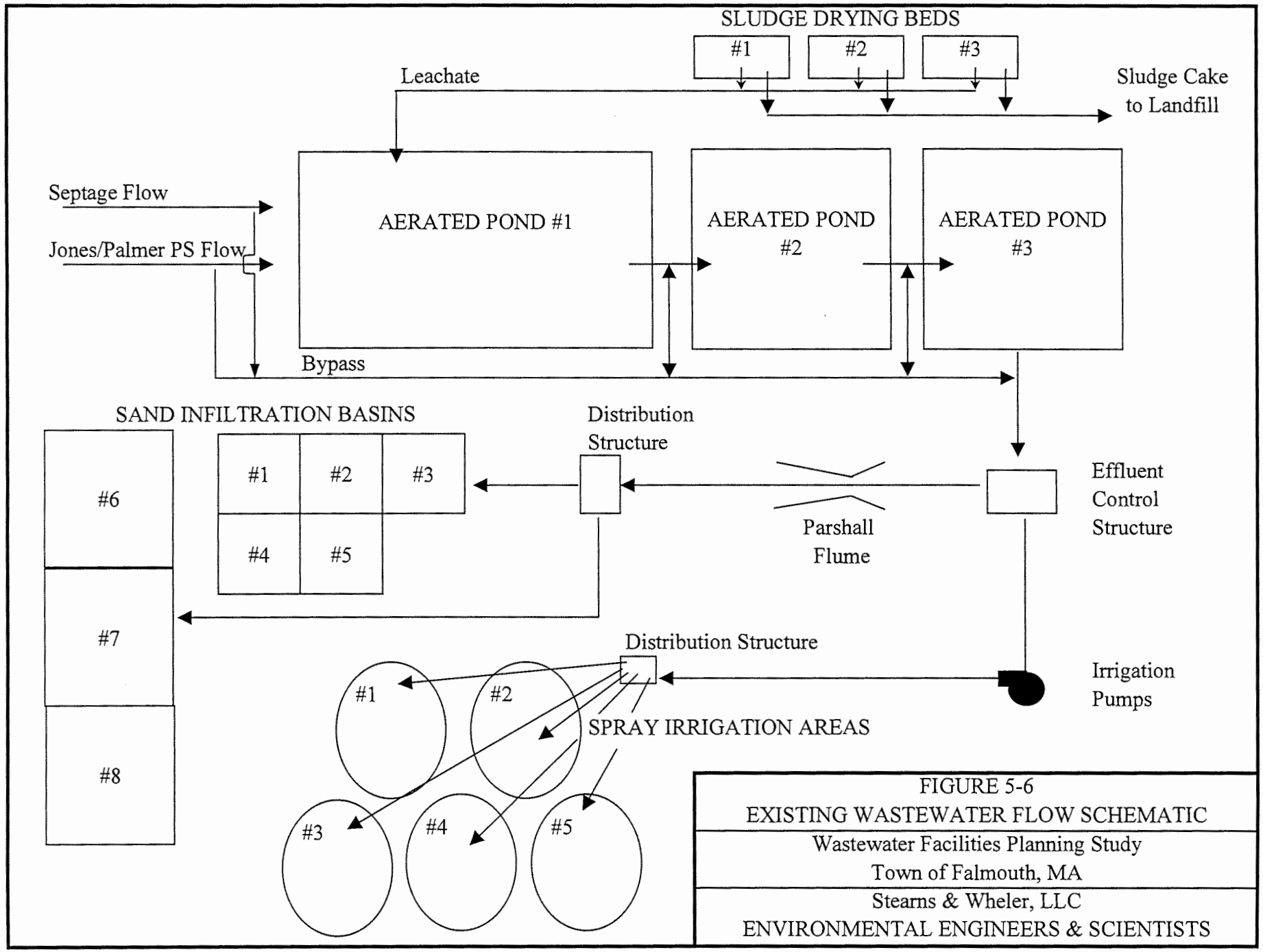


FIGURE 5-6
EXISTING WASTEWATER FLOW SCHEMATIC
Wastewater Facilities Planning Study
Town of Falmouth, MA
Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS & SCIENTISTS

4/7/99
FalmouthWWTFSCHEMATC.XLS Fig5-6 (WW Flows)

three ponds is 1,900,000 cubic feet, with an average hydraulic detention time of 20 days at 0.55 mgd, and a peak hydraulic detention time of 13 days at 0.81 mgd.

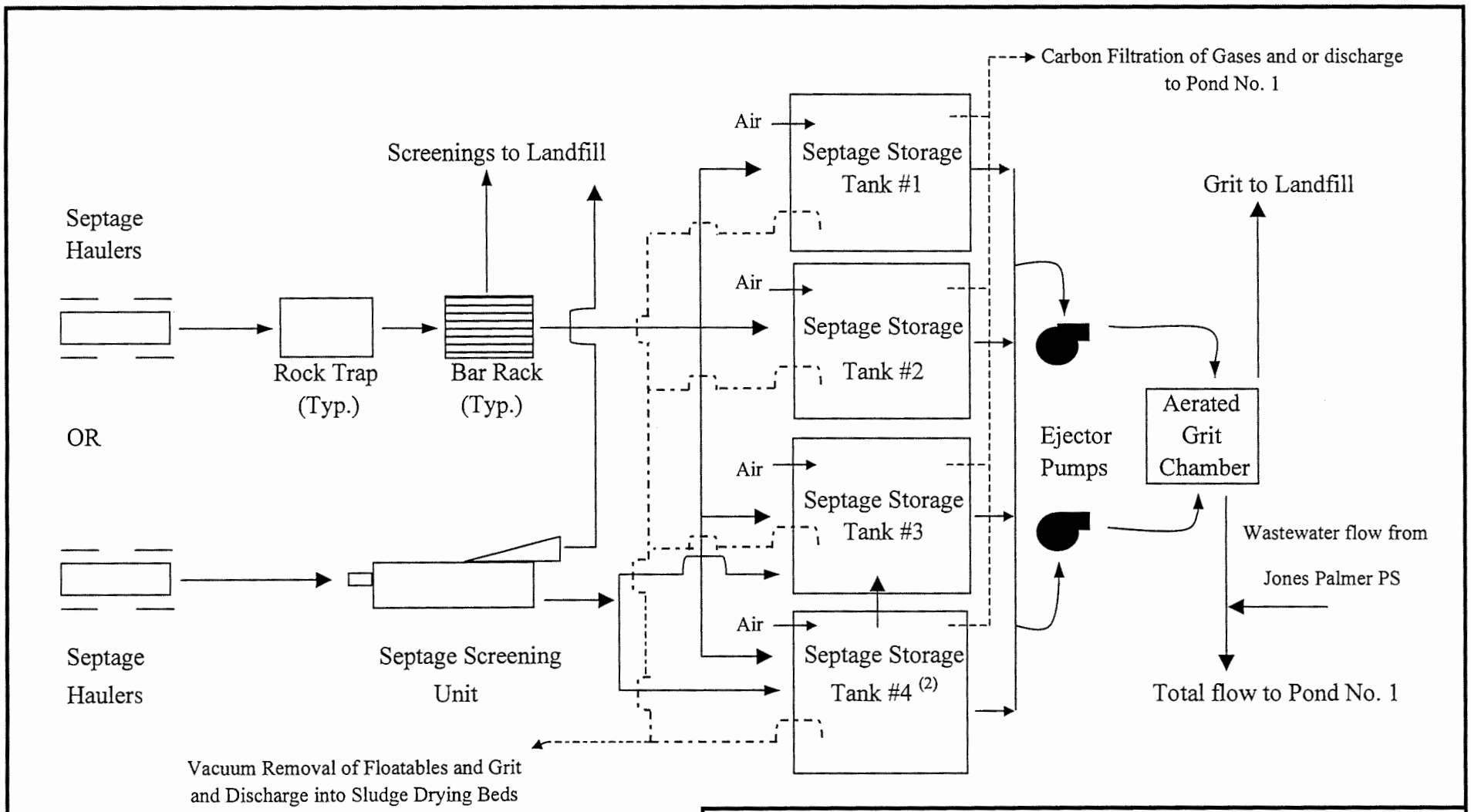
In 1996, all three ponds were modified, replacing the existing coarse bubble diffused air system with a fine bubble submerged plate diffused air system. In Pond No. 1, 172 diffusers and 12 laterals were installed. Pond No. 2 had 36 new diffusers and three laterals installed, and Pond No. 3 had 20 new diffusers and three laterals installed.

Flow is initially received in Pond No. 1, where most of the settable solids are settled, collected, and partially decomposed in the anaerobic zone on the bottom of the pond. The majority of BOD removal takes place in the aerobic zones of each of the ponds. Soluble BOD and suspended matter are processed by bacteria, thus reducing the BOD and TSS concentrations. Effluent polishing is accomplished at the end of Pond No. 2 and all of Pond No. 3. At this point, soluble BOD and TSS loadings are low and minimal oxygen is introduced to the system (currently the diffusers in Pond No. 3 are not used).

2. Performance. The aerated ponds perform well at removing BOD achieving an average of 92-percent removal in 1998. The effluent has only exceeded the 85 mg/l limit once in the past 4 years. Since the installation of the new aeration equipment in the summer of 1996 total nitrogen in the effluent has been below 30 mg/L.

The ponds are also performing well in removing TSS, removing an average of 94-percent of the TSS over the last four years and 96-percent in 1998.

The ponds were not designed for advanced nitrogen removal, and remove only about 20 percent of the influent nitrogen. The average effluent total nitrogen concentration is 23 mg/l. Additional nitrogen is estimated to be removed during effluent discharge (five percent for discharge in the sand beds and 45 percent for discharge at the spray irrigation as evaluated by the Cape Cod Commission, 1998 and Jordan, 1990).



Notes:

1. "Septage" includes septage, trap grease, and other wastewater brought to the WWTF by pump Truck.

2. All "Septage" Flow is initially directed to Tank #4. Typically only Tanks #3 and #4 are used. Chemical addition provided for odor and pH control to each tank.

FIGURE 5-7

EXISTING SEPTAGE (1) FLOW SCHEMATIC

Wastwater Facilities Planning Study

Town of Falmouth, MA

Stearns & Wheler, LLC

ENVIRONMENTAL ENGINEERS & SCIENTISTS

FalmouthWWTFSCHEMATC.XLS Fig5-7(SEPTAGE)
4/7/99

Septage is discharged directly from the haulers tank truck either directly to the individual septage holding tanks or to the septage screening unit. Septage discharged directly to the septage tanks passes through a rock trap and hand cleaned coarse bar rack. The rocks and screenings are manually raked following each discharge, and disposed of at the landfill.

Typically, septage is discharged into the septage screening unit, limiting septage discharge to only one truck at a time. Screenings generated at this location are collected and disposed of at the landfill as construction and demolition material. Flow from the unit passes to septage holding tank No. 4 with an overflow to tank No. 3. Both tanks are aerated, and gasses are collected and treated by a carbon filtration unit or are passed onto Pond No. 1. The septage receiving tanks are equipped with a baffle at the bottom of the tank to allow grit and stones to settle without being pulled into the septage ejector suction lines.

The ejector suction lines are operated such that Tank No. 4 receives all the septage initially, and then the septage is allowed to flow to Tank No. 3. Septage is then pulled from Tank No. 3 via the suction lines and discharged to the headworks of the facility were it enters the aerated grit chamber (See Section 5.1F – Pretreatment Facilities). Tank Nos. 1 and 2 are typically not used unless there are several septage haulers waiting to discharge their wastes.

2. Performance. The septage receiving tanks are not equipped with level sensors so the tanks are completely drained before the ejectors shut off. This allows floatables, such as plastics, to flow into the ejectors and plug them. The septage screening unit has only been in operation since August of 1998 and will be shut off during the winter months due to expected freezing problems. This unit will be operational year-round after completion of the odor control project scheduled in 1999. The screening unit performs well, but limits the number of haulers allowed to discharge at one time. The aerated grit chamber performs well, but its use is limited since the majority of grit and screenings are removed prior to reaching the facility, and it is only used for septage flows at this time.

3. Capacity. Typical loading rates for sludge drying beds for primary digested sludge are between 25 to 30 lb. dry solids/ft^2-yr. In 1994, the three facultative ponds were dredged and solids dewatered using belt filter presses, so the sludge drying beds were not utilized. The mass of dry solids removed during the 1994 sludge dredging equaled 1,174,000 dry lbs. of sludge. This mass divided by the total area of the sludge drying beds (60,000 ft^2) equals 19.5 lb. dry solids/ft^2-yr. This demonstrates that the loading rate is below the design loading rate to these beds. At a loading rate of 25 to 30 lb. dry solids/ft^2-yr, the sludge drying beds could handle between 1.5 to 1.8 million dry lbs. of sludge.

I. Effluent Disposal.

1. Description and capacity of existing discharge beds. The effluent from Pond No. 3 flows by gravity through a 24-inch effluent line to Structure No. 4. At this structure effluent flow is split to the infiltration basins and the spray irrigation system. The effluent sent to the infiltration basins all passes through a flume structure located between infiltration basins No. 1 and 2. Routing of the effluent is controlled through manual operation of sluice gates at the flume structure and three other diversion structures. Each of the original sand infiltration beds (Nos. 1 through 5) is fed from a 20-inch diameter pipe, which tees into a 16-inch diameter pipe at the center of each infiltration basin. The three new infiltration basins (Nos. 6, 7, and 8) are fed from a 12-inch diameter pipe and discharge onto a splash pad at the middle of the southern side of each of these basins.

Each of the original infiltration basins has a leaching area of 37,500 ft^2 and the three new infiltration basins have a leaching area of 62,500 ft^2 each for a total of approximately 375,000 ft^2. The original five infiltration beds contain one foot of sand, and the side slopes are at a three to one ratio and covered with 6-inches of stone. The side slopes on the three new infiltration beds are at a two to one ratio and covered with 6-inches of crushed stone.

The system was designed at a loading rate of 2.0 inches per acre per week (in/ac/wk). Using that loading rate, the five irrigation areas have a capacity of 0.50 mgd. The spray irrigation appears to handle flows greater than 0.5 mgd without problems.

3. Description of existing groundwater plume. Groundwater quality sampling has been routinely performed since the initial startup of the WWTF as part of the groundwater discharge permit. During the most recent round of sampling in March 1998, samples were analyzed for pH, specific conductance, sodium, total iron, manganese, sulfate, chloride, ammonia-nitrogen, nitrate-nitrogen, TKN, phosphorus, copper, surfactants, and total coliform.

Laboratory results indicated that two wells exceeded the nitrate-nitrogen Massachusetts Drinking Water Standard's Maximum Contaminant Level (MCL) of 10 mg/L, and three exceeded the manganese Secondary Maximum Contaminant Level (SMCL) of 0.05 mg/L. Well MW-16 had a nitrate nitrogen concentration of 12.6 mg/L, MW-17 had a concentration of 11.3 mg/L. Wells MW-2 and MW-3 had a manganese concentration of 0.09 mg/L and MW-18B had a concentration of 0.06 mg/L.

As part of this study, additional groundwater monitoring wells will be installed to further delineate and characterize the WWTF plume. The location of the new wells will be identified later in the project at the same time as new wells are identified to delineate the landfill plume.

J. Residual Disposal.

1. Biosolids. The sludge from the aerated ponds has only been removed twice since the initial facility startup. Sludge profiles are developed in the spring and fall of every year. The same profile points are used each time, and sludge volume is calculated based on these profiles.

to an ejector station on Water Street for ultimate disposal into Great Harbor through an 8-inch diameter outfall pipe.

In 1986, Following the 1981 Facilities Planning Study, additional portions of Falmouth including Falmouth Beach, portions of Falmouth Center and Woods Hole, were sewered in 1986. These areas consist of various diameter pipes from 8 to 21 inches, which ultimately discharge to the Jones Palmer pump station, which pumps to the Falmouth WWTF. This new collection system expanded on the 1949 system, and abandoned the 8-inch outfall. The 1986 construction project also built the existing Woods Hole pump station at the location of the ejector station built in 1949.

Since the 1986 expansion of the sewer system, several smaller expansions and connections have been made to the system including:

- Extension along Morin Ave (off Davis Straits) and across Jones Road to pick-up Stop and Shop, Morse Pond School and a nursing home.

- Extension down Scranton Avenue (gravity line) to connect a condominium property and apartments.

- Extension down Scranton Avenue (force main connection) to connect a restaurant and marina along Falmouth Inner Harbor.

- Extension along Waterside Avenue in Falmouth Beach to pick-up two residences.

- Extension to connect the Lawrence School.

- Connection of Mullen-Hall School.

A sanitary sewer typically has a rated design life of 50 years. However, with proper system maintenance and appropriate repairs, it is possible to extend the life of a sewer

Overview of Town of Falmouth Gravity Sewer System [1]

Diameter (inches)	Length (feet)	Percent of Overall System	Material Type [2]
6	1,970	5	VC
8	25,065	67	PVC
10	2,305	6	PVC
12	3,235	9	PVC
18	4,055	11	PVC
21	577	2	RC

Notes: 1. Does not include sewer extensions installed after 1986.
2. VC refers to vitrified clay pipe, RC for reinforced concrete and PVC for poly vinyl chloride.

The extent of the wastewater collection system and existing sewered properties is illustrated in Figure 4-1 and in several figures in Chapter 6. The Town of Falmouth is also developing a detailed map of the collection system based on new Geographic Information System (GIS) data being developed by the Town. This map should be available in mid 1999. The following Table presents a breakdown of the 1949 and 1986 gravity sewers by service area.

Summary of Gravity Sewers by Service Area

	Length of Sewer By Pipe Diameter (ft.)					
Service Area	6– inch	8– inch	10- inch	12- inch	18- inch	21- inch
DS/IH[1]	0	3,574	770	1,427	0	0
Falmouth Beach	0	8,828	1,109	1,808	0	0
Main Street	0	2,413	0	0	4,055	577
Woods Hole	1,970	10,250	426	0	0	0

eastern end of Main Street, Davis Straits and Scranton Avenue. The Inner Harbor Pumping Station also discharges to the gravity sewer in Main Street at Scranton Avenue.

Flow from the Main Street interceptor is collected at the Shivericks Pond Pumping Station and then discharged to the Jones Palmer Pumping Station.

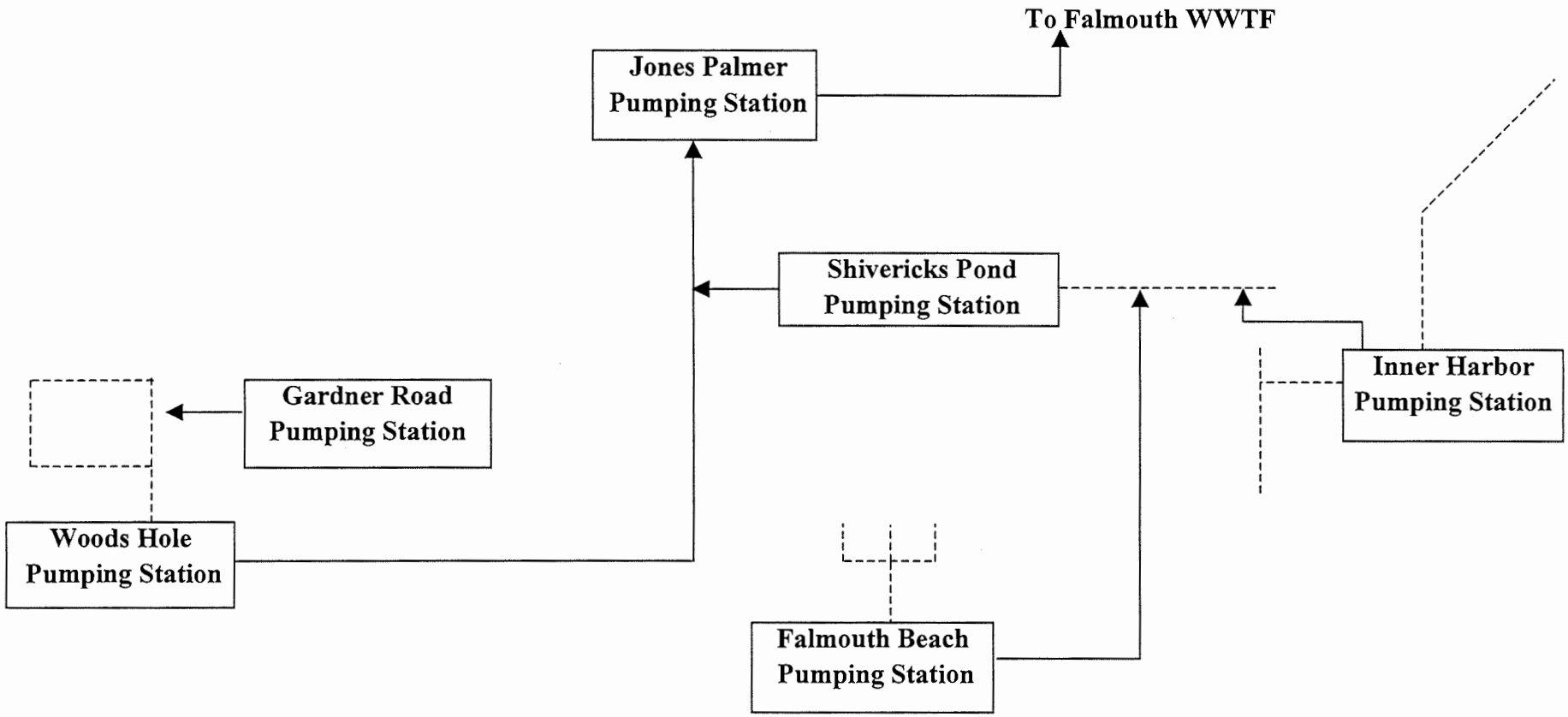
The Jones Palmer Pumping Station is the central collection point for the Town of Falmouth. This pumping station receives wastewater from both Shivericks Pond and Woods Hole pumping stations, as well as gravity flow from the Falmouth Hospital area. This station discharges directly to the Falmouth WWTF, and the treatment facility influent flow is measured at this location.

A schematic diagram of the collection system is presented in Figure 5-8.

The following table presents information on the force mains and Town owned pumping stations.

Summary of Pumping Stations and Force Mains

Pumping Station	Year Built	Force Main Size (inches)	Approximate Length (feet)	Force Main Material	Discharge Location
Falmouth Beach	1986	6	4,430	Ductile Iron	18-inch gravity sewer on Main St
Gardiner Road	1986	4	1,180	Ductile Iron	Manhole and 8-inch VC pipe
Inner Harbor	1986	8	640	Ductile Iron	18-inch gravity sewer on Main St
Jones Palmer	1986	18	17,200	Ductile Iron	WWTF
Shivericks Pond	1986	14	1,830	Ductile Iron	Jones Palmer Pump Station
Woods Hole	1986	12	21,400	Ductile Iron	Jones Palmer Pump Station



LEGEND:

→ **Pumping Station From Main**

---- **Gravity Line (s)**

FIGURE 5-8
Collection System Schematic

Wastewater Facilities Planning Study
Town of Falmouth, MA

Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS & SCIENTISTS

FalmouthWWTFSCHEMATC.XLS Fig5-8(sewer)
4/7/99

C. Hydraulic Capacity of Sewers. It is important to know the full pipe capacity of all major sewer segments for planning and evaluation purposes. This knowledge combined with existing average and peak flows, helps to determine the available sewer capacity for growth and to plan for upgrades and expansions to the system. This section summarizes the hydraulic capacity evaluation of the Town's sewer system.

1. Methodology. The full-pipe hydraulic capacity of each section in Falmouth's gravity sewer system was computed using the Manning's equation. Pipe size and slope information was taken from the 1949 and 1986 sewer design record drawings. Pipe roughness (Manning's "n" value) was based on pipe material. Falmouth's existing sewer system was constructed using reinforced concrete, vitrified clay, and PVC pipe. An "n" value of 0.0014 was used in the equation if the pipe material was unknown, which is typical of reinforced concrete or concrete lined D.I. pipe. The majority of the existing collection system is PVC and thus a "n" value of 0.01 was used for these.

2. Results. The majority of Woods Hole is built out and currently connected to the sewer system. There are portions where the peak flows exceed the half-hydraulic capacity of these lines, but the full line capacity is sufficient to meet all flows. The portions of the Woods Hole collection system installed in 1949 and 1986 have sufficient hydraulic capacity to meet the peak day flows metered at the Woods Hole and Gardiner Road pump station.

Meter Readings from the Falmouth Beach Pumping Station were used to assess the hydraulic capacity of the Falmouth Beach Collection System. Based on these values, all the sewer lines are sufficiently sized at half and full capacity to handle those average and peak flows.

The Davis Straits, Inner Harbor Planning Area is one, which could possibly see increased flows due to expansion of the existing collection system. Based on the meter flows

Section 5.1 B-1 identifies an assessment to quantify I/I by evaluating water consumption data and comparing it to pumping station data. Findings of that assessment indicate that approximately 41 percent of the WWTF influent flow (without septage) is due to I/I. This equates to an I/I of 2,650 gpd/im, which is below the DEP criteria of 10,000 gpd/im commonly used for obtaining state funding and the need for remediation. Recommendations for further study and correction of I/ I in the system are provided in Chapter 7.

Chapter 6

Existing and Future Conditions in Planning Areas

CHAPTER 6

EXISTING AND FUTURE CONDITIONS IN PLANNING AREAS

6.1 INTRODUCTION

There are eight planning areas used for the Wastewater Facilities Planning Study. These areas were identified in the ENF and DRI documents, and summarized in Chapter 1. These areas include:

- West Falmouth Watershed Area
- Falmouth High School
- Woods Hole
- Main Street
- Davis Straits/Inner Harbor
- Falmouth Beach
- Falmouth Heights
- Maravista

This chapter identifies the existing and future conditions in these Planning Areas. It utilizes existing conditions discussed in Chapter 4 for the whole Town as applicable to particular planning area. The chapter also utilizes information developed for individual parcels in the planning areas including: water usage, land use, zoning, living and commercial area, building date of construction, Title 5 design flow, location of historic districts and properties, and location of failed septic systems. The parcel information is based on Tax Assessor maps digitized into a Geographic Information System in 1994, recent updates to that system based on approved subdivision from 1993 to the present, and tax assessor data from 1998.

C. Populations. Population values for the planning areas are calculated based on 1990 census data indicating 2.48 people per household, and five people per household in the summer season as estimated by the Town Planning Department.

6.3 WEST FALMOUTH HARBOR WATERSHED

A. Introduction. The West Falmouth Harbor Planning Area is identified as the groundwater recharge (watershed) areas for West Falmouth Harbor and its subembayments as shown on Figure 6-1. The Harbor's subembayments include Snug Harbor, Harbor Head, and Oyster Pond. The individual subembayments have their own subwatersheds as identified in more detailed maps presented later in this section.

The watershed delineation is based on the watershed for West Falmouth Harbor embayment that has been developed by the Cape Cod Commission, and adopted by the Town of Falmouth Local Comprehensive Plan and Zoning Bylaws. It is based on measured groundwater elevations in the area, and a review of available water supply, wastewater and environmental evaluations. Other efforts to identify this watershed area are discussed later in this chapter.

The major focus for this planning area is nitrogen loading from the watershed to the groundwater system and then, into West Falmouth Harbor and its subembayments. The Falmouth WWTF is located within this watershed and is a source of the nitrogen. Other sources include the Town's sanitary landfill, old septage lagoons located at the landfill, individual septic systems, fertilizers used for lawn and agricultural use, and storm runoff. These nitrogen sources and their effect on the West Falmouth Harbor are quantified in this section.

B. Existing Conditions.

1. West Falmouth Harbor

a. **Uses.** West Falmouth Harbor, like many harbors throughout Cape Cod, provides many natural, cultural, and recreational resources to the area. Harbor attractions and uses include tourism, transportation, recreational uses, and fishing. Recreational boating and shellfishing are as two of the larger harbor uses.

b. **Water quality concerns.** The water quality in West Falmouth Harbor has been monitored by the Falmouth Pond Watchers for several years, and their 1998 report states that the water quality remains good as evidenced by the presence of eel grass beds and benthic animal population. There is minimal evidence of water quality degradation. Water quality sampling and analysis indicates nitrogen and dissolved oxygen concentrations in the Harbor's outer portions similar to water quality in Buzzards Bay and Vineyard Sound. However, water quality measurements at the Harbor's inner reaches indicate elevated nitrogen levels and lower dissolved oxygen levels. This reduced water quality is attributed to the nitrogen loading from the Falmouth WWTF and other nitrogen sources in the watershed (Howes and Goehringer, 1998).

Nitrogen loading assimilation, and monitoring studies performed by the Cape Cod Commission, Buzzards Bay Project, Falmouth Pond Watchers, and Aubrey Consulting, Inc. indicate that the WFH is beginning to see the impacts of this nitrogen loading. Recent studies indicate that the assimilative capacity (critical nitrogen loading) for the Snug Harbor and Harbor Head/Oyster Pond subembayments is being exceeded, although the entire harbor remains below these critical nitrogen loads. Nitrogen impacts are discussed in greater detail in Section 6.2 C.

Characteristics[1] of the West Falmouth Harbor (WFH) Embayment and Watershed

Embayment	Watershed Area (acres)	Mid-Tide Volume (m^3)	Surface Area (acres)	Local Residence Time (days)[2]
Entire WFH	2,245	1,059,168	207	-
Snug Harbor	919	181,248	37	0.85
Oyster Pond/ Harbor Head	733	108,749	18	1.62
Oyster Pond	229	53,808	7	6.16

Notes:

1. Data from Cape Cod Commission, September 1998 Draft Report on Selected Coastal Embayments as attached in Appendix G.
2. The Local Residence Time is the time required for water in subembayments to be exchanged with water from the main body of West Falmouth Harbor, which has water quality similar to water quality in Buzzards Bay. The entire WFH requires 0.57 days to exchange with Buzzards Bay water.

Topography of the area varies from lower elevations of 0-40 feet above MSL along the coastline and west of Route 28A. The hilly terrain east of Route 28A has elevations up to 190 feet above MSL. These elevations are illustrated on Figure 5-2. The hilly terrain marks the location of the Buzzards Bay Moraine, created by glacial activity during the ice age. Further east, the West Falmouth Harbor Planning Area transitions into the Mashpee Outwash Plains (east of Locusfield Road), with rolling to flat terrain and a change in soil conditions to looser, sandier soils.

None of the properties in the West Falmouth Harbor Watershed are connected to the public sewer, and they all rely on individual septic systems for wastewater treatment and disposal. Fifteen percent of the developed properties in this Planning Area have structures over 20 years old. These properties probably utilize cesspools or old forms of Title 5 systems. These systems will probably fail in the next 20-years depending upon how heavily they are used.

Topography is also a factor when siting an onsite soil absorption system. Steep slopes, like those of HkD, PxD, and PsD soils, may limit where these onsite systems can be located on a particular site. Attempting to adjust these slope of 15-35 percent can be very expensive and is not recommended.

The soils least suitable for on-site soil absorption systems are located north of West Falmouth Harbor, along the southern shore of the harbor, and near the north shore of Oyster Pond.

Other soils like the Freetown Swanset mucks (Fs), Ipswich, Pawcatuck, and Matunuck peats (ImA) and the Nantucket sandy loam (NsB), have other limiting factors making them less suitable for onsite soil absorption systems. The Fs soil type is poorly suited for onsite soil absorption systems due to soil wetness, the ImA soils are subject to flooding and ponding, and NsB soils are very tight, compact tills, and have slow percolation rates.

The majority of the soil types in the West Falmouth Harbor watershed area are the PxC, PxD, and BeC (or the Plymouth-Barnstable, Barnstable-Plymouth complexes) soil types. These soils contain boulders and vary from rolling to hilly terrain. These soil types are located between Route 28A and the Falmouth Sanitary Landfill.

4. **Land Use.** The 1998 tax assessor data has been evaluated for the West Falmouth Harbor Watershed Area, and Figure 6-4 illustrates this land use. The following Table further summarizes the existing land use in this planning area.

Land Use Group	Number of Parcels	Percentage of Total
Residential	920	80%
Commercial and Industrial	50	4%
Institutional	80	7%
Undevelopable	88	8%
Agricultural	6	<1%

Approximately 80-percent of the parcels in the West Falmouth Harbor Planning Area is identified as residential. The majority of these residential parcels are located west of Route 28, along West Falmouth Harbor. Only 2-percent of the West Falmouth Watershed Planning Area is made up of commercial properties, which are located along the Route 28A corridor. Industrial properties in West Falmouth Harbor Watershed Planning Area also account for approximately 2-percent of the Planning Area's parcels, and are located east of Route 28 and the WWTF. Together, the commercial and industrial properties make up only 4 percent of the total. Institutional properties account for 7-percent of the total number of properties, and undevelopable properties make up 7.5-percent of the total. Agricultural properties make up the smallest number of properties (6 properties or 0.5-percent).

5. **Zoning.** The following table summarizes the zoning regulations relative to this planning area including: classification, minimum lot size, minimum frontage, and minimum width.

Zoning District	Minimum Lot Area (ft^2)	Minimum Lot Width (ft)	Minimum Lot Frontage (ft)
Single Residence B	40,000	125	100
Business 3	40,000	125	100
Public Use	45,000	150	100
Light Industrial B	80,000	200	150
Light Industrial A	40,000	150	100
Agricultural AA	80,000	200	150
Agricultural A	45,000	150	100

Single Residence B and Business 3 zoning are located west of Route 28. The majority of the Planning Area east of Route 28 is either Agricultural A or AA, with the Falmouth

Technology Park zoned as Light Industrial A and B, and the landfill and WWTF the largest zoned Public Use properties.

C. Wastewater Flows and Loads. Wastewater flows and loading have been calculated for the West Falmouth Planning Area based on the considerations identified in Section 6.2. This area has no sewered properties; therefore, the flows and loadings are presented only for Title 5 flows and average annual flows based on 90 percent of the waster consumption. Table 6-1 presents these flows and loadings.

D. Future Conditions. Future conditions in the West Falmouth Harbor Watershed Planning Area are based on the existing land use, the number and size of vacant properties, existing zoning, and average water consumption rates. This basis is used to calculate future flows and loadings for the area.

This planning area has 216 vacant residential properties that could be subdivided into 271 three-bedroom properties based on an average lot size of 1.5 acres. The area also contains eight vacant commercial properties totaling 960,000 square feet in area and vacant industrial land in Technology Park.

Future wastewater flows and loadings are calculated for this planning area based on the considerations listed in Section 6.2 and the vacant properties identified above. These flows and loadings are summarized in Table 6-2.

E. Nitrogen Loading Assessment.

1. **Review of Existing Information.** Nitrogen loading into the West Falmouth Harbor has been extensively studied in the past. Many past planning, research, and monitoring efforts have been reviewed for this nitrogen loading assessment, and many meetings and telephone contacts have been made to coordinate this effort with on-going work in the West Falmouth Harbor area. These past efforts and on-going projects are listed in Chapter 2.

TABLE 6-1

EXISTING WASTEWATER FLOWS AND LOADINGS IN WEST FALMOUTH HARBOR PLANNING AREA
Wastewater Facilities Planning Study
Town of Falmouth, Massachusetts

Source		Title 5 Flows	Average Annual
West Falmouth Harbor			
Residential			
	Flow, gpd	295,000	109,000
	BOD_5, lb/day	980	360
	TSS, lb/day	740	270
	TKN lb/day	100	40
Commercial & Industrial			
	Flow, gpd	8,000	4,000
	BOD_5, lb/day	40	20
	TSS, lb/day	20	10
	TKN, lb/day	3	1
Institutional			
	Flow, gpd	16,000	8,000
	BOD_5, lb/day	50	30
	TSS, lb/day	40	20
	TKN, lb/day	10	3
Total			
	Flow, gpd	320,000	120,000
	BOD_5, lb/day	1,100	400
	TSS, lb/day	800	300
	TKN, lb/day	100	40

TABLE 6-2

FUTURE WASTEWATER FLOWS AND LOADINGS IN WEST FALMOUTH HARBOR PLANNING AREA
Wastewater Facilities Planning Study
Town of Falmouth, Massachusetts

Source		Title 5 Flows	Average Annual
West Falmouth Harbor			
Residential			
	Flow, gpd	385,000	161,000
	BOD_5, lb/day	1,300	540
	TSS, lb/day	960	400
	TKN lb/day	130	50
Commercial & Industrial			
	Flow, gpd	65,000	33,000
	BOD_5, lb/day	300	150
	TSS, lb/day	160	80
	TKN, lb/day	20	10
Institutional			
	Flow, gpd	18,000	9,000
	BOD_5, lb/day	60	30
	TSS, lb/day	50	20
	TKN, lb/day	10	4
Total			
	Flow, gpd	470,000	200,000
	BOD_5, lb/day	1,600	720
	TSS, lb/day	1,200	510
	TKN, lb/day	160	70

The most recent of these past efforts is the September 1998 Cape Cod Commission Coastal Embayments Report. It is a thorough evaluation, which has referenced past efforts for appropriate data, embayment flushing rates, land use information, and Falmouth WWTF performance data. The portions of the Cape Cod Commission Coastal Embayments Report pertaining to West Falmouth Harbor are contained in Appendix I.

This nitrogen loading assessment of the Cape Cod Commission Coastal Embayments Report is the primary source of methodology and findings for the Needs Assessment Report.

2. **Nitrogen Loading Assessment Methodology.** Nitrogen loading assessments are typically comprised of the following components.

- Identification of the water quality standards and appropriate goals that are desired for the embayment.

- Determination of embayment flushing rates (local residence time) to understand how long the water stays within the embayment before it is flushed to a larger water body where there is relatively pristine (background) water quality.

- Calculation of the embayment nitrogen assimilative capacity (critical nitrogen loading) based on water quality standards and local residence time. This calculation typically uses procedures developed by the Buzzards Bay Project (USEPA & MAEOEA, 1991) and state surface water quality standards. The calculation can also use water quality concentration standards and a mass balance approach. Both calculations were performed for West Falmouth Harbor.

- Delineation of the watershed (recharge area) that contributes surface and groundwater to the embayment or subembayment.

- Calculation of existing and future nitrogen loading in the watershed to indicate the

mass of nitrogen that is introduced to the edges of the embayment with the normal groundwater recharge.

- Assessment of nitrogen interception by wetland systems through which the groundwater (with its soluble nitrogen content) must flow before it recharges into the embayment.

- Comparison of current and future nitrogen loading (after consideration of nitrogen interception by bordering wetlands) to critical nitrogen loading to determine if nitrogen management alternatives should be identified and evaluated.

3. **Water Quality Standards for West Falmouth Harbor.** The state classification system in 314 CMR 4 identifies three types of coastal waters, SA, SB, and SC. These classifications have limited numerical water quality criteria (dissolved oxygen, temperature, pH, solids, color and turbidity, oil and grease, and taste and color) that tend to focus on impacts from point source wastewater discharges. These criteria do not include nitrogen, which is the primary source of coastal over fertilization (eutrophication).

West Falmouth Harbor is classified as SA, which means that the harbor has the following characteristics.

- "Suitable for shellfish harvesting without depuration"

- "Excellent habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation"

- "Excellent aesthetic value".

All of the coastal waters in Falmouth are classified as SA except Falmouth Inner Harbor, which is classified SB. The SB classification allows for the following characteristics.

- "Suitable for shellfish harvesting with depuration"

- Habitat for fish, other aquatic life3 and wildlife, and for primary and secondary recreation.

- Consistently good aesthetic value.

The SC classification is associated with poorer quality waters, and none of Falmouth's waters have this classification.

The state also has a classification called Outstanding Resource Water (ORW), which is the highest classification and further prevents degradation. Coastal waters adjacent to the Cape Cod National Seashore have this classification.

The Cape Cod Commission developed the following additional nitrogen loading standards in their 1998 Coastal Embayments Report.

- The Outstanding Resource Water – Nitrogen (ORW-N) standard represents an increase of 0.05 ppm above the background concentration for a total of 0.35 ppm.

- The Buzzards Bay Project Outstanding Resource Water (BBP ORW) standard represents an increase of 0.1 ppm above the background for a total of 0.4 ppm.

- The SA-N standard represents an increase of 0.15 ppm above the background for a total of 0.45 ppm.

An additional set of nitrogen loading standards has been developed by the Town and has been adopted as Article XXI of the Zoning Bylaws. It is commonly called the Nitrogen Zoning Bylaw. It limits the nitrogen concentration of West Falmouth Harbor extending to Chappaquoit Road, and Snug Harbor extending to Nashawena Road to a nitrogen limit

of 0.32 ppm. These areas are considered High Quality Areas. Harbor Head and Oyster Pond are not specifically classified in this bylaw but are believed to be Stabilization Areas, which have a nitrogen limit of 0.52 ppm.

As discussed in the preceding text, there are several nitrogen loading standards that have been identified for West Falmouth Harbor. The Town should review these nitrogen loading standards to identify the standard that best meets the Town's goals and can be agreed to by all parties. The state classification of SA (BBP-SA as referenced in the Cape Cod Commission Coastal Embayments Report) and the Town's Nitrogen Zoning Bylaw limits are the most enforceable from a regulatory perspective. The Nitrogen Zoning Bylaw standard of 0.32 ppm probably is not attainable for Snug Harbor given the current land use in the watershed, and that it nearly represents background nitrogen concentrations as observed in Buzzards Bay. The BBP-SA classification is attainable and is utilized as the nitrogen loading standard for this nitrogen loading assessment.

4. **Flushing Analysis and Residence Times.** The flushing analyses in Falmouth Harbor and determination of local residence time are described in the following excerpt from the Cape Cod Commission Coastal Embayment Report (CCC, 98).

> "Aubrey Consulting, Inc. (ACI) began a flushing study by collecting tidal data from five TDRs located throughout the Harbor for a 30 day period in July and August 1994. A sixth TDR was also installed in Snug Harbor, but it was vandalized and no data was collected from it (ACI, 1995). Salinity data were also collected at 40 sites and bathymetric data was collected using a boat-mounted total station and fathometer. Two dye dispersion studies and chlorophyll-*a* sampling were also conducted. Tidal and bathymetric information was incorporated into a two dimensional depth-averaged model to determine system residence times and hydrodynamics within the system and to evaluate potential water quality problems based on data collected by the Falmouth Pond Watchers (Howes and Goehringer,

1995). A subsequent contract by the Commission with ACI resulted in the determination of local residence times."

Findings of these analyses are summarized below.

SUMMARY OF FLUSHING AND EMBAYMENT CHARACTERISTICS FOR WEST FALMOUTH HARBOR [1]					
Embayment	**Volume at Mid Tide (M^3)**	**Tidal Prism Volume[2] (M^3)**	**Surface Area (Acres)**	**Residence Time (days)**	
				System[3]	**Local[4]**
Whole System	1,059,168	961,610	207	0.57	
Snug Harbor	181,248	110,350	37	4.52	0.85
Harbor Head/Oyster Pond	108,749	34,740	18	14.78	1.62
Oyster Pond	53,808	17,190	7	106.80	6.16

Notes: 1. Most data from Cape Cod Commission's September 1998 Draft Report on Coastal Embayments.

2. Tidal prism values are calculated based on the mid tide volume, the local residence time defined as mid tide volume divided by tidal prism volume times 12.42 hours per tidal cycle.

3. The System Residence Time is the time (days) required for the total mid tide volume to be exchanged with water from Buzzards Bay.

4. The Local Residence time is the time (days) required for the total mid tide volume to be exchanged with water from the main portion of West Falmouth Harbor, which has the same water quality as Buzzards Bay.

5. Critical Nitrogen Loading Calculation. The Buzzards Bay Project (BBP) has developed methodology to calculate the nitrogen assimilative capacity of an embayment (critical nitrogen loading) based on the flushing characteristics and the state classification of coastal waters. The methodology was presented in the "Comprehensive Conservation and Management Plan for Buzzards Bay" (USEPA and EOEA, 1991). The methodology is based on the following limits.

BUZZARDS BAY PROJECT, NITROGEN LOADING LIMITS			
EMBAYMENT	**ORW/SA**	**SA**	**SB**
Shallow			
- flushing: 4.5 days or less	100 $mg/m^3/Vr$	200 $mg/m^3/Vr$	350 $mg/m^3/Vr$
- flushing; greater than 4.5 days	$5/g/m^2/r$	15 $g/m^2/yr$	30 $g/m^2/yr$
Deep			
- select rate resulting in lesser annual loading	130 $mg/m^3/Vr$ 10 $g/m^2/yr$	260 $mg/m^3/Vr$ 20 $g/m^2/yr$	500 $mg/m^3/Vr$ 45 $g/m^2/yr$
Note: Vr = Vollenweider flushing term; Vr = r/(1 + sqrt (r); r = flushing time (yrs) Source: USEPA and MA EOEA, 1991, and Cape Cod Commission, 1998.			

All of the embayments except Oyster Pond are considered shallow with 4.5 days of flushing or less, and the critical nitrogen loadings are calculated using the 200 $mg/m^3/Vr$ limit. Oyster Pond is a shallow embayment with flushing greater than 4.5 days, and is calculated using the 15 $g/m^2/yr$ limit. The critical nitrogen loading values for the West Falmouth Harbor embayments are summarized below.

CRITICAL NITROGEN LOADING FOR WEST FALMOUTH HARBOR BASED ON BUZZARDS BAY PROJECT METHODOLOGY, LOCAL RESIDENCE TIME, AND SA CLASSIFICATION	
Embayment	**Critical Nitrogen Loading (kg/yr.)**
West Falmouth Harbor System	141,000
Snug Harbor	16,300
Harbor Head/Oyster Pond	5,200
Oyster Pond	400

The critical nitrogen loading has also been calculated based on the Falmouth Zoning Bylaw Water Quality Standards of 0.32 ppm for Snug Harbor, Harbor Head/Oyster Pond and Oyster Pond alone, and 0.52 ppm for Harbor Head and Oyster Pond. This calculation assumes a background concentration of 0.3 ppm, and allows an increase of 0.02 ppm for Snug Harbor, and an increase of 0.22 ppm for Harbor Head and Oyster Pond. These critical nitrogen loadings are presented below.

CRITICAL NITROGEN LOADING FOR WEST FALMOUTH HARBOR BASED ON FALMOUTH ZONING BYLAW, TIDAL PRISM VOLUME, AND LOCAL RESIDENCE TIME [1]	
Embayment	**Critical Nitrogen Loading**
Snug Harbor	1,600
Harbor Head/Oyster Pond	5,400
Oyster Pond	2,700
Note: 1. Calculated based on 1.93 tidal prisms/day and the increase in nitrogen allowed by the Nitrogen Zoning Bylaw.	

The small critical nitrogen loading for Snug Harbor is noted due to the small allowed increase (0.02 ppm) in nitrogen.

6. **Watershed Delineation.** This watershed delineation used for this evaluation was developed and adopted by the Cape Cod Commission. It is based on measured groundwater elevations, in the area, a review of available water supply, wastewater and environmental evaluations and previous efforts to identify this watershed.

The United States Geologic Survey (USGS) is currently modeling the groundwater system in western Cape Cod as part of the remediation program at the Massachusetts Military Reservation (MMR). They have used a regional groundwater model to delineate contributing areas (recharge areas) to public water supplies in this area. This work was presented in their report entitled "Water Resources Investigation Report 98-4237". During the summer of 1999, USGS plans to use the same regional model to delineate contributing areas to Buzzards Bay and Vineyard Sound. They may also delineate contributing areas to smaller embayments such as West Falmouth Harbor if they feel their data is sufficiently accurate to support such a delineation.

Stearns & Wheler has had several conversations with Cape Cod Commission and USGS about appropriate watershed delineations for West Falmouth Harbor. The discussions recognized the uncertainties in delineating a contributing area to West Falmouth Harbor with minimal hydraulic conductivity data in that portion of Falmouth and the limitations of the modeling procedure. Discussions with the Cape Cod Commission staff indicate that the Falmouth Wastewater Facilities Planning Project should utilize the Commission's delineation until the Commission changes their delineation due to more accurate information.

Preliminary review of a potential West Falmouth Harbor watershed delineation by USGS indicates a total watershed delineation similar to the Cape Cod Commission delineation except that the eastern portion tends to extend more to the north. Also, the watershed that drains into the upper reaches of Snug Harbor north of the Nashawena Road (Mashapaquit Creek) is larger and appears to include the Falmouth WWTF.

7. **Existing and Future Nitrogen Loading in the Watershed.** The existing and future nitrogen loadings to the West Falmouth Harbor embayment are developed based on work by the Cape Cod Commission, which was published in their Coastal Embayments Report (1998) and recent data for the Falmouth WWTF. Calculation summaries are attached in Appendix I.

The existing nitrogen loadings in Snug Harbor are summarized below.

SUMMARY OF EXISTING NITROGEN LOADING IN SNUG HARBOR	
Source	**Average Loadings, Kg/yr.**
Sanitary wastewater from on-site systems	2,509
Runoff from roofs and paved areas	712
Groundwater recharge from lawn areas	725
Groundwater recharge from natural areas	211
Groundwater recharge from Falmouth LF[1]	1,217
Groundwater recharge from the Falmouth WWTF Effluent	11,300
Total existing nitrogen loading	**16,674**
Note: 1. Includes nitrogen from the Town's old septage disposal lagoons.	

The first four nitrogen loadings were calculated by the Cape Cod Commission based on the land use in the Snug Harbor Watershed including the residential and commercial properties; population estimates; and land areas estimated for lawns, natural areas and impervious (road and roof) areas. The commission's Technical Bulletin, 91-001 (CCC, 1991) was used as the basis for the calculations.

The groundwater recharge from the Falmouth Landfill and old septage lagoons was calculated by the Commission based on groundwater nitrogen analyses and the average precipitation for the area. This loading will dissipate over time because the landfill will soon be capped and precipitation will no longer be able to leach nitrogen from the landfilled material into the groundwater system.

The groundwater recharge from Falmouth WWTF effluent discharge is based on 1998 operations data and assumed nitrogen removal at the points of discharge based on previous studies. In 1998, the Falmouth WWTF discharged approximately 101.7 M gallons of treated effluent at the spray irrigation fields and 80.8 M gallons at the discharge sand beds. The effluent had an average total nitrogen concentration of 22.7 mg/l. Approximately 55 percent of the nitrogen is believed to leach past the root zone of the spray irrigation area based on a previous assessment of the discharge site (Jordan, 1991), and approximately 95 percent of the nitrogen is believed to leach into the discharge sand beds (CCC, 1998). This results in a total nitrogen loading of 25,000 lb/yr. or 11,300 kg/yr. to the groundwater system. The Cape Cod Commission had previously calculated this loading at 6,736 kg/yr. based on a lower total nitrogen concentration and flow.

In the future, the Snug Harbor Watershed is projected to have approximately 4,626 kg/yr. more nitrogen loading based on the following factors:

- Approximately 4,143 kg/yr. additional nitrogen loading from development of vacant and commercial properties in the watershed.

- Reduced nitrogen loading from the landfill and old septage lagoons resulting from the landfill cap and remediated lagoon area.

- Approximately 1,700 kg/yr. more nitrogen loading from the existing Falmouth WWTF based on approximately 15 percent growth in the existing wastewater collection system through infilling and redevelopment.

The existing nitrogen loadings to the Oyster Pond and Harbor Head embayments were calculated by the Cape Cod Commission based on: the number of residential and commercial properties; populations for these tributary areas; area estimated for lawn, natural and impervious (road and roof) areas; and nitrogen concentrations in the

Commission's Technical Bulletin 91-001. These existing nitrogen loadings are summarized below.

SUMMARY OF EXISTING NITROGEN LOADING IN OYSER POND	
Source	**Annual Loadings, kg/yr.**
Sanitary wastewater from on-site systems	481
Runoff from roofs and paved areas	176
Groundwater recharge from lawn areas	49
Groundwater recharge from natural areas	45
Total	**751**

SUMMARY OF EXISTING NITROGEN LOADING IN HARBOR HEAD	
Source	**Annual Loading, kg/yr.**
Sanitary wastewater from on-site systems	1,749
Runoff from roofs and paved areas	315
Groundwater recharge from lawn areas	271
Groundwater recharge from natural areas	84
Total	**2,419**

In the future, Oyster Pond and Harbor Head are projected to have approximately 599 kg/yr. and 1,897 kg/yr. more nitrogen loading based on development of vacant properties in the watershed (CCC, 1998).

The existing nitrogen loading to the entire West Falmouth Harbor Embayment System is the sum of the Snug Harbor, Oyster Pond, Harbor Head, and the additional watershed loads that discharge into the system. These existing nitrogen loadings are summarized in the following table. The loadings are based on the previous work by the Cape Cod Commission and the updates previously described for Snug Harbor.

SUMMARY OF EXISTING NITROGEN LOADING FOR WFH SYSTEM	
Source	**Annual Loading, kg/yr.**
Sanitary wastewater from on-site systems	6,644
Runoff from roofs and paved areas	1,620
Groundwater recharge from lawn areas	1,490
Groundwater recharge from natural areas	927
Groundwater Recharge from Falmouth LF	2,434
Groundwater Recharge from Falmouth WWTF Effluent	11,300
Total	**24,415**

In the future, this area is projected to have approximately 7,812 kg/yr. more nitrogen based on development of vacant properties in the watershed (8,546 kg/yr. calculated by CCC), approximately 15 percent greater flow to the WWTF (based on infilling and increased land use), and reduced loadings from the landfill and old septage lagoons due to capping of the landfill and remediation of the lagoons.

8. Potential Benefits of Fringing Wetlands to Intercept Nitrogen from Groundwater Recharge. The ability of fringing wetlands to intercept nitrogen from the groundwater that discharges into West Falmouth Harbor was studied by Applied Science Associates, Inc. (ASA) of Narragansett, Rhode Island as part of this project. Their findings are included in Appendix J.

ASA's findings indicate that minimal nitrogen removal should be expected as a result of wetlands intercepting nitrogen from the groundwater recharge into West Falmouth Harbor. Oyster Pond and the upper reaches of Snug Harbor (Mashapaquit Creek) are the only portions of the West Falmouth Harbor System that appear to have enough wetland area to potentially intercept nitrogen. These wetlands may actually be net producers of nitrogen.

Dr. Brian Howes and a graduate student from the University of Massachusetts at Dartmouth are currently performing research on this topic. Findings of their work will be incorporated into this project, as they are available.

9. Summary of Nitrogen Loading Assessment. The nitrogen loading to West Falmouth Harbor has been assessed based on previous scientific work and recent data from the Falmouth WWTF. The Cape Cod Commission's Coastal Embayment Report (CCC, 1998) has been a major source of information on previous studies and nitrogen loading in the watershed. The main findings of the assessment are summarized below .

SUMMARY OF NITROGEN LAODING ASSESSMENT				
Embayment	**Critical Loading Values (kg/yr.)**		**Watershed Nitrogen Loading (kg/yr.)**	
	BBP-SA[1]	**Zoning Bylaw**	**Existing**	**Future**
Whole System	141,000	-	24,415	32,227
Snug Harbor	16,300	1,600[2]	16,674	21,300
Oyster Pond/ Harbor Head	5,200	5,400[3]	3,170	5,067
Oyster Pond	400	2,700[3]	751	1,350

Notes: 1. Based on Buzzards Bay Project (BBP) methodology and SA state classification
2. Based on the Nitrogen Zoning Bylaw limit of 0.32 ppm total nitrogen.
3. Based on the Nitrogen Zoning Bylaw limit of 0.52 ppm total nitrogen.

The summary above indicates that the entire harbor system has the required assimilative capacity (critical nitrogen loading) for the existing and proposed future nitrogen loadings from the watersheds. The summary also indicates that nitrogen loading from the Snug Harbor Watershed exceeds the assimilative capacity for both regulatory limits presented. The nitrogen loading from Oyster Pond exceeds the BBP-SA limit but does not exceed the Zoning Bylaw limit. Current water quality data in Snug Harbor and Oyster Pond

indicate that these two surface water bodies are being impacted by nitrogen loading in their watersheds.

Alternative management technologies and scenarios will be evaluated in the next two phases of this Project, to mitigate the impacts of excessive nitrogen loadings to Snug Harbor, Oyster Pond, and Oyster Pond/Harbor Head embayments. Before these evaluations can be truly useful, the Town and regulatory committees must agree that the BBP-SA limit is the most appropriate limit for the Harbor.

F. Plume Delineation for Falmouth WWTF and Falmouth Landfill, and Review of Previous Groundwater Models. Many groundwater monitoring wells have been installed in the West Falmouth Harbor Watershed area and around Long Pond Water Supply. Existing information has been collected and reviewed for those wells (and at several soil borings) and entered into a monitoring well inventory. Additional monitoring wells may be needed to provide the necessary data to more accurately delineate the plumes.

The location of any future wells to be installed as part of this Project will be reviewed with staff from USGS, and the Cape Cod Commission to gain their concurrence. After the new wells are installed, Stearns & Wheler will monitor the appropriate wells necessary to delineate these plumes.

Two groundwater models have been developed for this area of Falmouth. In the 1970s and 1980s, Camp Dresser & McKee, Inc. (CDM) developed a finite element model to investigate the effects of discharge at the Falmouth WWTF, possible impacts of a groundwater plume from the landfill, and the safe yields of the Long Pond Water Supply and the (proposed) Mares Pond Well. Their findings were presented in the following reports.

- Water Supply Investigation: Zone of Contribution Study, May 1986.

- Draft Summary of Groundwater Investigations in Support of Land Disposal of Treated Wastewater from the Falmouth WWTF, January 1987.

- Water Supply Investigation: Joint Zone of Contribution Study, July 1987.

- Final Report on Groundwater Management/Water Supply Planning.

Findings of the last two reports indicate average annual safe yields of 2.6 mgd from Long Pond and 1.0 mgd from the Mares Pond Well at the same time that there is an average annual WWTF discharge of 0.64 mgd. Pumping at greater rates creates the potential to draw contaminated groundwater adjacent to the landfill into the contributing area of the Long Pond Water Supply.

The USGS has developed a regional finite difference model for the Sagamore Lens to investigate contributing areas to public water supplies as part of the remediation program at the Massachusetts Military Reservation. This model is described in the 1998 USGS report entitled "Delineation of Contributing Areas to Selected Public Supply Wells, Western Cape Cod Water Resources Investigations Report 98-4237". Their findings indicate that the Falmouth Landfill is within the contributing area of the Long Pond Water Supply. Discussions with staff of USGS have identified uncertainties with the delineation of this contributing area due to uncertain hydraulic conductivity values west of the landfill. It is believed that better delineation of the landfill plume through groundwater characterization (as described early in this section) will assist USGS in model calibration and recharge area delineation.

6.4 FALMOUTH HIGH SCHOOL

A. Introduction. Falmouth High School is considered in this Wastewater Facilities Planning Study as a planning area because of its location in the Long Pond Watershed and its high wastewater design flow. It is located north of Brick Kiln Road south of the

West Falmouth Harbor Planning Area as shown on Figures 6-1, 6-2, and 6-4. The school complex encompasses approximately 92 acres including the school building, parking area and athletic fields. The site contains no wetlands, is not located in an ACEC or part of the DCPC. The High School is located upgradient and approximately one-half mile northeast of the Long Pond Reservoir, and is located inside the Long Pond Water Supply Protection Area. The school property is also approximately 2.5 miles from the Falmouth WWTF.

B. Student Population and Wastewater Flows. The student population is approximately 1,250 students with a school staff of approximately 100 people. Based on discussions with the school business office, no expansion of the school is projected in the next five years. It was also stated that the school population is stable and has actually declined from 1,500 students. The decline in population occurred when students from Mashpee left the Falmouth High School after Mashpee constructed a new high school.

The Falmouth High School was originally constructed in 1974, and since then no additions have been constructed.

In 1998, the High School had an average annual water use of 7,000 gpd. The maximum day water flow is unknown.

C. Title 5 Design Flow. The existing septic system was originally designed based on 1,600 students, 140 support staff, and the environmental code of the time period. Four separate septic systems were constructed for the High School: three for the school and one for the fieldhouse. The systems are made up of four septic tanks and 30, 6.5-foot diameter precast leaching pits. The original total design flow for this system was 34,528 gpd.

An estimated wastewater flow of 25,000 gpd is calculated using the current Title 5 regulations and a student population of 1,250. This flow is less than the original design flow but exceeds the current Title 5 regulation limit of 10,000 gpd for systems designed

after 1995 and 15,000 gpd for all other systems. Because this system exceeds this threshold and is located inside the Long Pond Watershed Protection District, DEP may require that the property apply for a groundwater discharge permit or connect to the Falmouth Wastewater Treatment Facility.

D. Soils. There are four soil types identified by the 1993 Barnstable County Soil Survey for the Falmouth High School property. These soil types are: Udipsamments (Ud), Hinckley sandy loam 0-3 percent slopes (HeA), Hinckley sandy loam 3-8 percent slopes (HeB), and Hinckley gravelly sandy loam 15-35 percent slopes (HkD).

The Soil Survey identifies Udipsamments soils as "nearly level soils in areas that have been excavated or filled during construction." Because the majority of this property is identified as Ud, on-site investigations would be necessary to identify more specific soil conditions on this site. The remaining soils are identified as providing poor filtering for onsite soil absorption systems. Figure 6-3 shows the soil locations for the Falmouth High School property.

E. Future Conditions. The school population and overall school facility is not expected to change in the next five years based on discussion with the Falmouth School Department. Enrollment projections for the school show no significant increases.

F. Existing and Future Flows and Loadings. Existing and future flows and loadings are calculated based on the following factors:

- 100 percent water consumption to represent the average annual wastewater flow.
- Existing Title 5 design flows based on 1,250 students.
- Future Title 5 design flow based on s student population of 1,600 (the original design population) students.

- Future average annual flow is based on the existing wastewater flow times a 1.28 factor, which accounts for an increase to 1,600 students.

- Typical concentrations for the sewered flow pumped to the Falmouth WWTF.

The existing and future flows and loadings are presented in Tables 6-3 and 6-4.

It is noted that daily and monthly flow data is needed to accurately investigate alternative treatment scenarios for this Planning Area. Also, more accurate characterization of the wastewater is needed.

6.5 WOODS HOLE PLANNING AREA

A. Location and Existing Conditions.

The Planning Area is made up mostly of sewered properties, and is bounded by properties along Gardiner Road and Milfield Street to the north, School Street to the east, Juniper Point to the south, and Great Harbor and Buzzards Bay to the west. Juniper Point is the largest non-sewered part of the Woods Hole Planning Area. The limit of the Woods Hole Planning Area is depicted in Figure 6-5.

The southeastern portions of this planning area are in the Woods Hole Historic District. This District extends from Church Street to the Nobska Lighthouse, along Water Street to Eel Pond Bridge, and also includes Woods Hole Road, School Street, and Luscombe Avenue. Also included in the Planning Area is Woods Hole School, which is listed in the National Register of Historic Places.

Thirty Five percent of the unsewered properties, 26 in total, identified in the Woods Hole Planning Area, have structures which were constructed prior to 1978. Due to their age, these properties may still use cesspools to dispose of their wastewater. Because so much

TABLE 6-3

FALMOUTH HIGH SCHOOL
EXISTING FLOWS AND LOADS
Wastewater Facilities Planning Study
Town of Falmouth, Massachusetts

Parameters	Title 5 Flows	Average Annual Water Consumption
Flow (gpd)	25,000	7,000
BOD (lb/day)	80	20
TSS (lb/day)	60	20
TKN (lb/day)	10	2

TABLE 6-4

FALMOUTH HIGH SCHOOL
FUTURE FLOWS AND LOADS
Wastewater Facilities Planning Study
Town of Falmouth, Massachusetts

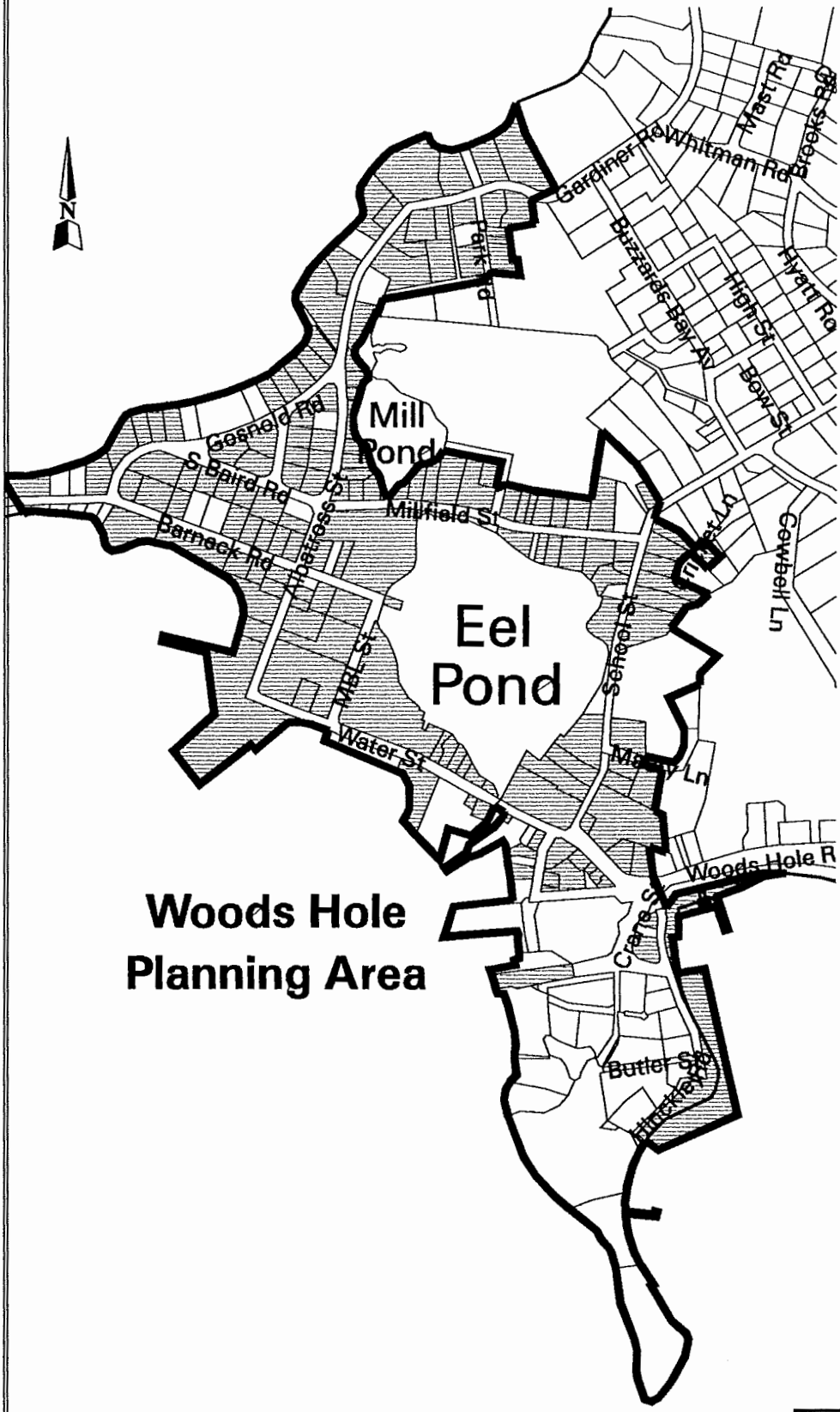
Parameters	Title 5 Flows	Average Annual Water Consumption
Flow (gpd)	32,000	9,000
BOD (lb/day)	110	30
TSS (lb/day)	80	20
TKN (lb/day)	10	3

Town of Falmouth
Woods Hole Area

This map was developed by Stearns & Wheler, LLC, Environmental Engineers &Scientists for the purpose of studying Falmouth's wastewater management needs. Base map features such as coastlines, water bodies, roads and road names were automated by the Cape Cod Commission GIS department. Special technical assistance and data was provided by MassGIS of Boston, MA; and the Town of Falmouth.

Parcels were digitized by the Cap Cod Commission GIS Department for use by the Town of Falmouth from Falmouth 1994 Assessors Maps at the original scale of 1:1200 and 1:2400.

The map has been developed as a planning tool to investigate problems related to wastewater treatment and disposal. Much Town-wide and regional information has been intergrated to produce this map. The source information comes from a variety of dates, as noted above, and therefore, may not reveal more recent changes. Also, the source information was digitized with a regional prespective, and this may show inherent inaccuracies pertaining to individual properties. This map does not intend to provide design information or regulatory enforcement for individual properties.



Legend

- Parcels
- Coastline
- Town Boundaries
- Planning Area Boundaries
- Sawered Parcels

0 200 400 800 feet

Massachusetts State Plane Feet
North American Datum - 1927

February 19, 1999

FIGURE 6-5
PLANNING AREA

Wastewater Facilities Planning Study
Town of Falmouth, MA

Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS & SCIENTISTS

Map prepared by Harvard Design and Mapping Company, Inc.

of Woods Hole is at a low elevation, these systems could be in the groundwater, which is a failure criteria according to 310 CMR 15.303.

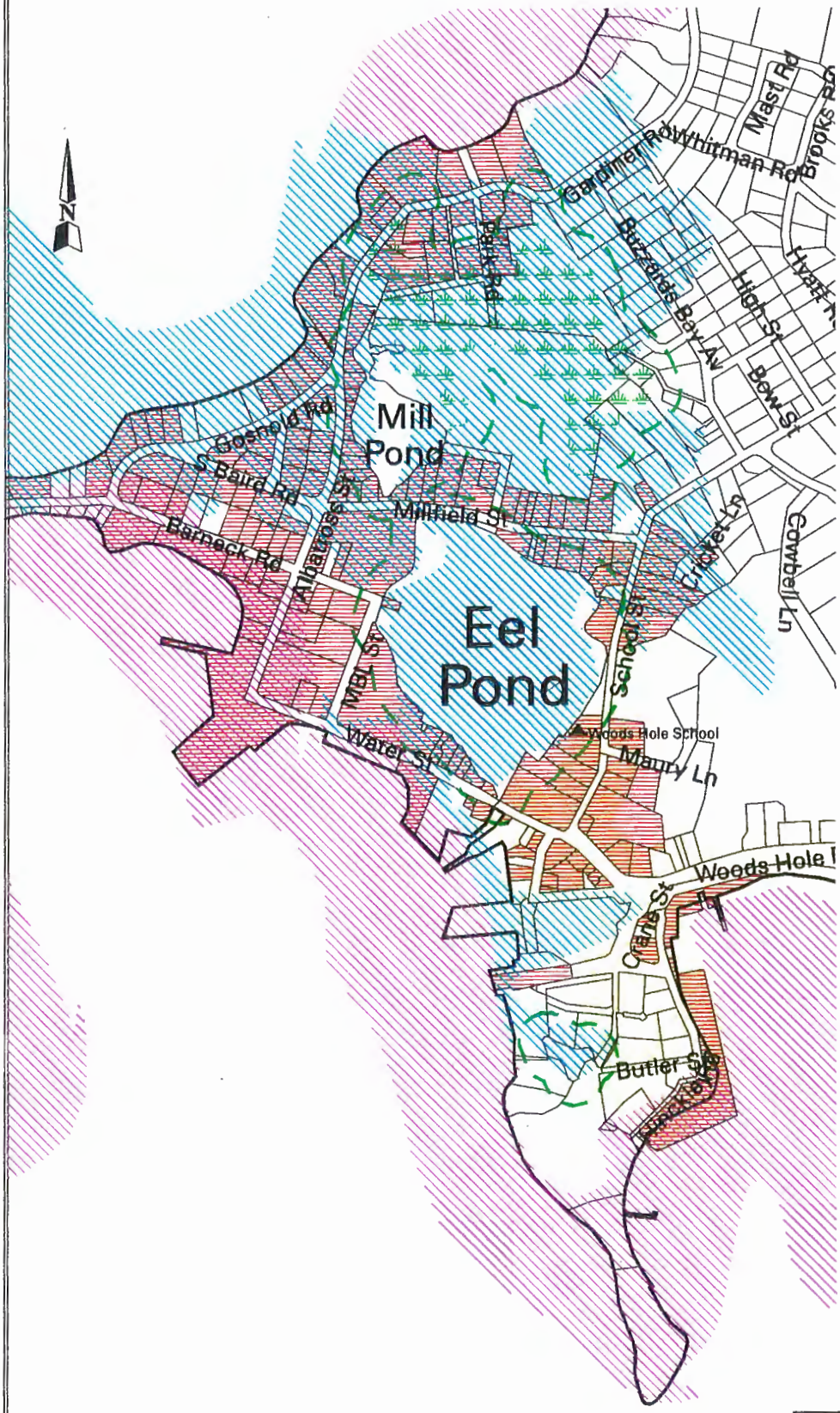
Natural resources identified in the Planning Area include wetlands, fresh and salt-water ponds, and flood zones. There is one large wetland located between Gardiner Road and Milfield Street, which is also the location of the Gardiner Road Pumping Station, and one small wetland restriction area located on Juniper Point. The FEMA Flood Insurance Rate Maps show the southern portions of Juniper Point in a velocity zone, and the northern and western portions of the point within the 100-year flood zone (or A-Zone). The Woods Hole Planning area does not include any ACECs or DCPCs.

The existing conditions discussed above are illustrated on Figure 6-6.

There are eight soil types identified by the 1993 Barnstable County Soil Survey, which are located in the Woods Hole Planning Area. These soil types are: Barnstable-Plymouth complex (PxD), Barnstable sandy loam 8-15 percent slopes (BdC), Hooksan-dune land complex (HxC), Ipswich, Pawcatuck, and Matunuck peats (ImA), Merrimack sandy loam 3-8 percent (MeB), Plymouth-Barnstable complex (PxD), Udipsamments (Ud), and Urban (Ur).

Because the majority of the Woods Hole Planning Area is already sewered, soil conditions are not an issue. Juniper Point, located between Inner Harbor and Great Harbor, is the largest non-sewered part of the Planning Area. Soils in the non-sewered portions of the point are characterized as PxD, and BdC type soils. These soils are sandy loams having rapid permeability. These soils are limited in their ability to provide additional filtering of septic tank effluent. Figure 6-7 shows the locations of these soil types.

Review of septage pumping records indicated no failing on-site systems in this Planning Area.



Town of Falmouth Woods Hole Area

This map was developed by Stearns & Wheler, LLC, Environmental Engineers &Scientists for the purpose of studying Falmouth's wastewater management needs. Sewered parcels were digitized in 1990 for the Cape Cod Commission's Regional Policy Plan. Other base map features such as coastlines, water bodies, roads and road names were automated by the Cape Cod Commission GIS department. Special technical assistance and data was provided by MassGIS of Boston, MA; and the Town of Falmouth.

Parcels were digitized by the Cap Cod Commission GIS Department for use by the Town of Falmouth from Falmouth 1994 Assessors Maps at the original scale of 1:1200 and 1:2400. Wetlands were digitized by Cape Cod Commission GIS and orginated from 1990 MacConnell Aerial Photo Land Use and 1982 Mass DEP wetland restriction maps. Wetland restriction areas were provided by the Town of Falmouth, digitized by Cape Cod Commission. Flood hazards were digitized by the Cape Cod Commission from 1986 Flood Insurance Rate Maps produced by the Federal Emergency Management Agency, and rubber-sheeted to match MassGIS 1:25,000 road network.

The map has been developed as a planning tool to investigate problems related to wastewater treatment and disposal. Much Town-wide and regional information has been intergrated to produce this map. The source information comes from a variety of dates, as noted above, and therefore, may not reveal more recent changes. Also, the source information was digitized with a regional prespective, and this may show inherent inaccuracies pertaining to individual properties. This map does not intend to provide design information or regulatory enforcement for individual properties.

Legend

- Parcels
- Coastline
- Town Boundaries
- Wetland Restriction Area
- Wetlands
- Surface Water Bodies
- A Flood Zone
- V Flood Zone
- Sewered Parcels
- Historic Districts
- Historic Sites

0 200 400 800 feet

Massachusetts State Plane Feet
North American Datum - 1927

February 12, 1999

FIGURE 6-6
EXISTING CONDITIONS

Wastewater Facilities Planning Study
Town of Falmouth, MA

Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS & SCIENTISTS

Map prepared by Harvard Design and Mapping Company, Inc.

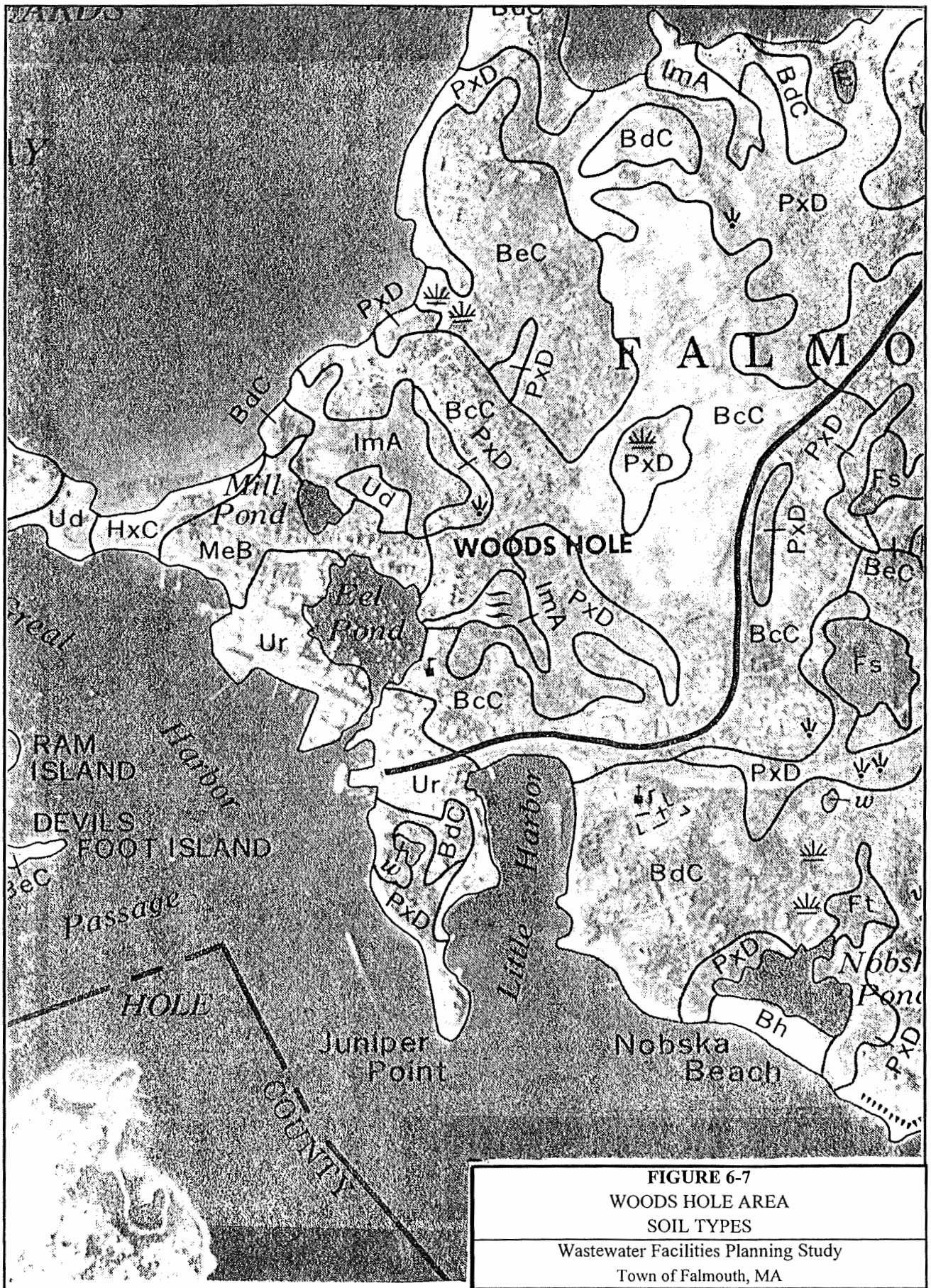


FIGURE 6-7
WOODS HOLE AREA
SOIL TYPES

Wastewater Facilities Planning Study
Town of Falmouth, MA

Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS AND SCIENTISTS

Source: Barnstable County Soil Survey, 1993

Soilmap-borders.xls Fig6-5

The Coast Guard station has a private pumping station that discharges to the gravity collection system through a force main in the Town road. Little information is available regarding the pumping station.

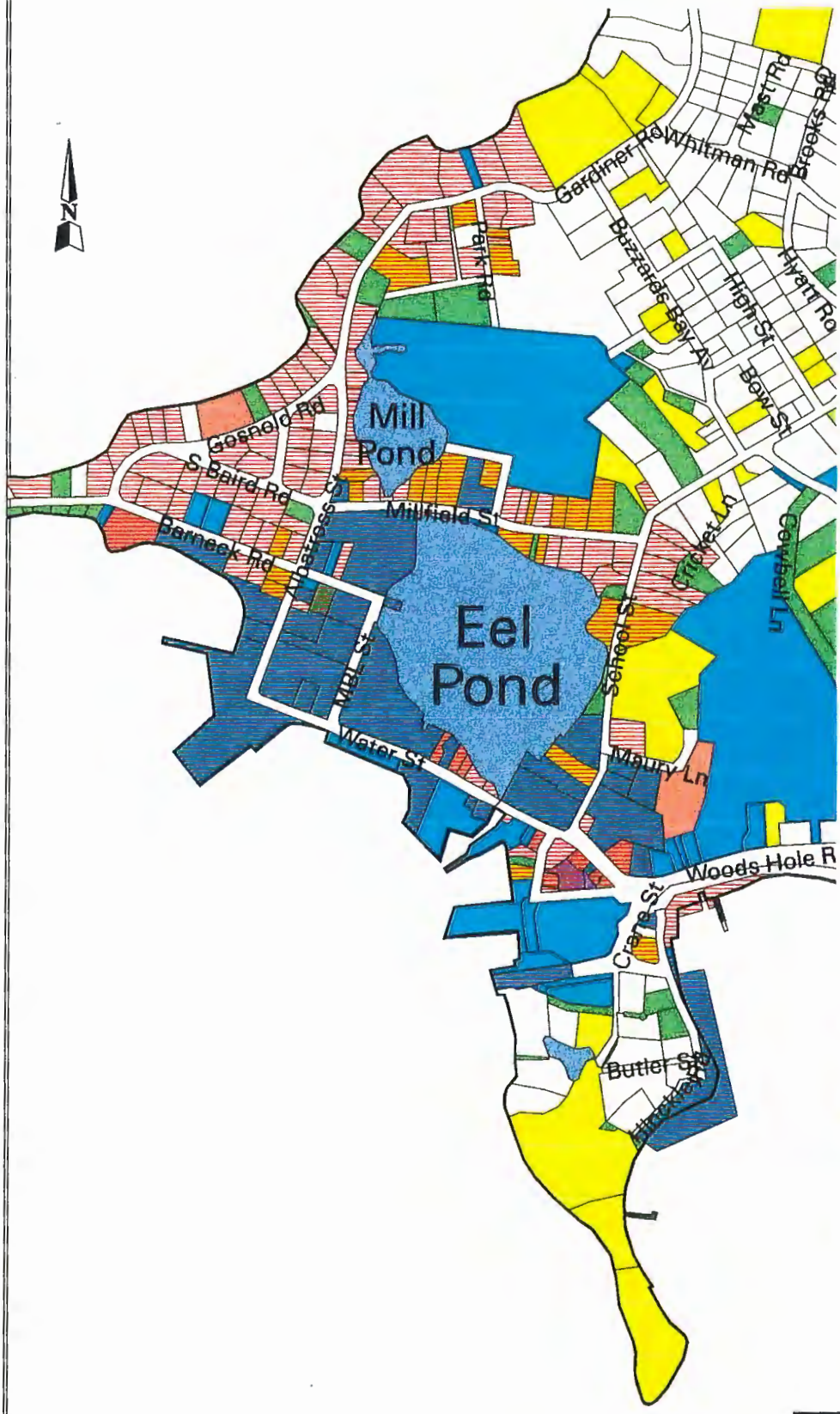
Two properties on Little Harbor Road have connected to this force main with low pressure grinder pumps. A third resident on Little Harbor Road has requested connection to this force main. Sewer extension to the properties on Juniper Point will be the main focus of wastewater treatment evaluations for this planning area.

B. Land Use and Zoning. There are 233 parcels in the Woods Hole Planning Area, 141 (or 60-percent) are residential, 21 (or 9-percent) are commercial, 52 (or 22-percent) are institutional, and 18 (or 8-percent) are undevelopable. The following Table summarizes this information.

Land Use Group	Number of Parcels	Percentage of Total
Residential	141	61%
Commercial	21	9%
Industrial	0	0%
Institutional	52	22%
Undevelopable	18	8%
Agricultural	0	0%

Figure 6-8 presents the land use in the Woods Hole Planning Area.

The Woods Hole Planning Area has five different zoning districts, with the single and general residence districts covering the largest portions of this area. Public Use zoning extends along Great Harbor from the Steamship Authority, past the Woods Hole Pump Station where Water Street changes to Albatross Street. Outside this stretch of Water Street, the Coast Guard Station is also zoned Public Use. The Business 1 Zoning District, in Woods Hole, is located at the intersection of Water and School Streets and is the



Town of Falmouth Woods Hole Area

This map was developed by Stearns & Wheler, LLC, Environmental Engineers &Scientists for the purpose of studying Falmouth's wastewater management needs. Sewered parcels were digitized in 1990 for the Cape Cod Commission's Regional Policy Plan. Other base map features such as coastlines, water bodies, roads and road names were automated by the Cape Cod Commission GIS department. Special technical assistance and data was provided by MassGIS of Boston, MA; and the Town of Falmouth.

Parcels were digitized by the Cap Cod Commission GIS Department for use by the Town of Falmouth from Falmouth 1994 Assessors Maps at the original scale of 1:1200 and 1:2400.

The map has been developed as a planning tool to investigate problems related to wastewater treatment and disposal. Much Town-wide and regional information has been intergrated to produce this map. The source information comes from a variety of dates, as noted above, and therefore, may not reveal more recent changes. Also, the source information was digitized with a regional prespective, and this may show inherent inaccuracies pertaining to individual properties. This map does not intend to provide design information or regulatory enforcement for individual properties.

Legend

- Parcels
- Coastline
- Town Boundaries
- Sewered Parcels
- Single Family Residential (101, 106)
- Multi Family Residential (102, 104, 105, 109, 111, 112, 121, 140)
- Office and Retail Trade (13, 31, 315, 321-325, 340-342, 355, 356, 358, 359, 361, 364, 384)
- Motel and Restaurant (300, 301, 302, 304, 326)
- Industrial (384, 400, 401, 402)
- Auto Related Business (314, 330-334, 337, 338)
- Storage Warehouse and Distribution (310, 311, 313, 316, 318)
- Public Utility (423, 424, 430, 431, 433)
- Vacant Land (130, 131, 132, 220, 221, 390, 391, 392, 440, 441, 442)
- Agricultural Land (210, 317, 393, 710, 712-714, 717-720, 722)
- Recreation and Open Space (201, 202, 370, 374, 375, 380-383, 385, 386, 388, 805, 814)
- Institutional (350, 352-354, 900-908)
- Ponds

0 200 400 800 feet

Massachusetts State Plane Feet
North American Datum - 1927

February 12, 1999

FIGURE 6-8
LANDUSE

Wastewater Facilities Planning Study
Town of Falmouth, MA

Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS & SCIENTISTS

Map prepared by Harvard Design and Mapping Company, Inc.

location of most of the commercial properties in the Woods Hole Planning Area. The following Table summarizes the Woods Hole Planning Area Zoning.

Zoning District	Minimum Lot Area (ft^2)	Minimum Lot Width (ft)	Minimum Lot Frontage (ft)
Business 1	---	---	---
Single Residence B	40,000	125	100
Single Residence C	40,000	100	100
General Residence	20,000	125	100
Public Use	45,000	150	100

There are no minimum lot size requirements for Business 1 zoning.

C. Existing Sewered Area. The existing sewer system in the Woods Hole Planning Area was examined in Chapter 5 to evaluate the existing sewer system's ability to handle current and future wastewater flows. This evaluation involved calculating the hydraulic capacity of the various sewers, calculating the capacity of the existing pumping stations and assessing the existing systems ability to handle increased flows generated from "infilling" and new sewer extensions.

The original Woods Hole Collection System was constructed in 1949, servicing the area of Woods Hole surrounding Eel Pond. This collection system was extended and modified in 1986 as a result of the 1981 Wastewater Facilities Plan for the Town. Currently 70 percent (or 160 of 233 parcels) in the Woods Hole Planning Area is sewered and the largest concern for this system is I/I. Some rehabilitation was performed during the 1986 modifications. These issues are discussed in Chapter 5.

D. Flows and Loadings. The existing flows and loadings for Woods Hole Planning Area are summarized on Table 6-5, and indicate the sewered flows as well as the non-sewered flows. These flows and loadings were developed based on the land uses described above and the considerations listed in Section 6-2.

TABLE 6-5

EXISTING WASTEWATER FLOWS AND LOADINGS IN WOODS HOLE PLANNING AREA
Wastewater Facilities Planning Study
Town of Falmouth, Massachusetts

	Sewered Flow	Non-Sewered Flow	
Source	Average Annual	Title 5 Flows	Average Annual
West Falmouth Harbor			
Residential			
Flow, gpd	14,000	9,000	5,000
BOD_5, lb/day	50	30	20
TSS, lb/day	40	20	10
TKN lb/day	5	3	2
Commercial & Industrial			
Flow, gpd	11,000	0	0
BOD_5, lb/day	50	0	0
TSS, lb/day	30	0	0
TKN, lb/day	4	0	0
Institutional			
Flow, gpd	74,000	22,000	11,000
BOD_5, lb/day	250	70	40
TSS, lb/day	190	60	30
TKN, lb/day	30	10	4
Total			
Flow, gpd	100,000	31,000	16,000
BOD_5, lb/day	340	100	50
TSS, lb/day	250	80	40
TKN, lb/day	40	10	10

E. Future Conditions. The Woods Hole Planning Area contains only seven developable vacant residential parcels, and two dvelopable vacant commercial parcels. Development of the residential parcels with 3-bedroom houses would result in an addition Title 5 flow of 2,300 gpd. Development of the commercial vacant lots would result in additional Title 5 flow of 500 gpd.

Future wastewater flows and loadings are summarized in Table 6-6, and are based on the vacant properties identified above and the considerations listed in Section 6-2.

6.6 FALMOUTH CENTER AREA

A. Introduction. The Falmouth Center Area, shown on Figure 6-9, contains five planning areas: Main Street, Davis Straits/Inner Harbor, Falmouth Beach, Falmouth Heights, and Maravista.

B. Existing Sewered Areas. Three of the five planning areas identified above (Main Street, Davis Straits/Inner Harbor, and Falmouth Beach) contain sewered parcels. These sewered areas are included in the planning area assessments to evaluate the existing sewer system's ability to handle current and future wastewater flows. This evaluation involved calculating the hydraulic capacity of the various sewers and pumping stations as summarized in Chapter 5. This information will be used in the Project's next phase to assess the ability to handle increased wastewater flows from potential sewer extensions.

The majority of the existing sewer system for these areas was constructed as part of the 1981 Facilities Plan implementation in 1986, although several minor extensions have been constructed since 1986.

TABLE 6-6

FUTURE WASTEWATER FLOWS AND LOADINGS IN WOODS HOLE PLANNING AREA
Wastewater Facilities Planning Study
Town of Falmouth, Massachusetts

	Sewered Flow	Non-Sewered Flow	
Source	Average Annual	Title 5 Flows	Average Annual
West Falmouth Harbor			
Residential			
Flow, gpd	15,000	11,000	6,000
BOD_5, lb/day	50	40	20
TSS, lb/day	40	30	20
TKN lb/day	10	4	2
Commercial & Industrial			
Flow, gpd	12,000	500	300
BOD_5, lb/day	60	2	1
TSS, lb/day	30	1	1
TKN, lb/day	4	0	0
Institutional			
Flow, gpd	81,000	24,000	12,000
BOD_5, lb/day	270	80	40
TSS, lb/day	200	60	30
TKN, lb/day	30	10	0
Total			
Flow, gpd	110,000	36,000	18,000
BOD_5, lb/day	380	120	60
TSS, lb/day	270	90	50
TKN, lb/day	40	10	10

C. Main Street

1. **Location and Existing Conditions.** The Main Street Planning Area begins at the Route 28 / Palmer Avenue split at the West End of Main Street. The area then extends east to the intersection of Main Street and Scranton Avenue. The planning area does not continue much farther north or south of those properties directly along Main Street. There are 135 parcels in this planning area, and most are sewered.

The eastern end of this Planning Area; up to Shore Street, is part of the Falmouth Village Green District. This is a Nationally Registered Historic District, which includes 79 buildings, and the Old Burying Grounds.

Thirteen unsewered properties with structures were identified that date prior to 1978. On-site systems for these properties may not meet present code requirements and may require upgrade, replacement or connection to the existing sewer system. One unsewered parcel located at 85 Shore Street has a high water consumption, and has access to the sewer at Cahoon Court. It is expected that this parcel will connect to the sewer in the near future.

Natural resources identified in the planning area include: wetlands, coastal embayment recharge areas, coastal embayments, fresh and salt-water ponds, and flood zones. There are no ACECs or DCPCs identified in the Main Street Planning Area. Several of the sewered parcels are located inside the wetland restriction areas north of Siders Pond, and south of Shivericks and Nye Ponds. There is also a portion of this planning area, west of Shore Street, that is located in the Inner Harbor coastal embayment recharge area.

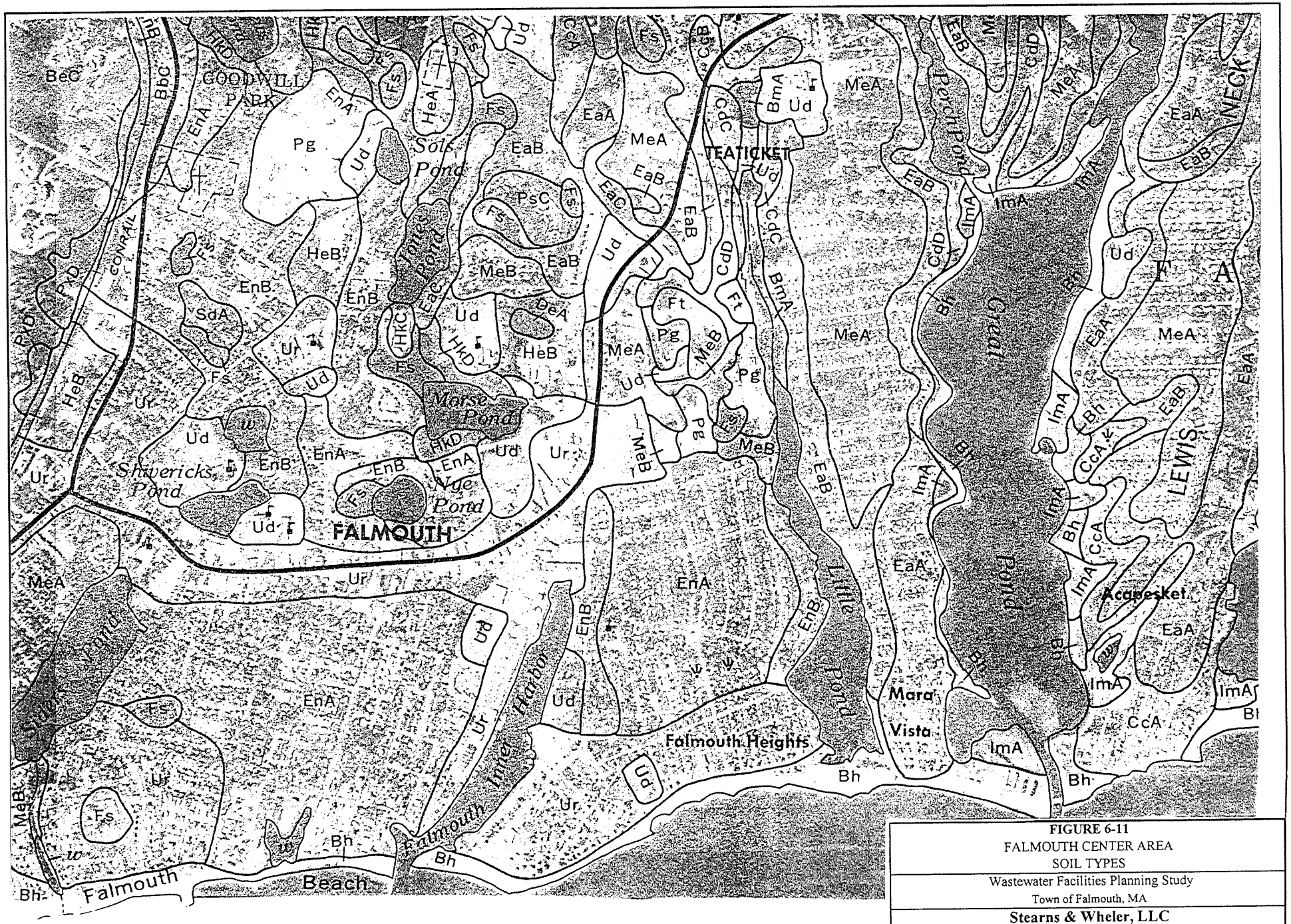
The Planning Area has several parcels surrounding Town Hall, which are located inside an A-Flood Zone (A-Zone). The A-Zone, as defined by FEMA, identifies the 100-year flood boundary. Topography of the area is flat, and ground surface elevations vary from 5 to 20 feet above MSL. Figure 6-10 presents the existing conditions for this area.

Four different soil types were identified in the Main Street Planning Area by the Barnstable County Soil Survey. The four soil types are: Enfield silt loam 0-3 percent (EnA), Enfield silt loam 3-8 percent slopes (EnB), Upidsamments (Ud), and Urban (Ur). The majority of this area is sewered; therefore, soil conditions for sewered parcels are not an issue. In the areas not currently sewered, Enfield silt loam soils are the predominant soil type. Figure 6-11 presents soil type locations for this area.

2. **Land Use and Zoning.** The majority of the Main Street Planning Area is classified as Commercial, with 87 parcels making up 64 percent of the total number of parcels in this Planning Area. The remaining area is delineated as follows: 18 percent residential, 14 percent institutional and 3 percent industrial. Land use codes did not identify any undevelopable or agricultural land in this area. Figure 6-12 identifies land uses in the Falmouth Center Area, and the following Table summarizes that land use.

Land Use Group	Number of Parcels	Percentage of Total
Residential	25	19%
Commercial	87	65%
Industrial	3	2%
Institutional	19	14%
Undevelopable	0	0%
Agricultural	0	0%

The Main Street Planning Area has six different zoning districts: Public Use, Business 1, Business 2, Business 3, Single Residence C, and General Residence. Most of the Planning Area is zoned business. Residential zoning areas are located north and south of properties along Main Street. There are also several areas zoned Public Use including the Town Hall property, and the Shivericks Pond Pump Station property. The following Table summarizes the minimum lot sizes for these districts.



Source: Barnstable County Soil Survey, 1993

FIGURE 6-11
FALMOUTH CENTER AREA
SOIL TYPES

Wastewater Facilities Planning Study
Town of Falmouth, MA

Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS AND SCIENTISTS

Soilmap-borders.xls Fig6-9

Zoning District	Minimum Lot Area (ft^2)	Minimum Lot Width (ft)	Minimum Lot Frontage (ft)
Public Use	45,000	150	100
Business 1	---	---	---
Business 2	40,000	200	200
Business 3	40,000	100	100
Single Residence C	40,000	100	100
General Residence	20,000	125	100

3. **Flows and Loadings**. The existing flows and loadings for the Woods Hole Planning Area are summarized on Table 6-7. These flows and loadings were developed based on the land use described above, and the considerations listed in Section 6-2.

4. **Future Conditions.** Limited growth is expected in the Main Street Planning Area. The hospital may grow a small amount with the recent addition of the Maternity Center. Town Hall will expand in size but no expansion of Town personnel is planned. Also, Mullen-Hall is planning an expansion but the student population is expected to remain constant. Only one vacant developable residential property and 6 vacant developable commercial properties were identified. Future flows and loadings for this planning area based on the vacant properties and the considerations listed in Section 6-2 are summarized in Table 6-8.

D. Davis Straits/Inner Harbor

1. **Location and Existing Conditions.** This Planning Area runs north/south from the intersection of Davis Straits and Maravista Avenue south along Scranton Avenue to Waterside and Clinton Avenues. Sixty-nine of the parcels in this Planning Area are sewered.

TABLE 6-7

EXISTING WASTEWATER FLOWS AND LOADINGS IN MAIN STREET PLANNING AREA
Wastewater Facilities Planning Study
Town of Falmouth, Massachusetts

	Sewered Flow	Non-Sewered Flow	
Source	Average Annual	Title 5 Flows	Average Annual
West Falmouth Harbor			
Residential			
Flow, gpd	15,000	1,000	1,000
BOD_5, lb/day	50	3	3
TSS, lb/day	40	3	3
TKN lb/day	10	0	0
Commercial & Industrial			
Flow, gpd	31,000	20,000	10,000
BOD_5, lb/day	140	90	50
TSS, lb/day	80	50	30
TKN, lb/day	10	10	3
Institutional			
Flow, gpd	19,000	0	0
BOD_5, lb/day	60	0	0
TSS, lb/day	50	0	0
TKN, lb/day	10	0	0
Total			
Flow, gpd	70,000	21,000	11,000
BOD_5, lb/day	260	100	50
TSS, lb/day	160	50	30
TKN, lb/day	20	10	4

TABLE 6-8

FUTURE WASTEWATER FLOWS AND LOADINGS IN MAIN STREET PLANNING AREA
Wastewater Facilities Planning Study
Town of Falmouth, Massachusetts

	Sewered Flow	Non-Sewered Flow	
Source	Average Annual	Title 5 Flows	Average Annual
West Falmouth Harbor			
Residential			
Flow, gpd	17,000	2,000	1,000
BOD_5, lb/day	60	10	3
TSS, lb/day	40	10	3
TKN lb/day	10	1	0
Commercial & Industrial			
Flow, gpd	34,000	24,000	12,000
BOD_5, lb/day	160	110	60
TSS, lb/day	90	60	30
TKN, lb/day	10	10	4
Institutional			
Flow, gpd	21,000	0	0
BOD_5, lb/day	70	0	0
TSS, lb/day	50	0	0
TKN, lb/day	10	0	0
Total			
Flow, gpd	70,000	26,000	13,000
BOD_5, lb/day	280	120	60
TSS, lb/day	180	70	30
TKN, lb/day	30	10	4

Wetlands in this Planning Area are located north of Inner Harbor around Morse Pond and the Falmouth Mall property and east of Morton Avenue. Also, a large portion of this Planning Area, between Clinton Avenue and Spring Bars Road, is located in the Inner Harbor coastal embayment recharge area.

Several of the non-sewered parcels along Inner Harbor and Clinton Avenue are located in the 100-year flood zone and a number of these properties are located in FEMA designated velocity zones.

Also, 52 properties have structures over 20 years old. These structures may still be using cesspools for septic systems, or have systems which, due to age, may require repair or replacement.

Large portions of the Planning Area to the south (along Clinton Ave.) and the north (along Davis Straits by the Falmouth Mall area) are not sewered. Soils along the Clinton Ave. portions of the planning area are identified as Enfield silt loam, which generally drains well.

Soils in the northern portions of the Planning Area are characterized as Eastchop loamy fine sands of various slopes and Merrimack sandy loams. Both these soil types have moderate to rapid permeability, which provides good percolation rates for onsite systems but limited filtering. There is also some Freetown coarse sand, located near the Falmouth Mall property, and depth to groundwater in these areas is usually less than 2 feet. Figure 6-11 illustrates these soil locations.

2. **Land Use and Zoning**. The following Table summarizes the land use for the Davis Straits/Inner Harbor Planning Area.

Land Use Group	Number of Parcels	Percentage of Total
Residential	121	45%
Commercial	120	45%
Industrial	0	0%
Institutional	15	5%
Undevelopable	15	5%
Agricultural	0	0%

As the summary table shows, there is an even split between residential and commercial properties in this area. The majority of the residential properties are located along the southern portions of Scranton Avenue, and along Clinton Avenue. The commercial properties line all of Davis Straits and the northern portions of Scranton Avenue.

The following Table summarizes zoning in this planning area.

Zoning District	Minimum Lot Area (ft^2)	Minimum Lot Width (ft)	Minimum Lot Frontage (ft)
Single Residence C	40,000	100	100
Business 3	20,000	125	100
Public Use	45,000	150	100
Business 2	40,000	200	200
Marine	20,000	100	100
General Residence	20,000	125	100

The largest section of this Planning Area is zoned Business 2, and extends from Robbins Road, north to the Davis Straits and Maravista Avenue intersection. Marine Districts are located along the Inner Harbor shoreline, and the residential zoning districts are along Clinton Avenue, Scranton Avenue and west of Davis Straits.

3. **Review of Subareas and Individual Properties in the Planning Area.** The properties along Clinton Avenue are large and generally have sufficient space to construct Title 5 systems as the existing systems need to be upgraded. Only one property on this street had its septic system pumped more than two times per year (See Appendix C), and that is a commercial property at the east end of the avenue that has minimal land for a Title 5 system. Connection of all but the east end of this avenue to the centralized collection system should be considered a low priority.

Several of the commercial properties at the middle and southern end of Scranton Avenue have connected to the centralized collection system via a gravity sewer extension and with individual pumping stations with a force main in the road. The commercial property located at the east end of Clinton Avenue has investigated connection to the centralized collection system. Additional properties at the south end of Scranton Avenue need to connect to the existing collection system.

The planning area extends west along Jones Street to include the Lawrence School that was recently connected to the centralized collection system. The next property to the west is the Quality Inn, which has a high water consumption and had its septic system pumped more than ten times in the 1996/1997 period, which was analyzed for septic system pumping. The property has significant wetland area, and groundwater is expected to be close to the ground surface. Also, it is located upgradient of Morse Pond and could pose a threat to that Pond.

The non-sewered area along Davis Straits and Worcester Court was included in the Planning Area because this area is zoned commercial and has a high concentration of commercial properties that have high wastewater flows. Also, based on Board of Health records two properties, Tataket Square and Admiralty Inn have frequent septic system pumpings and have had problems with their septic systems. The Admiralty Inn has expressed an interest to connect to the central collection system, and may be forced by DEP to install a treatment system to meet Class I groundwater standards if it can not connect. The Falmouth Mall is located in this area, and has expressed desire to be

connected to the centralized collection system. The Falmouth Housing Authority, James Conley Apartments, has a high Title 5 design flow, and may need to connect to the collection system in the future.

4. **Flows and Loadings**. Of all the existing sewered planning areas, Davis Straits/Inner Harbor has the largest portion of non-sewered properties. Wastewater generation for this area was calculated using wastewater flow to the WWTF, Title 5 design criteria, and 90 percent of water consumption as calculated for the previously described planning areas. Table 6-9 provides a summary of flows and loads for this Planning Area based on the land use described above, and the considerations listed in 6-2.

5. **Future Conditions.** High wastewater flows could occur in this planning area especially in the Davis Straits area. The Falmouth Housing Authority, James Conley Apartments, may expand onto the vacant property to the west, which may increase their Title 5 design flow to greater than 10,000 gpd. The Falmouth Mall has stated a desire to connect to the collection system with estimated potential flow of 30,000 gallons per day. They have a small wastewater flow now, and are not expected to generate 30,000 gallons per day if they do not connect to the collection system. There are 18 vacant residential properties that could be developed into three-bedroom houses and 20 vacant commercial properties totaling 540,000 square feet.

Table 6-10 summarizes the future flows and loadings for the Davis Straits/Inner Harbor Planning Area based on the potential future growth described above and the considerations in Section 6-2.

E. Falmouth Beach

1. **Location and Existing Conditions.** This planning area is bordered to the north by Siders Pond, to the west by Salt Pond, and the south by the Nantucket Sound. Eighty-four percent of the properties in this area are sewered as a result of dense population, and low ground elevations.

TABLE 6-9

EXISTING WASTEWATER FLOWS AND LOADINGS IN DAVIS STRAITS/INNER HARBOR PLANNING AREA
Wastewater Facilities Planning Study
Town of Falmouth, Massachusetts

	Sewered Flow	Non-Sewered Flow	
Source	Average Annual	Title 5 Flows	Average Annual
West Falmouth Harbor			
Residential			
Flow, gpd	10,000	41,000	32,000
BOD_5, lb/day	30	140	110
TSS, lb/day	30	100	80
TKN lb/day	3	10	10
Commercial			
Flow, gpd	60,000	78,000	39,000
BOD_5, lb/day	280	360	180
TSS, lb/day	150	200	100
TKN, lb/day	20	30	10
Institutional			
Flow, gpd	2,000	90,000	45,000
BOD_5, lb/day	10	300	150
TSS, lb/day	10	230	110
TKN, lb/day	1	40	20
Total			
Flow, gpd	70,000	209,000	116,000
BOD_5, lb/day	320	800	440
TSS, lb/day	180	520	290
TKN, lb/day	20	80	40

TABLE 6-10

FUTURE WASTEWATER FLOWS AND LOADINGS IN DAVIS STRAITS/INNER HARBOR PLANNING AREA
Wastewater Facilities Planning Study
Town of Falmouth, Massachusetts

	Sewered Flow	Non-Sewered Flow	
Source	Average Annual	Title 5 Flows	Average Annual
West Falmouth Harbor			
Residential			
Flow, gpd	10,000	47,000	38,000
BOD_5, lb/day	30	160	130
TSS, lb/day	30	120	100
TKN lb/day	3	20	10
Commercial			
Flow, gpd	66,000	154,000	77,000
BOD_5, lb/day	300	710	350
TSS, lb/day	170	390	190
TKN, lb/day	20	50	30
Institutional			
Flow, gpd	2,000	99,000	50,000
BOD_5, lb/day	10	330	170
TSS, lb/day	10	250	130
TKN, lb/day	1	40	20
Total			
Flow, gpd	80,000	300,000	165,000
BOD_5, lb/day	340	1,200	650
TSS, lb/day	200	750	410
TKN, lb/day	30	110	60

The historic district, which runs along Shore Street, intersects this planning area along the eastern end of this area. The southern most portions of the area are in a velocity zone and the remainder of the planning area is located inside the 100-year flood zone. There is a large wetland in the center of the Planning Area and there are wetland restriction areas that parallel the Salt Pond shoreline and a small stream, which extends south from Siders Pond.

The Falmouth Beach Planning Area soils consist of three types: Freetown and Swanset mucks 0-1 percent slopes (Fs), Beaches (Bh) and Urban land (Ur). This planning area is completely sewered; so soil conditions are not a concern for wastewater disposal. Figure 6-11 outlines the various soil class locations in this planning area.

2. Land Use and Zoning.

The following Table summarizes the land use in the Falmouth Beach Planning Area.

Land Use Group	Number of Parcels	Percentage of Total
Residential	169	89%
Commercial	3	2%
Industrial	0	0%
Institutional	10	5%
Undevelopable	7	4%
Agricultural	0	0%

Figure 6-12 shows the land use in this Planning Area. The Falmouth Beach Planning area consists mainly of seasonal and year-round residences, and is located outside any major commercial areas, as indicated by the percentage of residential properties. As shown on Figure 6-12, the majority of these residential units are single family homes.

The following Table summarizes zoning in this planning area.

Zoning District	Minimum Lot Area (ft^2)	Minimum Lot Width (ft)	Minimum Lot Frontage (ft)
Single Residence B	40,000	125	100
Single Residence C	40,000	100	100
Public Use	45,000	150	100

As demonstrated by the Falmouth Beach Land use, Residential zoning is predominate in this area. Single Residence C zoning applies to over 95 percent of this area. Public Use zoning is limited to between Surf Drive and the Nantucket Sound, and Single Residence B zoning is limited to the southeastern shore of Salt Pond.

3. **Flows and Loadings.** The existing flows and loadings for the Falmouth Beach Planning Area are summarized on Table 6-11. These flows and loadings are developed based on the land use described above and the considerations listed in Section 6-2.

4. **Future Conditions.** Falmouth Beach has almost reached buildout, with only 11 vacant developable properties available. Table 6-12 presents the future flows and loadings expected for this Planning Area based on the considerations of Section 6-2.

F. Falmouth Heights

1. **Introduction.** Falmouth Heights is a planning area in this study because it was designated as one of the Phase 2 Sewer Areas in 1981 as part of the previous Wastewater Facilities Plan. This means that it was identified as a problem area at that time, and was scheduled to be sewered approximately ten years after the Phase 1 sewer areas of Falmouth Center and Woods Hole. This area has not been sewered yet.

2. **Location and Existing Conditions.** The Falmouth Heights Planning Area is located between Inner Harbor and Little Pond and is made up of those properties that are located along and south of Grand Avenue. There are no historic districts in this

TABLE 6-11

EXISTING WASTEWATER FLOWS AND LOADINGS IN FALMOUTH BEACH PLANNING AREA
Wastewater Facilities Planning Study
Town of Falmouth, Massachusetts

	Sewered Flow
Source	Average Annual
West Falmouth Harbor	
Residential	
Flow, gpd	17,000
BOD_5, lb/day	60
TSS, lb/day	40
TKN lb/day	10
Commercial	
Flow, gpd	2,000
BOD_5, lb/day	10
TSS, lb/day	5
TKN, lb/day	1
Institutional	
Flow, gpd	200
BOD_5, lb/day	1
TSS, lb/day	1
TKN, lb/day	0
Total	
Flow, gpd	20,000
BOD_5, lb/day	70
TSS, lb/day	50
TKN, lb/day	10

TABLE 6-12

FUTURE WASTEWATER FLOWS AND LOADINGS IN FALMOUTH BEACH PLANNING AREA
Wastewater Facilities Planning Study
Town of Falmouth, Massachusetts

Source		Sewered Flow Average Annual
West Falmouth Harbor		
Residential		
	Flow, gpd	21,000
	BOD_5, lb/day	70
	TSS, lb/day	50
	TKN lb/day	10
Commercial		
	Flow, gpd	2,000
	BOD_5, lb/day	10
	TSS, lb/day	10
	TKN, lb/day	1
Institutional		
	Flow, gpd	200
	BOD_5, lb/day	1
	TSS, lb/day	1
	TKN, lb/day	0
Total		
	Flow, gpd	23,000
	BOD_5, lb/day	80
	TSS, lb/day	60
	TKN, lb/day	10

Planning Area, although the western half of Falmouth Heights has been proposed as a Town Historic District.

Limited areas of wetland restrictions exist along the western shore of Little Pond. Coastal embayment recharge areas exist along the eastern and western most portions of this Planning Area for Little Pond and Inner Harbor respectively. Velocity zones in this area exist only along the beaches and do not affect any of the properties located in this Planning Area. However, the eastern half of the Planning Area is located in a 100-year flood zone indicating properties in this area are situated at low elevations. Topography in Falmouth Heights ranges from 0 to 50 feet above MSL, with the highest elevations on the western end of the Planning Area.

The Barnstable County soil survey identified five soil types in the Falmouth Heights Planning Area, including: Beaches (Bh), Enfield silt loam 0-3 percent slopes (EnA), Enfield silt loam 3-8 percent slopes (EnB), Upidsamments (Ud), and Urban (Ur). The majority of this Planning Area is classified as Urban land or Upidsamment; these areas require onsite investigations in order to identify the specific soil conditions on any particular site. The remainder of the soils are characterized as capable of absorbing septic tank effluent, while providing limited filtering due to the fast percolation rates of these soils. Figure 6-11 presents the locations of these soil types.

3. **Land Use and Zoning.** The following Table summarizes the land use in the Falmouth Heights Planning Area.

Land Use Group	Number of Parcels	Percentage of Total
Residential	314	80%
Commercial	32	8%
Industrial	1	<1%
Institutional	17	4.5%
Undevelopable	17	4.5%
Agricultural	0	0%

Similar to the Falmouth Beach Planning Area, Falmouth Heights is 80 percent residential, but, there is a larger number of multi-family residential properties in this Planning Area, unlike Falmouth Beach. Figure 6-12 illustrates the land use in this area. Falmouth Heights also has a larger number of commercial properties, mostly motels and restaurants located along the shoreline that are active in the summer but closed in the winter. Falmouth Heights has very seasonal use as a summer vacation area.

Four properties in this Area have had three or more septic system pumpouts in a year as described in Section 4.5, and illustrated in Appendix C.

The highest priority areas of this Planning Area are the low elevation areas along the coast, Inner Harbor, and Little Pond. These areas are typically indicated by the 100 year flood areas (A Flood Zone) of Figure 6-10. Small portions of this planning area are in the recharge (watershed) areas to Inner Harbor and to Little Pond. Septic systems in these recharge areas will contribute nitrogen to water quality problems in these two surface water bodies. Most of the Planning Area recharges to Vineyard Sound where nitrogen loading is not a problem.

This Planning Area is primarily zoned Single Residence C. A marine zoning district is located along the Inner Harbor shoreline. Business 3 zoning is scattered throughout this Planning Area, as is the Public Use zoning. The zoning for the Planning Area is presented on the following table.

Zoning District	Minimum Lot Area (ft^2)	Minimum Lot Width (ft)	Minimum Lot Frontage (ft)
Single Residence C	40,000	100	100
Business 3	40,000	100	100
Public Use	45,000	150	100
Marine	20,000	100	100

4. **Flows and Loadings.** Similar to the West Falmouth Harbor Planning Area, Falmouth Heights is not currently sewered. Therefore, wastewater generation is estimated based on water consumption and Title 5 design flow criteria as described in Section 6-2. Table 6-13 presents the flows and loadings for this Planning Area.

5. **Future Conditions.** Discussions with the Town Planning Department indicate that Falmouth Heights is expected to remain a seasonal vacation area. Falmouth Heights has 20 vacant developable residential properties and one vacant developable commercial property. Table 6-14 summarizes the future flows and loadings for the Falmouth Heights Planning Area based on the vacant properties and the considerations presented in Section 6-2.

G. Maravista

1. **Introduction.** Like Falmouth Heights, the Maravista areas is a planning area in this study because it was designated as one of the Phase 2 Sewer Areas in 1981 as part of the previous Wastewater Facilities Plan. It was identified as a problem area at that time and was scheduled for sewering approximately ten years after the Phase 1 sewer areas of Falmouth Center and Woods Hole. This area has not been sewered yet.

2. **Location and Existing Conditions.** The Maravista Planning Area is situated between Little Pond and Great Pond and includes those properties from Vineyard Sound north to Nickerson Street. Limited areas of wetland restrictions exist along the shores of Little and Great Ponds. The Planning Area is divided by the coastal embayment recharge areas for these ponds. Approximately two-thirds of he area is within the Little Pond recharge area and one-third in the Great Pond recharge area.

No historic districts, historic sites, ACECs, or DCPCs have been identified in this Planning Area. Flood zones mirror the wetland restriction areas, except in the southern most sections of the area. Velocity zones are limited to properties south of Cataumet

TABLE 6-13

EXISTING WASTEWATER FLOWS AND LOADINGS IN FALMOUTH HEIGHTS PLANNING AREA
Wastewater Facilities Planning Study
Town of Falmouth, Massachusetts

Source		Title 5 Flows	Average Annual
West Falmouth Harbor			
Residential			
	Flow, gpd	113,000	24,000
	BOD_5, lb/day	380	80
	TSS, lb/day	280	60
	TKN lb/day	40	10
Commercial & Industrial			
	Flow, gpd	30,000	15,000
	BOD_5, lb/day	140	70
	TSS, lb/day	80	40
	TKN, lb/day	10	10
Institutional			
	Flow, gpd	200	100
	BOD_5, lb/day	1	0
	TSS, lb/day	1	0
	TKN, lb/day	0	0
Total			
	Flow, gpd	143,000	39,000
	BOD_5, lb/day	520	150
	TSS, lb/day	360	100
	TKN, lb/day	50	10

TABLE 6-14

FUTURE WASTEWATER FLOWS AND LOADINGS IN FALMOUTH HEIGHTS PLANNING AREA
Wastewater Facilities Planning Study
Town of Falmouth, Massachusetts

Source		Title 5 Flows	Average Annual
West Falmouth Harbor			
Residential			
	Flow, gpd	120,000	29,000
	BOD_5, lb/day	400	100
	TSS, lb/day	300	70
	TKN lb/day	40	10
Commercial & Industrial			
	Flow, gpd	34,000	17,000
	BOD_5, lb/day	160	80
	TSS, lb/day	90	40
	TKN, lb/day	10	10
Institutional			
	Flow, gpd	200	100
	BOD_5, lb/day	1	0
	TSS, lb/day	1	0
	TKN, lb/day	0	0
Total			
	Flow, gpd	154,000	46,000
	BOD_5, lb/day	560	180
	TSS, lb/day	390	120
	TKN, lb/day	50	20

Street, and A-Zones impact properties south and west of Maple Street and Maravista Avenue, and south and east of Ardmore Street and Maravista Avenue.

Topography is flat, except along the eastern and western shorelines, and ranges in elevation from 0 to 25 feet above MSL.

Five different soil types are identified in the 1993 Barnstable County Soil Survey for the Maravista Planning Area. These soil types include: Beaches (Bh), Enfield silt loam 0-3 percent slopes (EnA), Enfield silt loam 3-8 percent slopes (EnB), Merrimack sandy loam 0-3 percent slopes, and Carver coarse sand 15-35 percent slopes (CdD). The southern portions of Maravista are made up of the Enfield silt loams and the Beach soils. The Enfield soils, as discussed in the other planning areas, are characterized by their rapid permeability and limited filtering abilities.

The Carver coarse sands and the Merrimack sandy loams exist in the northern portions of Maravista. These less loamy materials are also characterized by moderate to rapid permeability with limited ability to filter septic tank effluent discharges.

Very few properties have had their septic systems pumped two or more times in a year as described in Section 4.5 and shown in Appendix C. A greater number of septic system pumpouts is expected due to the small properties and the old systems. Discussions with the Town Health Agent indicated that the older septic systems have been able to be upgraded to present Title 5 systems at the time of property transfer or system failure.

The highest priority portions of this planning area are the low elevation properties along Little Pond as shown by the 100 year flood areas (A Flood Zone) in Figure 6-10. These properties would tend to need mounded systems to meet the Title 5 requirements, which will minimize impacts to Little Pond.

A large portion of the Maravista Planning Area is in the recharge areas to Little Pond. This means that nitrogen loading from these properties (from septic systems and other

land use activities) drains into Little Pond, which has water quality problems as documented by the Falmouth Pond Watchers (Howes and Goehringer, 1998). Little Pond also receives nitrogen loading from land areas that extend nearly to Long Pond as shown on Figure 4-1 and 4-2.

3. **Land Use and Zoning.** The following Table summarizes the land use in the Maravista Planning Area.

Land Use Group	Number of Parcels	Percentage of Total
Residential	850	89%
Commercial	1	<1%
Industrial	0	0%
Institutional	17	2%
Undevelopable	83	9%
Agricultural	0	0%

Maravista is almost entirely residential, with one lone commercial property located at the inlet to Great Pond. Maravista is similar to Falmouth beach, with the majority of residential land use consisting of single family residences. Residential properties in this area are a mix of densely developed seasonal and year-round properties. The seasonal properties are located in the southern sections of Maravista, and more year-round properties in the northern sections, closer to the commercial center of Falmouth.

Maravista has only one zoning district, Single Residence C. The minimum lot sizes and dimensions are listed on the following Table.

Zoning District	Minimum Lot Area (ft^2)	Minimum Lot Width (ft)	Minimum Lot Frontage (ft)
Single Residence C	40,000	100	100

4. **Flows and Loadings.** The existing flows and loadings for the Maravista Planning Area are summarized on Table 6-15. These flows and loadings are based on the land use described above and the considerations listed in Section 6-2. The seasonal nature of this area is illustrated by the larger than usual difference between the Title 5 design flow and the average annual flow based on water consumption.

5. **Future Conditions.** Maravista has 65 vacant developable residential properties. Assuming that three-bedroom houses are constructed on each of these properties. The Title 5 design flow for the area would increase by 21,000 gpd. Table 6-16 presents the future flows and loadings expected for the Maravista Planning Area based on the vacant properties and the considerations listed in Section 6-2.

TABLE 6-15

EXISTING WASTEWATER FLOWS AND LOADINGS IN MARAVISTA PLANNING AREA
Wastewater Facilities Planning Study
Town of Falmouth, Massachusetts

Source		Title 5 Flows	Average Annual
West Falmouth Harbor			
Residential			
	Flow, gpd	258,000	65,000
	BOD_5, lb/day	860	220
	TSS, lb/day	650	160
	TKN lb/day	90	20
Commercial			
	Flow, gpd	20,000	10,000
	BOD_5, lb/day	90	50
	TSS, lb/day	50	30
	TKN, lb/day	10	3
Institutional			
	Flow, gpd	2,000	1,000
	BOD_5, lb/day	10	3
	TSS, lb/day	5	3
	TKN, lb/day	1	0
Total			
	Flow, gpd	280,000	76,000
	BOD_5, lb/day	960	270
	TSS, lb/day	700	190
	TKN, lb/day	90	30

TABLE 6-16

FUTURE WASTEWATER FLOWS AND LOADINGS IN MARAVISTA PLANNING AREA
Wastewater Facilities Planning Study
Town of Falmouth, Massachusetts

Source		Title 5 Flows	Average Annual
West Falmouth Harbor			
Residential			
	Flow, gpd	279,000	82,000
	BOD_5, lb/day	930	270
	TSS, lb/day	700	210
	TKN lb/day	90	30
Commercial			
	Flow, gpd	22,000	11,000
	BOD_5, lb/day	100	50
	TSS, lb/day	55	30
	TKN, lb/day	10	4
Institutional			
	Flow, gpd	2,000	1,000
	BOD_5, lb/day	10	3
	TSS, lb/day	10	3
	TKN, lb/day	1	0
Total			
	Flow, gpd	303,000	94,000
	BOD_5, lb/day	1,000	330
	TSS, lb/day	760	240
	TKN, lb/day	100	30

Chapter 7

Needs Assessment Summary

CHAPTER 7

NEEDS ASSESSMENT SUMMARY

7.1 INTRODUCTION

The purpose of this Wastewater Facilities Planning Project (Project) is to address wastewater issues and problems (needs) associated with the Falmouth Wastewater Treatment Facility (WWTF), the Town's centralized collection system (collection system), and the following planning areas.

- Falmouth High School
- West Falmouth Harbor Watershed
- Woods Hole
- Main Street
- Davis Straits/Inner Harbor
- Falmouth Beach
- Falmouth Heights
- Maravista

The first step of the Project is to determine the needs of the centralized facilities and the planning areas. Existing conditions and problems related to environmental resources, cultural resources, water supply, wastewater collection, on-site septic systems, and centralized treatment and disposal facilities have been evaluated and summarized. Future conditions of the planning areas related to commercial and residential growth have been discussed and evaluated.

The purpose of this chapter is to integrate the existing and future planning considerations, and summarize the wastewater needs for the centralized wastewater facilities and the planning areas.

7.2 FALMOUTH WASTEWATER TREATMENT FACILITY (WWTF)

The Falmouth WWTF is located in West Falmouth off Blacksmith Shop Road east of Route 6. On average, it receives and treats 433,000 gallons per day (gpd) of wastewater from the centralized collection system and 28,000 gpd of septage from all of Falmouth. It utilizes an aerated pond treatment system, and effluent sand beds and spray irrigation fields for effluent disposal into the ground. The treatment system works well, and it has consistently met its effluent discharge permit from the Massachusetts Department of Environmental Protection (DEP). The treatment system was not designed to provide advanced nitrogen removal (treatment to less than 10 parts per million total nitrogen), which is typically required for all treatment plants that have groundwater discharge permits. On average, the Falmouth WWTF effluent total nitrogen concentration is 23 parts per million (ppm).

The treated effluent mixes with the groundwater at the discharge site adjacent to the WWTF, and flows to West Falmouth Harbor. The groundwater emerges into the Harbor where the nitrogen can promote plant growth (eutrophication) and impact the water quality of Snug Harbor. The total nitrogen concentration of the Snug Harbor water has increased in recent years. Nitrogen loading evaluations have determined that the existing nitrogen loading in the Snug Harbor Watershed (where the Falmouth WWTF is located) exceeds the assimilative capacity of Snug Harbor based on the State SA coastal water quality standard, which has been adopted for this Report.

Other water quality standards have been considered during this evaluation. The Falmouth Nitrogen Zoning Bylaw (Article XXI) sets a total nitrogen standard of 0.32 part per million (ppm) for Snug Harbor, which is only 0.02 ppm above the background concentration observed in Buzzards Bay. This 0.32 limit is probably not attainable for Snug Harbor given the existing land use in the Snug Harbor Watershed. The Cape Cod Commission has identified other water quality standards of 0.35, 0.4, and 0.45 ppm, which have been reviewed but not used for their evaluation because they do not have the

same regulatory standing that the State's SA classification has. The Town and all interested parties must review these standards and agree on the most appropriate standard to use for the watershed because that standard will determine the allowable land use in the watershed and the treatment level that is required at the Falmouth WWTF.

The findings of the nitrogen loading assessment to Snug Harbor indicate that the Falmouth WWTF will need upgrading to provide advanced nitrogen removal. Several nitrogen removal technologies will be evaluated in the next two phases of the Project to determine the most cost effective and reliable technology to meet the new treatment requirement.

The effluent discharge beds have performed poorly ever since they were built. The original five beds were designed at a hydraulic loading rate of 3 gallons per day per square foot (gpd/ft.^{2}). Several investigations since construction have indicated actual infiltration rates of 0.7 to 1.4 gpd/ft.^{2}. Three additional discharge beds were constructed in 1995. The total capacity of the discharge beds has been assessed at 0.41 mgd based on an average infiltration rate of 1.1 gpd/ft.^{2}.

An average capacity of the spray irrigation area has been assessed at 0.5 mgd based on the design spray irrigation loading of 2 inches per acre per week.

The combined discharge capacity of the discharge beds and spray irrigation areas is 0.91 mgd. This capacity may need to be increased, especially in the winter when the spray irrigation system is not operated, if the Falmouth WWTF is expanded to treat additional flow from the planning areas.

In the past, treatment residuals (sludge, screenings and grit) have been disposed at the Falmouth Landfill. A new disposal location is needed, now that the landfill is closed.

Septage is pumped from septic systems in Falmouth, and is trucked to the Falmouth WWTF for treatment and disposal. Septage source and volume data is recorded by the

septage hauler and given to the Falmouth WWTF staff. This data is then given to the Falmouth Health Department to enter into a computerized database (SepTrac) for subsequent evaluation and management of septage pumping. Often, several months of data will accumulate before the Health Department staff can enter the data in the computer. At that time, verification of incorrectly recorded data may be difficult to correct. The Town should set up a computer at the Falmouth WWTF so that the septage data can be entered into the computer by WWTF staff.

The Town of Falmouth receives a high septage flow in the summer months, and has recently modified its septage disposal rate to encourage residents to have their septic systems pumped in the non-summer months when the total flows to the Falmouth WWTF are low. Also, the Town may want to establish a septage management program, which requires residents to pump their septic systems regularly (once every three to four years), which would send a more even septage flow to the Falmouth WWTF and provide better management on the on-site systems in Falmouth.

7.3 CENTRALIZED WASTEWATER COLLECTION SYSTEM.

The centralized wastewater collection system (Collection System) is comprised of approximately seven miles of gravity collection pipe, six municipally operated pumping stations, and approximately 8.8 miles of force main, which is a pressurized sewer that delivers wastewater from a pumping station to the Falmouth WWTF or another point in the collection system. The collection system collects wastewater from the following areas:

- Woods Hole,
- Main Street,
- Falmouth Beach, and
- Davis Straits and Inner Harbor Area.

Most of the collection system was constructed in 1986 though most portions of Woods Hole were sewered in 1949.

The collection system operates well, and has sufficient capacity for the existing wastewater flows.

Analysis of water consumption in the sewered areas and analysis of the wastewater flows to the Falmouth WWTF indicates there is extraneous flow in the collection system of 180,000 gpd or 41 percent of the total WWTF influent flow. This flow is groundwater infiltration into gravity collection pipes and manholes, and/or inflow to the gravity collection system from building sump pumps, catch basins, or roof leaders and is collectively called infiltration and inflow (I/I). Most of this I/I is believed to be entering the system in Woods Hole through the older gravity collection pipes. Also, pumping station data indicates a large portion of the I/I coming from the Main Street area. The high I/I at the Main Street area may be the result of poorly calibrated flow meters at the Woods Hole and Jones Palmer Pumping Stations, which could then indicate high I/I at Main Street instead of Woods Hole. The flow meters in these pumping stations need to be calibrated to more accurately identify where the I/I is entering the collection system. It is noted that this quantity of I/I is not considered excessive by Massachusetts DEP criteria for a collection system of this size. Never the less, the Town should take efforts to inspect the sewers regularly and prevent I/I from occurring. Also, sewered users should be notified that basement sump pumps and roof leaders should not be connected to the sewer.

7.4 PLANNING AREAS

A. West Falmouth Harbor Watershed Planning Area. As the name implies, this Planning Area is the watershed area to West Falmouth Harbor that contributes groundwater into the Harbor. Nitrogen loading in the watershed from the Falmouth WWTF, Falmouth Landfill, old septage lagoons located at the landfill, individual septic

systems, lawn fertilizer, and storm runoff have caused water quality impacts in portions of West Falmouth Harbor. The impacts to Snug Harbor were discussed in Section 7.2. The existing nitrogen loading to Oyster Pond exceeds the assimilative capacity (critical nitrogen loading) of that Pond due mainly to restricted tidal flushing of that Pond. Nitrogen removal and other remediation alternatives will be evaluated in the next two phases of this Project to reduce nitrogen loading to these two areas of West Falmouth Harbor.

B. Falmouth High School. Falmouth High School is considered in this Wastewater Facilities Planning Project as a Planning Area because of its location in the Long Pond Watershed Protection District and its high wastewater design flow. It is located north of Brick Kiln Road, south of the West Falmouth Harbor Planning Area, and approximately one-half mile northeast of Long Pond. The school property is also approximately 2.5 miles from the Falmouth WWTF. The High School currently uses four septic systems that were constructed in 1974.

The High School has a current Title 5 flow of 25,000 gpd based on a current student population of 1,250. This flow exceeds the Title 5 regulation limit of 10,000 gpd for septic systems designed after 1995 and 15,000 gpd for all other systems. Because this system exceeds this threshold and is located inside the Long Pond Watershed Protection District, DEP may require that the property apply for a groundwater discharge permit or connect to the Falmouth Wastewater Treatment Facility.

It is noted that daily and monthly flow data and wastewater characterization is needed to accurately investigate alternative treatment scenarios for this Planning Area. The Town should collect the flow data from daily and monthly water meter readings. The wastewater characterization could be obtained by sampling the school's wastewater flow or by using influent wastewater characterization from a similar high school.

C. Woods Hole Planning Area. The Woods Hole Planning Area is made up mostly of sewered properties. The main focus of future evaluations will be a potential sewer extension to allow properties on Juniper Point to connect to a sewer.

The Collection System has capacity to handle existing wastewater flows in this area, and is working well. Groundwater infiltration into the collection system is suspected in this area as discussed in Section 7.2

D. Main Street and Falmouth Beach Planning Areas. These Planning Areas are made up of mostly sewered properties. A few properties in each area are not connected and are expected to connect during the next 20 years. The collection system has sufficient capacity to handle the existing wastewater flows and the future flows that will occur from connecting these unsewered properties.

E. Davis Straits/Inner Harbor Planning Area. This Planning Area extends from the intersection of Davis Straits and Maravista Avenue south to Clinton Avenue. It extends west along Jones Street to the Quality Inn and east to the commercially zoned properties of Worcester Court.

The non-sewered area along Davis Straits and Worcester Court is included in the Planning Area because this area is zoned commercial and has a high concentration of commercial properties that have high wastewater flows. Also, based on Board of Health records, two properties, Tataket Square and Admiralty Inn have frequent septic system pumping and have experienced problems with their septic systems. The Admiralty Inn has expressed an interest to connect to the collection system, and may be forced by DEP to install its own advanced treatment system if it can not connect. The Falmouth Mall is located in this area, and has expressed desire to be connected to the Collection System. The Falmouth Housing Authority, James Conley Apartments, has a high Title 5 design flow, and may need to connect to the collection system in the future if it plans to expand. This area is where much of the Town's commercial activity occurs and is promoted

through the existing zoning. Centralized collection facilities are needed to support this commercial activity.

The Planning Area extends west along Jones Street to include the Lawrence School that was recently connected to the collection system. The next property to the west is the Quality Inn, which has a high water consumption and had its septic system pumped more than ten items in the 1996/1997 period, which was analyzed for septic system pumping. The property has significant wetland area, and groundwater is expected to be close to the ground surface. Also, it is located upgradient to Morse Pond and could pose a threat to that Pond.

Several of the commercial properties at the middle and southern end of Scranton Avenue have connected to the Collection System via a gravity sewer extension, and with individual pumping stations connected to a force main in the road. The commercial property located at the east end of Clinton Avenue has investigated connection to the centralized collection system. Additional properties at the south end of Scranton Avenue need to connect to the existing collection system.

The properties along Clinton Avenue are large and generally have sufficient space to construct Title 5 systems, as their existing systems need to be upgraded. Only one property on this street had its septic system pumped more than two times (see Appendix C), and this is a commercial property at the east end of the avenue that has minimal land for a Title 5 system.

F. Falmouth Heights and Maravista Planning Areas. These two Planning Areas are evaluated in this Project because they were designated as Phase 2 sewer areas in 1981 as part of the previous Wastewater Facilities Plan, and scheduled for sewering approximately ten years after the Phase 1 sewering of Davis Straits, Inner Harbor, Main Street, Falmouth Beach and Woods Hole. These areas have not been sewered, yet.

These areas are located a long distance from the existing collection system, and would contribute a large wastewater flow to the Falmouth WWTF if they were sewered. Sewering these areas would be expensive. These areas have high usage in the summer and minimal usage in the winter.

The highest priority areas in these areas are the low elevation areas along the Vineyard Sound coast, Inner Harbor, and Little Pond. These areas are in the 100-year flood zone.

Many of the properties in these areas are small, and would require variances to meet requirements of the existing Title 5 regulations.

G. Prioritization of Planning Areas. The following list prioritizes the planning areas (and subareas of planning areas) with respect to wastewater needs. The highest priority areas are listed first.

1. Falmouth High School, which is located in the Long Pond Water Protection Area, and has a high Title 5 design flow.

2. West Falmouth Harbor Watershed Planning Area and the Falmouth WWTF discharge, which is impacting water quality in Snug Harbor.

3. Unsewered portions of Davis Straits and Jones Road where commercial properties have high wastewater flows and Town Zoning has been established to site commercial development.

4. Unsewered areas of Scranton Avenue, which have commercial properties that need to connect to the collection system.

5. Unsewered areas of Woods Hole on Juniper Point.

6. Low elevation areas in Falmouth Heights and Maravista.

7. Other areas in Falmouth Heights and Maravista.

8. Existing collection systems at Main Street, Davis Straits, and Inner Harbor that may need to convey additional wastewater to the Falmouth WWTF if the collection system is extended.

9. Falmouth Beach Planning Area, which may need an inspection for properties with sump pumps contributing to I/I.

10. Clinton Street Planning Area, which is at low elevations but has large properties that can accommodate new Title 5 systems when their existing systems need to be updated.

7.5 INSTITUTIONAL ISSUES.

The Town needs to consider several institutional issues as the Wastewater Facilities Planning Project proceeds. Several properties have connected to the collection system with low pressure grinder pumps and small diameter force mains. Some of them have connected into existing force mains. The Town needs a uniform policy on how these types of pumps can be connected to the existing system. Also, the Town should consider forming a sewer district, which would identify which properties can connect, and how they would connect to the Collection System.

The construction of centralized wastewater facilities for the planning areas could be very expensive. Federal grants are no longer available for these projects. Low interest loans are available from the State, but there are may projects that compete for these loans. The Town needs to discuss how centralized facilities will be financed in the future.

The recommendation from this Project to sewer or to not sewer various planning areas could be controversial due to the costs for centralized facilities, the perception of environmental impact, and fears that the quality of life will change in areas that are connected to centralized wastewater facilities. The Town should initiate discussions with property owners in the planning areas to learn if they want centralized wastewater facilities, and if they are willing to pay their share of capital costs through property betterments and operations costs through a user fees.

7.6 NO ACTION ALTERNATIVE

Under the "No Action Alternative" future wastewater treatment and disposal would continue at the Falmouth WWTF with an approximate 15 percent flow increase due to unsewered properties connecting to the collection system (infilling) and increased land use in the sewered areas. Snug Harbor and Oyster Pond would continue to have impacted water quality due to high nitrogen loading in their respective watersheds.

Existing substandard on-site systems would be upgraded to the standards of Title 5 and local Board of Health regulations. The Falmouth High School and several commercial properties would need to obtain groundwater discharge permits because their wastewater flows exceed the flow limits specified in the Title 5 Regulations. This means that they would need to construct their own advanced treatment systems.

7.7 NEXT STEPS TO IDENTIFY SOLUTIONS FOR WASTEWATER NEEDS.

The Needs Assessment Report documents the first third of the Project. The next phase of the Project will identify and screen centralized, decentralized, and on-site wastewater technologies and solutions for the planning areas and centralized facilities. These technologies and solutions will be described, and advantages and disadvantages will be summarized. Infeasible technologies and solutions will then be eliminated from further

evaluation. The third phase will evaluate the feasible technologies and solutions in detail, and present the Recommended Wastewater Facilities Plan.

The project scope for the next phase (Phase 4) is presented below as identified in the Environmental Notification Form (ENF) and Development of Regional Impact (DRI) documents.

Task 4.1 Identification and Development of Alternatives.

Develop an assessment of wastewater alternatives to determine those that will meet the needs of the planning area and provide the greatest environmental and cost benefits. The evaluation will include the following:

- A Baseline conditions alternative which will determine the level of treatment possible with optimum performance of existing wastewater collection, treatment and disposal facilities. Included will be an evaluation of septage management, regional septage disposal options and repair or upgrade of on-site systems within the planning area.

- Identify service areas where on-site systems are inadequate.

- Identify and develop decentralized treatment options for each service area including

  - Alternative treatment systems
  - Cluster systems
  - Package wastewater treatment plants
  - Combinations of the above

- Identify and develop centralized treatment options for each service area including:

- Improvement in operation of existing facility (Baseline conditions alternative).

- Expansion / upgrade of existing facility including nitrogen control strategies.

- Additional effluent disposal methods and sites including deep well injection.

- Regional solutions - identify and develop options for residuals disposal and discuss costs and environmental benefits for each. Include alternatives for reuse and contractual services for processing and disposal.

- Identify collection system alternatives for centralized and decentralized options.

- Identify flow and load reduction measures, including water conservation and toxic reduction.

- Identification and development of options using alternative technologies for reuse/recycling of wastewater, land application of sludge, co-disposal of sludge and solid waste, and innovative, alternative on-site systems. Consideration will be given to alternative technologies for collection systems including STEP systems, pressure sewers and small diameter sewers.

Task 4.2 Screening of Alternatives.

4.2.1 An evaluation methodology will be developed to screen alternatives for collection, treatment and residuals management utilizing technical, environmental, legal, financial, and cost criteria in order to determine

those alternatives that provide the greatest environmental and cost benefits.

4.2.2 With input from the Town, five alternatives will be selected for further evaluation, including the "No Action Alternative".

4.2.3 Submit Draft Screening Alternatives Report to MEPA/CCC for review and comments.

4.2.4 Revise Draft report based on public comments and develop and submit Final Report to the Town.

Appendix A

Certificate of the Secretary of Environmental Affairs

The Commonwealth of Massachusetts
Executive Office of Environmental Affairs
100 Cambridge Street, Boston, MA 02202

ARGEO PAUL CELLUCCI
GOVERNOR

JANE SWIFT
LIEUTENANT GOVERNOR

BOB DURAND
SECRETARY

MAR 01 1999

Tel. (617) 727-9800
Fax (617) 727-2754
http://www.magnet.state.ma.us/envir

February 22, 1999

CERTIFICATE OF THE SECRETARY OF ENVIRONMENTAL AFFAIRS
ON THE
ENVIRONMENTAL NOTIFICATION FORM

PROJECT NAME	: Falmouth Wastewater Facilities Planning Study
PROJECT MUNICIPALITY	: Falmouth
PROJECT WATERSHED	: Cape Cod
EOEA NUMBER	: 11857
PROJECT PROPONENT	: Town of Falmouth
DATE NOTICED IN MONITOR	: January 23, 1999

Pursuant to the Massachusetts Environmental Policy Act (G. L. c. 30, ss. 61-62H) and Section 11.03 of the MEPA regulations (301 CMR 11.00), I hereby determine that this project **requires** the preparation of an Environmental Impact Report.

This project involves the development of a Wastewater Facilities Plan for the Town of Falmouth. The Town developed a Wastewater Facilities Plan in 1981. Implementation of that plan resulted in the current sewerage collection and disposal system in Falmouth. The current proposal intends to update that plan and consider which other areas of the Town warrant extensions of the collection system and whether improvements are required at the existing wastewater treatment facility.

The project is subject to review and Mandatory Environmental Impact Report (EIR) pursuant to Section 11.03(5)(a)4 since implementation of the plan is expected to result in the construction of more than 10 miles of new sewers. The Town also expects to seek state funding for design and construction of any recommended facilities. Therefore, MEPA jurisdiction extends to all aspects of the project that may have environmental impacts.

In addition, the project qualifies as a Development of Regional Impact (DRI) in accordance with the Memorandum of Understanding between the Cape Cod Commission (CCC) and my office. As a result, I accept the request to allow this project to be reviewed under the joint review process.

The required EIR should follow the outline contained at Section 11.07 for content and form and should address the issues identified in the Proposed Detailed Scope of Work attached to the Environmental Notification Form. This proposed scope includes the following study tasks:

Needs Assessment/Problem Identification for Planning Area

Development and Screening of Alternatives

Detailed Evaluation of Alternatives and Identification of Recommended Plan

Draft Facilities Plan and Environmental Impact Report

Additionally, the following specific issues and those issues raised in the attached letters of comment should be addressed.

GROWTH MANAGEMENT

As part of the Needs Assessment, the EIR should contain a section on Growth Management to satisfy the requirements of Executive Order #385, Planning for Growth. This policy requires that state and local agencies engage in proactive and coordinated planning oriented towards both resource protection and sustainable economic development. For reasons both of environmental protection and fiscal prudence investments in public infrastructure should be carefully targeted toward those areas for which clear existing need has been established and for areas where denser development is appropriate, thereby relieving pressures on open space, agricultural lands, and other valuable natural resources.

The EIR should identify the land uses in those areas that are determined to need collection systems, and compare the potential secondary growth impacts that may be induced by public sewers with local and regional growth management policies. Since the Town has a current comprehensive and open space plan in place, the report should refer to that plan's identification of

priority areas for growth and development, and for open space and farmland preservation. I encourage the proponent to consult with DEP and the Growth Management Policy staff at the Executive Office of Environmental Affairs as it develops its growth management strategy.

WATER CONSERVATION

The EIR should present an analysis that begins to take into account measures that have the potential for reducing wastewater volumes, and adjust the Needs Assessment accordingly. The report should address the feasibility and effectiveness of such measures and should, at a minimum, include a preliminary water demand management and conservation plan. The MEPA Office has reviewed such conservation plans in the recent past that could serve as examples, and I recommend consultation with the MEPA staff on this matter.

JOINT REVIEW

As indicated in the Memorandum of Understanding between the CCC and the Executive Office of Environmental Affairs, the proponent, by virtue of requesting and receiving permission for joint review, agrees to prepare a joint document that addresses the issues required by the CCC as well as those issues required by this scoping document. I expect that most of those issues are set out in the attached comment letter from the CCC, but I suggest consultation with the CCC during development of the EIR to ensure that additional issues that may arise outside of those contained in that comment letter are addressed in the EIR.

ARCHAEOLOGY

The attached comment letter from the Massachusetts Historical Commission (MHC) indicates that there is a potential for impacts upon archaeological resources in Falmouth, including a number of resources that are listed in the MHC's Inventory. The EIR should include the results of consultation with the MHC regarding ways to avoid, minimize, or mitigate impacts to significant historical or archaeological resources within project areas.

The proponent has indicated a desire to submit interim documents on the various elements of the study for review and comment. I suggest that such interim filings and revisions resulting from comments may enhance the quality of the Draft and Final EIRs and, therefore, I agree to participate in this process in an informal manner. Nevertheless, to ensure strict compliance with MEPA, I expect that the Draft EIR will contain all the necessary information regardless of previous review of interim documents.

February 22, 1999
Date

Bob Durand, Secretary

Comments received :

Massachusetts Historical Commission
Cape Cod Commission
Robert McLaughlin

BD/rf

DF

The Commonwealth of Massachusetts

William Francis Galvin, Secretary of the Commonwealth
Massachusetts Historical Commission

RECEIVED
FEB 10 1999
MEPA

February 2, 1999

Secretary Robert Durand
Executive Office of Environmental Affairs
100 Cambridge Street
Boston, MA 02202

ATTN: MEPA Unit

RE: Wastewater Facilities Planning Study, Falmouth, EOEA #11857, MHC #RC.23109

Dear Secretary Durand:

Staff of the Massachusetts Historical Commission have reviewed the Environmental Notification Form for the proposed project referenced above and have the following comments.

The town of Falmouth contains more than 25 known Native American archaeological sites that are included in MHC's Inventory of Historical and Archaeological Resources of the Commonwealth. The majority of land in the town of Falmouth has never been systematically surveyed for archaeological resources. Additional as yet unidentified sites may also be present.

MHC requests the opportunity to review preliminary plans as early as possible in the planning of this project in order to determine the need for an archaeological survey. The scope of the Environmental Impact Report should include further consultation with the MHC in order to explore ways to avoid, minimize, or mitigate effects to significant historic or archaeological resources that are identified in project impact areas.

These comments are offered in compliance with Section 106 of the National Historic Preservation Act of 1966, as amended (36 CFR 800), M.G.L. Chapter 9, sections 26-27C, as amended by Chapter 254 of the Acts of 1988 (950 CMR 71.00), and MEPA. If you have any questions, please feel free to call Eric Johnson of my staff.

Sincerely,

Brona Simon

Brona Simon
State Archaeologist
Deputy State Historic Preservation Officer
Massachusetts Historical Commission

xc: Raymond A Jack, Falmouth Utilities Department
Nathan C. Weeks, Stearns and Wheeler
Falmouth Historical Commission
Cape Cod Commission
Ron Lyberger, BRP, DEP
Steve Hallem, BRP, DEP

220 Morrissey Boulevard, Boston, Massachusetts 02125 · (617) 727-8470
Fax: (617) 727-5128 · TDD: 1-800-392-6090
www.state.ma.us/sec/mhc

GILMAN, McLAUGHLIN & HANRAHAN LLP
COUNSELLORS AT LAW
470 ATLANTIC AVENUE
BOSTON, MASSACHUSETTS 02210-2208

TELEPHONE: (617) 482-1900
FACSIMILE: (617) 338-8079

ROBERT E. McLAUGHLIN, SR.
WALTER H. McLAUGHLIN, JR.*
DAVID G. HANRAHAN
JOHN B. SHEVLIN, JR.
WILLIAM F. YORK
MICHAEL EBY
DAVID L. KLEBANOFF

WALTER H. McLAUGHLIN, SR.
(1931-1994)

JAMES R. PELUSO
LEIGH A. McLAUGHLIN
ROSS D. GINSBERG†
ROBERT E. McLAUGHLIN, JR.
RAKEL M. MEIR‡
BRENDA A. BUAN
CHARLES W. JACKSON, JR.

OF COUNSEL
ARTHUR M. GILMAN
DONNA E. COHEN
* ALSO NH, FL, DC, PA, IL AND TX
† ALSO CT
‡ ALSO ME AND SC

DF

February 4, 1999

Robert Durand, Secretary
Commonwealth of Massachusetts
Environmental Protection Department
100 Cambridge Street
Boston, MA 02202

RECEIVED
FEB 8 - 1999
MEPA

ATTENTION: Mr. Richard Foster

RE: MEPA #11857

Dear Secretary Durand:

Kindly be advised that I am attorney for the West Falmouth Boat Club, Inc. It is a non-profit club with approximately 90 families from the West Falmouth area as members. Among the Club's concerns is the quality of West Falmouth Harbor as a recreational amenity.

We have been active for several years in expressing our concerns relating to the operation of the West Falmouth treatment plant and the nitrogen plume migrating from the plant to West Falmouth Harbor. We have been distressed that heretofore the West Falmouth watershed has been allowed to be degraded to a Category III.

It is my understanding that Falmouth has filed an environmental notification form relating to a study for an upgrade of the Wastewater Treatment Plant. It is also my understanding that the wastewater discharge permit expires on August 10, 1999, and the town must apply for a renewal no later than February 10, 1999.

Please consider this letter as our request to be completely involved in the MEPA process in the review of both the study and/or of any proposed plan to renovate or improve the Falmouth Wastewater Treatment Plant. For notice purposes, will you please add the following to the service list:

West Falmouth Boat Club, Inc.
c/o John D. Ross, President
Box 225
W. Falmouth, MA 02574

Robert E. McLaughlin, Sr.
Attorney for West Falmouth Boat Club, Inc.
Gilman, McLaughlin & Hanrahan, LLP
470 Atlantic Avenue
Boston, MA 02210

Thank you for your attention to this request and for your anticipated cooperation in the future.

Very truly yours,

Robert E. McLaughlin, Sr.

REMSr./sjf

cc: John D. Ross, President
West Falmouth Boat Club

David DeLorenzo, Deputy Regional Director
Mr. Brian Dudley
Bureau of Resource Protection
Commonwealth of Massachusetts
Environmental Protection Department
20 Riverside Drive
Lakeville, MA 02347

Ms. Sarah Korjeff
Mr. Ed Eichner
Cape Cod Commission
3225 Main Street
P.O. Box 226
Barnstable, MA 02630
Re: Falmouth Wastewater Facilities Planning Study
Development of Regional Impact #ENF99001

CAPE COD COMMISSION

3225 MAIN STREET
P.O. BOX 226
BARNSTABLE, MA 02630
(508) 362-3828
FAX (508) 362-3136
E-mail: frontdesk@capecodcommission.org

RECEIVED
FEB 17 1999
MEPA

February 12, 1999

Secretary Robert Durand
Massachusetts Executive Office of Environmental Affairs
100 Cambridge Street
Boston, MA 02202

Attention: Dick Foster, MEPA Unit

EOEA #11857
CCC #ENF99001

Dear Secretary Durand:

The proposed Falmouth Wastewater Facilities Planning Study is being reviewed jointly by the Executive Office of Environmental Affairs (EOEA) - MEPA Unit, and by the Cape Cod Commission as a Development of Regional Impact (DRI) in accordance with the Memorandum of Understanding (MOU) between the Commission and EOEA. An Environmental Notification Form was received by the Commission on January 13, 1999. The proposed project qualifies as a DRI under Chapter A, Section 2(a)(ii) of the Code of Cape Cod Commission Regulations as a project requiring submittal of an Environmental Impact Report. A subcommittee of the Commission held a public hearing on Tuesday, February 2, 1999 at 3 pm in the Falmouth Town Hall to gather comments regarding the scope of the project.

An Environmental Notification Form (ENF) has been filed by the Town and its consultant, Stearns and Wheler. The proposed project will develop a Final Wastewater Facilities Plan for the town. The ENF includes a draft scope of services for the planning process, which includes a Needs Assessment/Problem Identification, Development and Screening of Alternatives, a Detailed Evaluation of Alternatives, and Preparation of a Recommended Facilities Plan. Because the project is a study, no facility or construction project has been identified at this time. Specific proposals, however, will be presented in the Final Wastewater Facilities Plan and Environmental Impact Report which result from this study.

Unlike other town-wide wastewater facility plans currently under Cape Cod Commission review, the applicant has identified a specific planning area for this study. The planning area includes:

- The West Falmouth watershed area;
- Existing sewered areas of Falmouth which could receive additional flow from sewer extensions or infilling, including portions of Scranton Avenue, Clinton Avenue, Davis Straits Road, and Little Harbor Road;
- Falmouth Heights and Maravista areas, which were identified to be sewered as the second phase of sewers in Falmouth;
- Falmouth High School, which has a high Title 5 design flow and may need a groundwater discharge permit (and advanced treatment) or connection to the Falmouth Wastewater Treatment Facility.

A primary focus of the study will be West Falmouth Harbor and identifying means to limit nitrogen loading and protect water quality there.

A Commission subcommittee has reviewed the proposed scope and has the following comments:

PUBLIC PARTICIPATION
Public participation is an important part of this process. To help ensure community involvement and public support of selected solutions, the town and consultant should hold regular meetings with the working group throughout the study and include a list of the working group members in all documents.

WATER RESOURCES
The stated intent of the scope of the study that is contained in the ENF is to address wastewater needs, develop alternatives, and cost effective solutions for the planning area within the Town of Falmouth. However, the key features of this study are the present and future impacts of wastewater discharge at the Town Wastewater Treatment Facility on West Falmouth Harbor.

West Falmouth Harbor has been identified as a nitrogen sensitive embayment through efforts of the Cape Cod Commission, Buzzards Bay Project, Falmouth Pond Watchers, and University of Massachusetts - Dartmouth, Center for Marine Science and Technology (CMAST). Modeling studies using tidal flushing information developed by the town, water quality collected by the Pond Watchers, and nitrogen loading estimates developed by the Commission have indicated that the ecological health in portions of the Harbor are likely to be negatively impacted by continued discharge of effluent with existing water quality at the treatment plant. This assessment can be refined and may be altered, but only with collection of new data.

Since new data is of primary importance in determining what changes are needed in the Treatment Facility and the quality of its effluent, the proposed

order of study in the ENF should be improved by completing the data gathering steps in Task 5.2.2 (part of Phase 5) during the Needs Assessment (Phase 3) portion of the scope. The steps in Task 5.2.2, including review of existing flushing studies, watershed delineations, installation of new wells, and preparation of plume delineations, should be used to inform the Development and Assessment of Alternatives (Phase 4).

Prior to the collection of new data, the Town and its consultants should also seek out data that has been collected in and around West Falmouth Harbor, but has not yet been published. This information, including installation and monitoring of near-shore wells, water quality monitoring within the Harbor, and groundwater modeling, is available from a number of sources, including the Commission, CMAST, the US Geological Survey, and the Falmouth Pond Watchers. Incorporation of this information into the Facilities Planning study may allow the collection of new data to be more limited.

Separate efforts in other areas of the town are being pursued through the Ashumet Plume Study, the development of a wastewater system in Old Silver Beach, and the Long Pond Watershed Study. Coordination with these concurrent studies and attention to the status of other plans for wastewater treatment facilities in town is necessary so that the Facilities Planning Study can address the potential need for additional volume at the Treatment Facility if it is found to be necessary.

Commission staff continue to be available to assist the Town in any of these efforts, including defining how much nitrogen reduction may be needed at the town treatment facility and in assessing the costs and advantages of management strategies with the watershed to West Falmouth Harbor.

LAND USE/GROWTH MANAGEMENT/ECONOMIC DEVELOPMENT

The potential increase in wastewater management capabilities may accommodate additional development in some areas of town, or encourage greater year round use of existing facilities. The Scope of Work states that both direct impacts to resources and indirect impacts to land use patterns will be assessed in the Detailed Evaluation of Screened Alternatives. This should include evaluating potential threats to existing and potential wellhead protection areas adjacent to the study area. As part of this evaluation, the ability of each alternative to conform to the Regional Policy Plan Minimum Performance Standards should be addressed to facilitate Commission review of the project. The study should also recognize the potential for impacts on the Great Sippewissett Marsh District of Critical Planning Concern, which is in close proximity to the West Falmouth Harbor planning area.

COMMUNITY CHARACTER/HISTORIC PRESERVATION
Potential impacts on the character and historic resources included in Falmouth's Local and National Register Historic Districts should be addressed in the consideration of wastewater facility alternatives. Resources in the historic district may be more impacted by some wastewater technologies, while other systems may be less visually obtrusive. Further site specific analysis of historic and archaeological impacts may be required depending upon the sites and types of facilities proposed.

TRANSPORTATION
When specific sites are considered for potential future facilities, they should be evaluated to identify direct transportation issues, impacts and necessary mitigation. At all alternative locations, the EIR should include an evaluation of the access and routing to ensure that the adjacent road system can accommodate any proposed increased traffic.

NATURAL RESOURCES/OPEN SPACE
The impact of potential wastewater facilities on natural resources and open space should be addressed during the environmental review process. The EIR should address the natural resource value of potential facility sites, as well as the potential impacts of locating facilities on these sites.

SUMMARY
The Cape Cod Commission appreciates the opportunity to be involved in the planning, review and coordination of this project. In addition to the issues in the scope of services, staff believes that the above-mentioned issues should be included in the scope of the project and the EIR. Thank you for the opportunity to comment.

Sincerely,

Robert Randolph
Subcommittee Chair

cc. Ray Jack, Utilities Manager
Brian Currie, DRI Liaison
Nathan Weeks, Stearns and Wheler
George Heufelder, County Health Department
Brian Dudley, DEP/SERO
Liz Kouloheras, DEP/SERO
Ron Lyberger, DEP/BRP
Bruce Rosinoff, US EPA
Rick Zeroka, MA CZM

cc. J. Mendes, Division of Marine Fisheries
Joe Costa, Buzzards Bay Project
Chair, Working Group
Falmouth Pond Watchers

COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS
DEPARTMENT OF ENVIRONMENTAL PROTECTION
SOUTHEAST REGIONAL OFFICE

MAR 01 1999 F

LATE COMMENT

ARGEO PAUL CELLUCCI
Governor

JANE SWIFT
Lieutenant Governor

BOB DURAND
Secretary

DAVID B. STRUHS
Commissioner

RECEIVED
FEB 23 1999
MEPA

February 17, 1999

Secretary Bob Durand
Executive Office of
Environmental Affairs
100 Cambridge Street
Boston, Massachusetts 02202

RE: FALMOUTH – ENF Review
EOEA #11857 – Falmouth Wastewater
Facilities Planning Study

LATE COMMENT

Dear Secretary Durand,

The Southeast Regional Office of the Department of Environmental Protection has reviewed the Environmental Notification Form (ENF) for the Wastewater Facilities Planning Study for Falmouth, Massachusetts (EOEA #11857).

The Cape Cod Watershed Basin Team indicates that the ENF provides a background on prior planning and construction efforts and develops a Scope of Work (SOW) for the present project.

The Town of Falmouth (Town) operates a POTW which currently services portions of Main Street, the Falmouth Inner Harbor, portions of Falmouth Beach and portions of Woods Hole. The POTW currently operates under a Class III Groundwater Discharge Permit which is due to expire in August, 1999. Groundwater modeling indicates that the effluent plume from the POTW is discharging toward the upper reaches of West Falmouth Harbor. Over the past several years, various studies have suggested that water quality in these sections of the harbor has degraded due to increased nutrient loading. Concurrent with the need to renew the existing discharge permit, the Town has decided to conduct a facilities plan that will address nitrogen management in the West Falmouth Harbor watershed in order to maintain or improve the current water quality in the harbor system.

The Department supports the Town's efforts and offers the following comments on the ENF in order to maintain appropriate focus on the issues at hand.

1. Assessment of the critical nutrient load in the impacted areas of West Falmouth Harbor needs to be performed before a meaningful screening of alternatives can proceed. That value will essentially determine the necessary level of treatment at the POTW and govern the design of the facility. Accordingly, the Department

believes that those tasks detailed in Task 5.2.2 of Phase 5 should more appropriately be included in Phase 3.

2. The Cape Cod Commission's evaluation of West Falmouth Harbor provides an excellent source of background information and a good initial estimate of critical loads in the whole embayment system and various subsystems. However, the Town and its consultants should undertake a critical review of previous studies in order to refine these values for engineering design. Accordingly, it will be necessary to perform supplemental field analyses, as described in Task 5.2.2, to further refine the critical nutrient load values.

3. The SOW proposes to identify and prioritize service areas. The Department suggests that priority should be given to areas in the West Falmouth Harbor watershed and managing nutrient inputs to that system from within the watershed itself. If the Town anticipates evaluating the feasibility extending sewers to other areas outside the watershed, then it must be established that these additional nutrient loads could be safely assimilated within the West Falmouth Harbor watershed and not exceed the established critical loading.

4. In accordance with Executive Order 385, the facilities plan should evaluate growth management issues resulting from any increased sewering.

The DEP Southeast Regional Office appreciates the opportunity to comment on this proposed project. If you have any questions regarding these comments, please contact Sharon Stone at (508) 946-2846.

Very truly yours,

Robert P. Fagan,
Regional Engineer,
Bureau of Resource Protection

RPF/SS

cc: DEP/SERO
ATTN: David DeLorenzo,
Deputy Regional Director

David Johnston,
Deputy Regional Director

John Viola,
Deputy Regional Director

Elizabeth Kouloheras
Team Leader, Cape Cod Watershed

Jeffrey Gould
Chief, Water Pollution Control

Appendix B

Excerpts from Crooked Pond Well DEIR and DRI Application on Water Conservation

potential environmental impacts to the proposed site, deprives the citizens of Falmouth the security of adequate and reliable water supply for domestic use and fire protection. As a public water supplier, the Town is required under state regulation (310 CMR 22.00) to "operate and maintain the system in a reliable manner and provide continuous adequate service to consumers". Presently, failure of one of the Town's major sources would render them unable to meet peak demands and maintain fire protection. The No-Build alternative would prevent the Town from maintaining essential services required by state regulations. Lack of additional supply capacity would likely lead to water use restrictions and possibly a moratorium on new service connections. A moratorium would prevent the Town from providing public water supply to residents whose wells have been impacted by MMR contamination.

The No-Build alternative would require excessive pumping of existing sources in order to meet peak demands. These withdrawals would impact water resources in the vicinity of the withdrawal points and, if continued in the future, may cause environmental and/or water quality impacts.

The No-Build Alternative is not a viable option for the Town. Lack of additional supply capacity will jeopardize public health and safety and lead to environmental and water quality impacts over a larger percentage of the Town's water resources. The new source will allow the Town to manage water withdrawals and reduce pumping of existing sources.

3.2.2 Water Conservation

The Town of Falmouth is committed to water conservation as a means to reduce present consumption and meet future demands. The results of their efforts are evident in the reduction in withdrawals attained since 1995 and are documented in the DEP Public Water Supply Annual Statistical Reports.

The Utilities Division has worked with the Board of Health, Planning Department, Natural Resources Department, Conservation Commission, Building Department, Board of Selectmen and the Cape Cod Commission in developing the Falmouth Local Comprehensive Plan. The plan was a combined effort to establish goals, strategies/policies and minimum performance standards for the protection of Falmouth's water resources. The plan includes specific water resource protection and conservation action items to be implemented including responsible parties and implementation schedule. A copy of the plan is included in Appendix F.

The Water Department has implemented water conservation measures in accordance with the Water Conservation Plan contained in the 1990 Water Management Permit application.

Additional, more advanced, measures have been implemented and more are being evaluated. The present water conservation program includes the following areas which are specified in the 1992 "Water Conservation Standards for the Commonwealth of Massachusetts":

- Public Education
- Leak Detection and Repair
- Metering
- Pricing
- Water Use Controls
- System Management

Public Education

In an effort to promote public awareness of the benefits of water conservation, the Town utilizes a number of means to educate the public. Informational pamphlets are distributed with water bills and at the Water Department office. The Water Department sponsors an open house, during Drinking Water Week, at the Long Pond Treatment Facility to educate the public on water supply issues including, treatment, conservation and watershed protection. Newspaper ads and cable television notices are also used to spotlight water conservation and provide conservation tips. The Utilities Manager is also active with community groups. Regular speaking engagements are held on water supply topics including conservation, water treatment and resource protection. Sample public education documents are included in Appendix F.

Water Audit/Leak Detection and Repair

Previous comprehensive water audits completed by the Town identified unaccounted water as high as 25%. The primary cause was under registration of service meters. To correct this condition, the Town has appropriated $55,000.00 in the Water Department annual budget for meter replacement. Presently the gross unaccounted for water is under 13%. With detailed accounting of authorized unmetered water use (fire fighting, street sweeping, sewer and hydrant maintenance, etc.) the unaccounted water would be under 10%.

The Water Department has completed leak detection surveys of the complete water system. Past surveys identified very few leaks (25) and of those identified a majority (19) were located at old hydrants. All identified leaks were repaired promptly. As a result of the leak detection findings the Water Department annual budget now includes $55,000.00 for replacement of old hydrants.

This preventive maintenance will eliminate potential future hydrant leakage. Additionally, all hydrants are inspected annually for proper operation and potential leakage.

The Water Department utilizes a computerized work order system to track all reported leaks and ensure prompt repairs are executed. The water billing system is designed to automatically identify accounts with a significant increase in consumption over the prior billing period. The meter readings are verified and if correct the service is field checked and the owner is contacted for inspection of potential interior leaks. Additionally, the Water Department is tracking abandoned water services and permanently capping them at the main to prevent leakage.

Falmouth, like most other water systems, uses bleeders to correct water quality problems on the existing system. Bleeders can account for a significant amount of unmetered water use which in many cases can be eliminated. At one point the Town had over sixteen bleeders discharging in excess of 85,000 gpd. The Water Department annual budget includes $200,000.00 for water main extensions and looping required to eliminate bleeders. Presently there are only nine active bleeders accounting for approximately 22,000 gpd of flow. Construction of water main extensions to eliminate bleeders is on-going and will continue until all bleeders are eliminated.

The Water Department is also replacing older water mains which are subject to leakage and breaks. Main replacements have been prioritized within a capital improvement plan which is supported by the Town Administrator and Board of Selectmen. Water rate increases have been approved to fund this program which is expected to run through the year 2003. Annual expenditures under this program have ranged between $300,000.00 and $500,000.00 over the past two years.

The Water Department has initiated a very effective program to reduce unaccounted for water and eliminate leakage in the distribution system. They have appropriated the funding necessary to ensure success of the program. This work is on-going and the goal is to eliminate all bleeders by the year 2000 and reduce unaccounted for water below 10%.

Metering

The Town is 100% metered, including public buildings. As previously discussed, meter under registration has been identified as a major component of unaccounted for water. Under registration also translates into lost revenue. The meter replacement program ($55,000.00/year) has significantly reduced the unaccounted-for water and at the same time increased revenues and raised consumer awareness of water consumption and cost. The Water Department

conducts routine testing of service meters to ensure accuracy. Residential meters are tested a minimum of every seven years and large meters are tested bi-annually to an accuracy of ±3%. Source meters are tested annually by certified testing companies.

An automated meter reading system is utilized to eliminate errors. Residential meters are read twice per year and large meters are read quarterly. The quarterly readings allow for frequent checks for meter error, which for large meters, can be a significant loss of revenue and a source of unaccounted-for water.

Pricing

Water rates are regularly evaluated by the Utilities Manager. Although not fully an enterprise system, the rates charged cover most of the public water supply costs including all of the system operations. Water is billed on a flat rate and rates were increased to $2.00 per hundred cubic feet in 1997. This rate is above average according to a 1996 survey conducted by the Plymouth County Water Works Association, which indicated an average rate of $1.80 per hundred cubic feet among 30 water suppliers in Southeastern Massachusetts. This rate is at a level which will encourage conservation. The Water Department will continue to work toward a fully enterprise rate structure.

Water Use Controls

The Water Department actively pursues effective measures to control water use. Public education and media notices are used to emphasize conservation and provide effective tips for consumers to implement. Restaurants are encouraged to only serve water when asked, toilet leak detection kits are provided free of charge to consumers and plumbing codes are enforced with new construction and building renovations.

The Town has adopted a Voluntary Water Conservation Program to heighten public awareness of conservation during non emergency periods. This program includes many of the measures typically included in an emergency plan (see Appendix F). Additionally, the program includes water pressure management measures to limit water use at boat docks and marinas. Water consumption is directly related to the pressure available at the tap, higher the pressure, greater the flow (consumption). The Town has required marina and boat docks owners to install pressure reducers at their facilities to control consumption. These locations typically have higher than necessary pressure due to the low elevation and pressure reducers will automatically limit consumption by controlling available pressures.

This program targets reducing peak summer demand associated with the many marinas in Falmouth. As much as a thirty percent reduction in water use could be realized with this program (EPA Draft Guidelines).

The Town also has a Water Supply Emergency Plan consisting of three levels of water use restrictions which are implemented based upon the severity of the emergency. The plan has been approved by DEP and is implemented upon declaration of a Water Emergency under the Falmouth Code (bylaws).

The Town has also funded a study to evaluate water distribution system storage. This study is intended to evaluate the water system storage requirements including location, volume and pressure distribution. The water system presently operates as one pressure zone with pressures regulated by a tank overflow elevation previously established to ensure adequate pressure to a majority of the Town. With ground elevations ranging from 0 to 200+ feet MSL, the single pressure zone creates excessive pressure at lower elevations and marginal pressure at the higher elevations. The proposed study will evaluate the feasibility of creating multiple pressure zones on the system which would provide appropriate service pressure to all areas while eliminating excessive pressures. This change, once implemented, will provide an effective means to control consumption. As much as a six percent (EPA Draft Guidelines) reduction in total consumption could be realized with this program. A summary of the Town's major water conservation measures presently being implemented are included in Table 3-1.

Table 3-1
Summary of Water Conservation Measures

Conservation Measure	Funding	Status
Public Education	Operating Budget	On-Going
Meter Replacement	$55,000.00/yr	On-Going
Hydrant Replacement	$55,000.00/yr	On-Going
Bleeder Reduction	$200,000.00/yr	On-Going
Water Main Replacement	$500,000.00/yr	On-Going
Storage/Pressure Study	$45,000.00	On-Going
Marina Pressure Control	Owner Funded	On-Going
Service Meter Calibration	Operating Budget	On-Going
Source Meter Calibration	Operating Budget	On-Going

System Management

The Utilities Division is committed to protection of natural resources through proper system management. System management consists of an integrated approach incorporating all of the above areas in an effort to maintain a reliable public water supply system capable of providing adequate supply to meet present and future needs while protecting the valuable natural resources of the community.

The Falmouth Local Comprehensive Plan sets forth goals, policies and minimum performance standards to be implemented by Town Departments in addressing growth, development and protection of natural resources. The Water Resources section of the plan (Element 2.1), includes six goals designed to protect natural resources including fresh and marine waters, public water supplies, wetlands and implementation of town-wide comprehensive water conservation. To meet these goals a schedule of Action Items was developed including implementation schedule, responsible party and milestones. This plan demonstrates the long term commitment of the Utilities Division and other Town Departments to the protection of water resources. Water conservation is a major part of the plan.

The Water Department will be implementing a Supervisory Control and Data Acquisition (SCADA) computer system to better manage the many facets of the water supply system. This system will allow for control and management of all aspects of the system including source withdrawal, storage, water quality, distribution pressure and all data related thereto. Real time collection and evaluation of system data will allow for close control of system operations and protection of natural resources.

Proposed EPA Water Conservation Plan Guidelines

In accordance with Section 1455 of the 1996 Amendments to the Safe Drinking Water Act, the United States Environmental Protection Agency has published (April 1998) draft "Water Conservation Plan Guidelines". The Guidelines have been released for public comment and are scheduled for enactment in late 1998. Three sets of guidelines are included in the draft plan, Basic, Intermediate and Advanced. The guidelines are applied based upon the system size category, with small systems (<3,300 people) utilizing a modified Basic approach, medium systems from 3,300 to 10,000 - Basic Approach and large systems from 10,000 to 100,000 - Intermediate Approach and greater than 100,000 - Advanced Guidelines. Additionally, the guidelines can be adapted based upon site specific conditions including, climate, water availability, infrastructure condition, demand factors and planning issues.

In general, more sophisticated conservation measures are required for larger systems and systems with critical water supply needs or issues.

Water conservation measures are divided into three levels (1, 2, 3) with four subcategories each, which are cumulatively implemented from the Basic to Advanced programs. Specific measures are listed within each subcategory and the number of recommended measures increases with the more advanced programs. Conservation measures are listed as follows:

Level 1

- Universal metering
- Water accounting and loss control
- Costing and pricing
- Information and education

Level 2

- Water audits
- Retrofits
- Pressure management
- Landscape efficiency

Level 3

- Replacements and promotions
- Reuse and recycling
- Water use regulation
- Integrated resource management

Based upon the service population, Falmouth would fall within the Intermediate Guideline requirements which includes Level 1 and Level 2 measures. There are 27 specific conservation measures identified under the Intermediate, Level 1 and 2 guidelines. The Town of Falmouth has already implemented 22 of the measures. The areas not implemented include, large user and landscape audits, plumbing retrofit kits and landscape efficiency and irrigation metering. The Falmouth Local Comprehensive Plan includes action items targeting landscape planning (Xeriscaping™) to reduce irrigation water demands.

The Advanced program includes an additional twelve measures under levels 1 & 2. Of these, the Town has implemented eight. The areas of user audits, plumbing retrofit and landscape management remain to be addressed. There are also ten additional measures under Level 3 of which the Town has implemented three. The areas not presently addressed are replacement and promotion programs (rebates & incentives), water reuse and recycling, regulation of new developments and alternative technologies for large users. As previously noted, the Falmouth

Comprehensive Plan includes action items for implementation of landscape planning for new developments and renovations. A copy of the EPA's Advanced Guideline checklist is included in Appendix F.

Water conservation will continue to be a high priority for the Utilities Division and other Town Departments. New areas, including some of the more advanced measures in the draft EPA guidelines, are being evaluated for implementation. The system wide pressure management measures will reduce consumption in all user categories. As much as a six percent reduction (EPA Draft Guidelines, April 1998) in total consumption could be realized with this program. The Town has implemented water conservation measures in accordance with the Massachusetts Water Conservation Standards. Substantial financial resources have been committed to ensure the program is successful.

3.2.3 Regional Water Supply

The Town of Falmouth has maintained emergency water supply interconnections with neighboring communities (Bourne and Mashpee Water Districts) for many years. These connections are intended to provide short term emergency water supply between the communities. The Town's water system infrastructure has not been designed to utilize the interconnections as transmission mains for high flows required to meet peak demand and fire flow. The Water Districts also do not have excess supply capacity which can be committed to fulfill Falmouth's needs.

In accordance with EOEA recommendations, the Town contacted neighboring communities to ascertain if they had potential well site(s) which could be made available to the Town of Falmouth for development. All neighboring water suppliers indicated that they did not have potential well sites which could be made available to Falmouth (Appendix A). Additionally, the Town of Falmouth does not have the legal authority to develop a water supply source outside Town boundaries.

Falmouth and neighboring water suppliers are presently working with DEP, the Cape Cod Commission and the MMR on long range water supply planning for the Upper Cape. These planning efforts are focused on determining present and future water supply needs for the communities and the MMR, engineering and infrastructure requirements for a regional water supply system. Most of the communities are striving to maintain adequate supply to meet their own demands and do not have excess supply capacity to dedicate to a regional system.

APPENDIX F*

Documentation of Water Conservation Efforts

Available in the Crooked Pond Well Draft EIR and DRI. (26 pages)

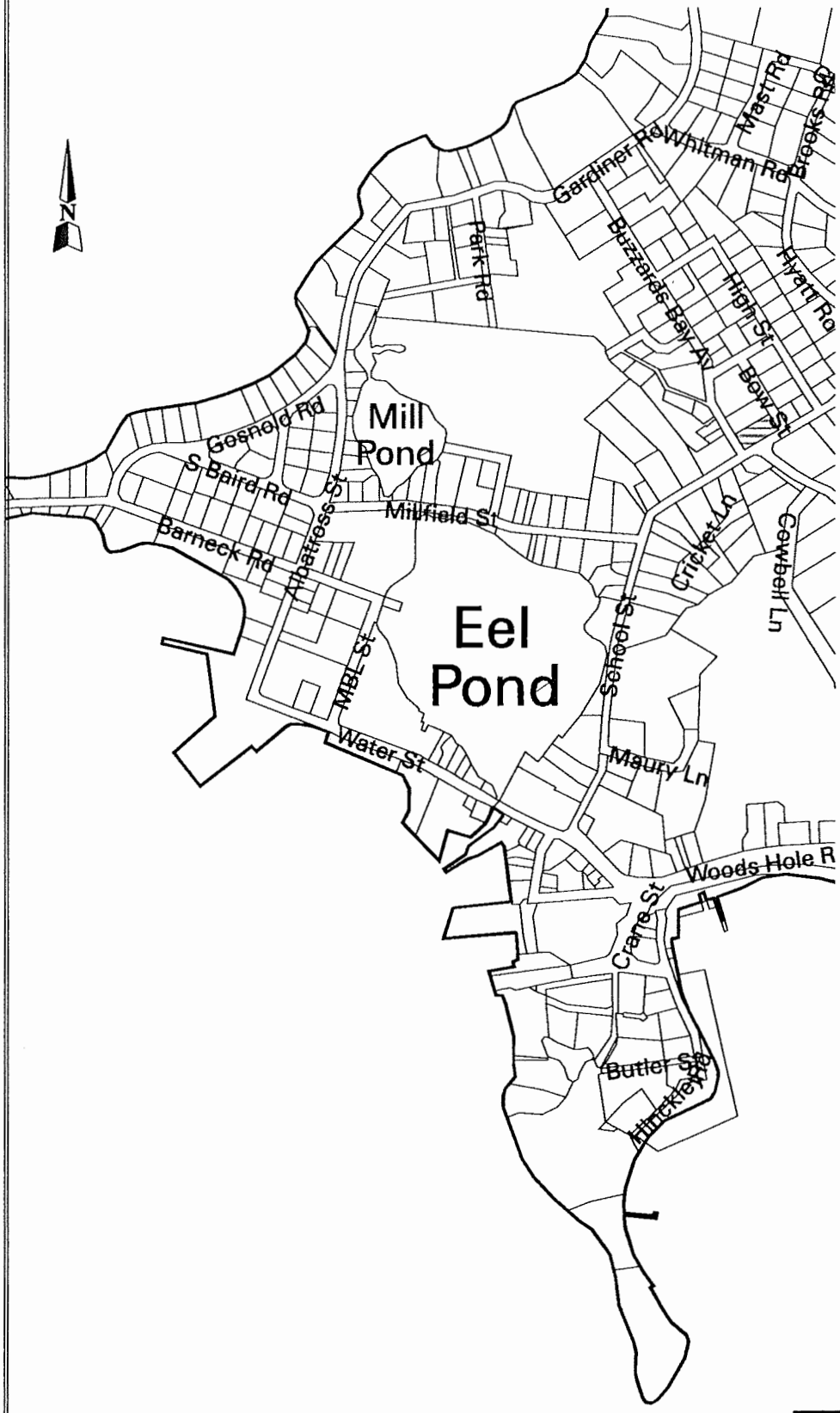
Not included in WWFP Needs Assessment Report. See Town LCP.

INDEX

* Appendix F of Crooked Pond Well Draft EIR and DRI

Appendix C

Properties with Septic Systems Pumped Two or More Times



Town of Falmouth Woods Hole Area

This map developed by Stearns & Wheler, LLC, Environmental Engineers &Scientists for the purpose of studying Falmouth's wastewater management needs. Sewered parcels, and the Water Pollution Control Facility were digitized in 1990 for the Cape Cod Commission's Regional Policy Plan. Other base map features such as coastlines, water bodies, coastal embayment recharge areas, water supply protection areas, groundwater elevation, roads and road names were automated by the Cape Cod Commission GIS department. Special technical assistance and data was provided by MassGIS of Boston, MA; and the Town ofFalmouth.

Parcels were digitized by the Cap Cod Commission GIS Department for use by the Town of Falmouth from Falmouth 1994 Assessors Maps at the original scale of 1:1200 and 1:2400. Wetlands were digitized by Cape Cod Commission GIS and orginated from 1990 MacConnell Aerial Photo Land Use and 1982 Mass DEP wetland restriction maps. Wetland restriction areas were provided by the Town of Falmouth, digitized by Cape Cod Commission. Flood hazards were digitized by the Cape Cod Commission from 1986 Flood Insurance Rate Maps produced by the Federal Emergency Managament Agency, and rubber-sheeted to match MassGIS 1:25,000 road network.

The map has been developed as a planning tool to investigate problems related to wastewater treatment and disposal. Much Town-wide and regional information has been intergrated to produce this map. The source information comes from a variety of dates, as noted above, and therefore, may not reveal more recent changes. Also, the source information was digitized with a regional prespective, and this may show inherent inaccuracies pertaining to individual properties. This map does not intend to provide design information or regulatory enforcement for individual properties.

Legend

- Parcels
- Coastline
- Town Boundaries
- Surface Water Bodies
- Septic Tank Pumped 2 Times
- Septic Tank Pumped 3 to 5 Times
- Septic Tank Pumped 6 to 10 Times
- Septic Tank Pumped Greater Than 10 Times

0 200 400 800 feet

Massachusetts State Plane Feet
North American Datum - 1927
Scale - 1:8,250

March 30, 1999

SEPTIC TANK PUMPING

Wastewater Facilities Planning Study
Town of Falmouth, MA

Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS & SCIENTISTS

Map prepared by Harvard Design and Mapping Company, Inc.
Base map prepared by the Cape Cod Commission, GIS Department

Appendix D

Monthly Operating Data

Falmouth WWTP
Operating Data Analysis
1/95-12/98

	Sewerage Flow (MGD)				Septage		Plant Influent				
	Average	Peak	Ambient Air Temp (F)		Septage Flow		BOD		TSS		pH
Month	Day	Day	Max	Min	(gal/mo)	gal/day	(mg/l)	(lb/d)	(mg/l)	(lb/d)	(SU)
Jan-95	0.2510	0.2800			333,000	11,100	376.2	790.0	346.0	720.0	6.5
Feb-95	0.2760	0.3120	42	3	251,000	8,400	382.1	880.0	273.3	630.0	6.5
Mar-95	0.3320	0.3560	54	22	460,000	15,300	423.8	1170.0	324.9	900.0	6.4
Apr-95	0.3090	0.3520	52	22	624,000	20,800	413.3	1070.0	502.9	1300.0	6.5
May-95	0.3500	0.4250	64	38	701,000	23,400	443.5	1300.0	430.7	1260.0	6.4
Jun-95	0.4170	0.4820	74	54	806,000	26,900	463.6	1610.0	576.7	2010.0	6.3
Jul-95	0.4790	0.5590	80	64	837,000	27,900	412.5	1650.0	431.0	1720.0	6.2
Aug-95	0.5400	0.6780	77	59	1,198,000	39,900	327.0	1470.0	333.2	1500.0	6.2
Sep-95	0.4820	0.5530	68	48	707,000	23,600	304.6	1230.0	360.2	1450.0	6.3
Oct-95	0.4260	0.5160	70	36	662,000	22,100	445.8	1580.0	451.3	1600.0	6.6
Nov-95	0.3940	0.5220	56	24	644,000	21,500	365.1	1200.0	378.8	1250.0	6.3
Dec-95	0.3470	0.4440	45	14	409,000	13,600	390.5	1130.0	289.1	840.0	6.4
1995 ave	0.3836	0.4566	62	35	636,000	21,200	395.7	1256.7	391.5	1265.0	6.4
1995 max	0.5400	0.6780	80	64	1,198,000	39,900	463.6	1650.0	576.7	2010.0	6.6
1995 min	0.2510	0.2800	42	3	251,000	8,400	304.6	790.0	273.3	630.0	6.2
Jan-96	0.3180	0.4200	46	0	247,000	8,200	232.3	620.0	154.9	410.0	6.4
Feb-96	0.3210	0.4010	41	2	282,000	9,400	335.2	900.0	233.4	630.0	6.5
Mar-96	0.3200	0.4090	47	20	436,000	14,500	331.6	890.0	314.7	840.0	6.6
Apr-96	0.3640	0.4510	57	30	692,000	23,100	538.1	1630.0	583.8	1770.0	6.5
May-96	0.4070	0.4770	68	42	869,000	29,000	430.2	1460.0	596.5	2030.0	6.4
Jun-96	0.4660	0.5400	74	58	738,000	24,600	382.5	1490.0	309.4	1200.0	6.4
Jul-96	0.5380	0.6400	76	60	973,000	32,400	384.2	1720.0	315.8	1420.0	6.2
Aug-96	0.5040	0.5590	70	60	1,073,000	35,800	397.4	1670.0	303.1	1270.0	6.2
Sep-96	0.5090	0.6500	69	47	695,000	23,200	343.3	1460.0	313.3	1330.0	6.3
Oct-96	0.4740	0.6840	62	32	898,000	29,900	373.1	1480.0	418.8	1660.0	6.4
Nov-96	0.3790	0.5730	60	20	690,000	23,000	460.2	1460.0	426.3	1350.0	6.7
Dec-96	0.3900	0.5040	52	20	667,000	22,200	300.7	980.0	285.2	930.0	6.7
1996 ave	0.4158	0.5257	60	33	688,333	22,900	375.7	1313.3	354.6	1236.7	6.4
1996 max	0.5380	0.6840	76	60	1,073,000	35,800	538.1	1720.0	596.5	2030.0	6.7
1996 min	0.3180	0.4010	41	0	247,000	8,200	232.3	620.0	154.9	410.0	6.2
Jan-97	0.3540	0.4400	44	-2	513,000	17,100	298.2	880.0	265.3	780.0	6.9
Feb-97	0.3530	0.4240	44	14	423,000	14,100	396.9	1170.0	320.6	940.0	7.0
Mar-97	0.3940	0.7000	48	20	582,000	19,400	406.2	1340.0	340.6	1120.0	6.9
Apr-97	0.4690	0.5960	52	28	721,000	24,000	394.0	1540.0	360.5	1410.0	6.8
May-97	0.4590	0.6200	60	42	1,009,000	33,600	525.6	2010.0	451.8	1730.0	6.8
Jun-97	0.5280	0.6660	78	48	933,000	31,100	340.4	1500.0	330.8	1460.0	6.7
Jul-97	0.6380	0.7480	78	60	1,127,000	37,600	502.3	2670.0	387.5	2060.0	6.6
Aug-97	0.5460	0.6870	76	57	1,053,000	35,100	507.5	2310.0	432.1	1970.0	6.6
Sep-97	0.4600	0.5560	72	46	737,000	24,600	310.4	1190.0	314.6	1210.0	6.7
Oct-97	0.3970	0.4810	60	34	875,000	29,200	426.5	1410.0	591.3	1960.0	6.7
Nov-97	0.3790	0.4720	58	22	640,000	21,300	400.2	1270.0	420.7	1330.0	6.8
Dec-97	0.3320	0.4130	42	18	772,000	25,700	413.2	1140.0	538.5	1490.0	6.8
1997 ave	0.4424	0.5669	59	32	782,083	26,100	410.1	1535.8	396.2	1455.0	6.8
1997 max	0.6380	0.7480	78	60	1,127,000	37,600	525.6	2670.0	591.3	2060.0	7.0
1997 min	0.3320	0.4130	42	-2	423,000	14,100	298.2	880.0	265.3	780.0	6.6
Jan-98	0.3710	0.4910	50	8	534,000	17,800	359.6	1110.0	416.3	1290.0	7.0
Feb-98	0.4110	0.5910	46	9	419,000	14,000	277.9	950.0	282.1	970.0	7.0
Mar-98	0.3870	0.5350	52	20	631,000	21,000	404.0	1300.0	434.2	1400.0	6.9
Apr-98	0.3950	0.4650	54	30	762,000	25,400	429.0	1410.0	458.4	1510.0	6.9
May-98	0.4250	0.4900	68	40	942,000	31,400	413.3	1470.0	347.3	1230.0	6.7
Jun-98	0.5310	0.6600	72	57	1,075,000	35,800	394.5	1750.0	352.8	1560.0	6.5
Jul-98	0.5500	0.6880	78	62	1,220,000	40,700	462.5	2120.0	425.7	1950.0	6.3
Aug-98	0.5640	0.6720	78	56	1,043,000	34,800	411.7	1940.0	385.7	1820.0	6.3
Sep-98	0.4510	0.5120	72	50	913,000	30,400	345.7	1300.0	506.7	1910.0	6.4
Oct-98	0.4360	0.5850	66	37	850,000	28,300	364.0	1320.0	435.6	1580.0	6.5
Nov-98	0.3640	0.4250	58	30	863,000	28,800	581.5	1770.0	1175.0	3570.0	6.6
Dec-98	0.3340	0.4030	52	14	773,000	25,800	492.8	1370.0	413.3	1150.0	6.6
1998 ave	0.4349	0.5431	62	34	835,417	27,900	411.4	1484.2	469.4	1661.7	6.6
1998 max	0.5640	0.6880	78	62	1,220,000	40,700	581.5	2120.0	1175.0	3570.0	7.0
1998 min	0.3340	0.4030	46	8	419,000	14,000	277.9	950.0	282.1	970.0	6.3

	Sewerage Flow (MGD)				Septage		Plant Influent				
	Average	Peak	Ambient Air Temp (F)		Septage Flow		BOD		TSS		pH
Month	Day	Day	Max	Min	(gal/mo)	gal/day	(mg/l)	(lb/d)	(mg/l)	(lb/d)	(SU)
Overall Averages											
January	0.3235	0.4078	47	2	406,750	13,550	316.6	850.0	295.6	800.0	6.7
February	0.3403	0.4320	43	7	343,750	11,475	348.0	975.0	277.3	792.5	6.8
March	0.3583	0.5000	50	21	527,250	17,550	391.4	1175.0	353.6	1065.0	6.7
April	0.3843	0.4660	54	28	699,750	23,325	443.6	1412.5	476.4	1497.5	6.7
May	0.4103	0.5030	65	41	880,250	29,350	453.1	1560.0	456.6	1562.5	6.6
June	0.4855	0.5870	75	54	888,000	29,600	395.3	1587.5	392.4	1557.5	6.5
July	0.5513	0.6588	78	62	1,039,250	34,650	440.4	2040.0	390.0	1787.5	6.3
August	0.5385	0.6490	75	58	1,091,750	36,400	410.9	1847.5	363.5	1640.0	6.3
September	0.4755	0.5678	70	48	763,000	25,450	326.0	1295.0	373.7	1475.0	6.4
October	0.4333	0.5665	65	35	821,250	27,375	402.4	1447.5	474.2	1700.0	6.6
November	0.3790	0.4980	58	24	709,250	23,650	451.8	1425.0	600.2	1875.0	6.6
December	0.3508	0.4410	48	17	655,250	21,825	399.3	1155.0	381.5	1102.5	6.6
Ave. Daily	0.4192	0.5231	61	34	735,458	24,525	398.2	1397.5	402.9	1404.6	6.6
Ave. Max	0.5700	0.6995	78	62	1,154,500	38,500	527.2	2040.0	734.9	2417.5	6.8
Ave. Min	0.3088	0.3743	43	2	335,000	11,175	278.3	810.0	243.9	697.5	6.3
Overall Max	0.6380	0.7480	80	64	1,220,000	40,700	581.5	2670.0	1175.0	3570.0	7.0
Overall Min	0.2510	0.2800	41	-2	247,000	8,200	232.3	620.0	154.9	410.0	6.2

Falmouth WWTP
Operating Data Analysis
1/95-12/98

	Final Effluent																
	BOD		TSS		pH	TKN		NO3-N		NO2-N		Total N		% Removal		Effluent Flow	
Month	(mg/l)	(lb/d)	(mg/l)	(lb/d)	(SU)	(mg/l)	(lb/d)	(mg/l)	(lb/d)	(mg/l)	(lb/d)	(mg/l)	(lb/d)	BOD	TSS	Ave.(mgd)	Peak Day(mgd)
Jan-95	18.3	38.3	8.1	17.0	6.9	21.50	45.03	0.35	0.73			21.9	45.8	95.1	97.7	0.2621	0.2911
Feb-95	21.2	48.8	14.1	32.5	6.9	21.80	50.21	0.20	0.46			22.0	50.7	94.5	94.8	0.2844	0.3204
Mar-95	19.3	53.5	7.5	20.8	6.8	13.60	37.68	0.05	0.14			13.7	37.8	95.4	97.7	0.3473	0.3713
Apr-95	19.2	49.5	13.2	34.0	6.8	25.60	66.01	0.45	1.16			26.1	67.2	95.4	97.4	0.3298	0.3728
May-95	39.9	116.5	28.7	83.8	6.7	27.80	81.20	0.10	0.29			27.9	81.5	91.0	93.3	0.3734	0.4484
Jun-95	53.1	184.8	46.6	162.2	6.7	40.40	140.59	0.25	0.87			40.7	141.5	88.5	91.9	0.4439	0.5089
Jul-95	31.2	124.7	52.6	210.3	6.6	36.40	145.50	1.45	5.80			37.9	151.3	92.4	87.8	0.5069	0.5869
Aug-95	26.6	119.9	50.6	228.0	6.4	30.50	137.44	0.35	1.58			30.9	139.0	91.9	84.8	0.5799	0.7179
Sep-95	43.0	173.0	43.2	173.8	6.5	30.20	121.47	0.13	0.52			30.3	122.0	85.9	88.0	0.5056	0.5766
Oct-95	24.0	85.3	23.0	81.8	6.6	25.40	90.30	0.18	0.64			25.6	90.9	94.6	94.9	0.4481	0.5381
Nov-95	23.8	78.3	12.8	42.1	6.6	20.40	67.07	0.20	0.66			20.6	67.7	93.5	96.6	0.4155	0.5435
Dec-95	23.0	66.6	20.3	58.8	6.6	20.20	58.49	0.20	0.58			20.4	59.1	94.1	93.0	0.3606	0.4576
1995 ave	28.6	94.9	26.7	95.4	6.7	26.15	86.75	0.33	1.12			26.5	87.9	92.7	93.2	0.4048	0.4778
1995 max	53.1	184.8	52.6	228.0	6.9	40.40	145.50	1.45	5.80			40.7	151.3	95.4	97.7	0.5799	0.7179
1995 min	18.3	38.3	7.5	17.0	6.4	13.60	37.68	0.05	0.14			13.7	37.8	85.9	84.8	0.2621	0.2911
Jan-96	41.0	108.8	30.0	79.6	6.5	20.30	53.87	0.30	0.80			20.6	54.7	82.4	80.6	0.3262	0.4282
Feb-96	55.4	148.4	24.5	65.6	6.5	19.70	52.77	0.16	0.43			19.9	53.2	83.5	89.5	0.3304	0.4104
Mar-96	66.2	176.8	44.8	119.6	6.6	22.50	60.08	0.12	0.32			22.6	60.4	80.0	85.8	0.3345	0.4235
Apr-96	70.7	214.8	51.5	156.3	6.5	21.30	64.70	0.15	0.46			21.5	65.2	86.9	91.2	0.3871	0.4741
May-96	76.0	258.0	25.1	85.3	6.4	28.00	95.10	0.01	0.03			28.0	95.1	82.3	95.8	0.4360	0.5060
Jun-96	41.3	160.4	36.0	140.0	6.4	28.40	110.44	0.15	0.58			28.6	111.0	89.2	88.4	0.4906	0.5646
Jul-96	26.6	119.4	13.3	59.5	6.2	8.85	39.73	10.04	45.08			18.9	84.8	93.1	95.8	0.5704	0.6724
Aug-96	16.0	67.3	6.4	26.7	6.4	17.50	73.60	4.10	17.24			21.6	90.8	96.0	97.9	0.5398	0.5948
Sep-96	10.7	45.2	6.2	26.3	6.4	12.50	53.10	4.84	20.56			17.3	73.7	96.9	98.0	0.5322	0.6732
Oct-96	24.0	94.9	7.2	28.5	6.5	15.90	62.89	2.63	10.40			18.5	73.3	93.6	98.3	0.5039	0.7139
Nov-96	31.4	99.3	12.4	39.2	6.7	14.80	46.81	6.00	18.98			20.8	65.8	93.2	97.1	0.4020	0.5960
Dec-96	37.7	122.7	26.5	86.2	6.8	16.90	55.00	5.22	16.99	0.08	0.27	22.2	72.3	87.5	90.7	0.4122	0.5262
1996 ave	41.4	134.7	23.6	76.1	6.5	18.89	64.01	2.81	10.99	0.08	0.27	21.7	75.0	88.7	92.4	0.4388	0.5486
1996 max	76.0	258.0	51.5	156.3	6.8	28.40	110.44	10.04	45.08	0.08	0.27	28.6	111.0	96.9	98.3	0.5704	0.7139
1996 min	10.7	45.2	6.2	26.3	6.2	8.85	39.73	0.01	0.03	0.08	0.27	17.3	53.2	80.0	80.6	0.3262	0.4104
Jan-97	29.6	87.4	30.6	90.4	7.1	16.40	48.45	4.59	13.56	0.04	0.13	21.0	62.1	90.1	88.5	0.3711	0.4571
Feb-97	37.8	111.4	35.4	104.1	7.1	19.70	58.03	2.32	6.83	0.03	0.07	22.0	64.9	90.5	89.0	0.3671	0.4381
Mar-97	55.6	182.8	33.0	108.5	7.0	18.70	61.48	3.25	10.69	0.10	0.32	22.0	72.5	86.3	90.3	0.4134	0.7194
Apr-97	44.7	174.9	30.1	117.8	6.9	17.40	68.10	0.93	3.64	0.18	0.68	18.5	72.4	88.7	91.7	0.4930	0.6200
May-97	33.1	126.8	12.3	47.1	6.8	13.00	49.79	8.67	33.21	1.03	3.95	22.7	86.9	93.7	97.3	0.4926	0.6536
Jun-97	34.0	149.8	11.1	48.9	6.5	15.70	69.18	3.00	13.22	0.65	2.87	19.4	85.3	90.0	96.6	0.5591	0.6971
Jul-97	25.2	134.2	12.0	63.9	6.5	6.09	32.42	8.18	43.55	9.82	52.28	24.1	128.3	95.0	96.9	0.6756	0.7856
Aug-97	34.3	156.3	6.7	30.5	6.8	9.28	42.28	9.70	44.20	0.93	4.24	19.9	90.7	93.2	98.4	0.5811	0.7221
Sep-97	16.3	62.6	5.9	22.6	7.0	25.80	99.04	0.34	1.31	0.31	1.17	26.4	101.5	94.7	98.1	0.4846	0.5806
Oct-97	39.3	130.2	13.6	45.1	6.9	28.20	93.43	1.27	4.21	0.78	2.58	30.3	100.2	90.8	97.7	0.4262	0.5102
Nov-97	65.4	206.8	22.6	71.5	6.8	15.30	48.39	9.20	29.10	0.55	1.73	25.0	79.2	83.7	94.6	0.4003	0.4933
Dec-97	29.8	82.6	30.6	84.8	7.0	10.90	30.20	9.12	25.27	0.38	1.05	20.4	56.5	92.8	94.3	0.3577	0.4387
1997 ave	37.1	133.8	20.3	69.6	6.9	16.37	58.40	5.05	19.06	1.23	5.92	22.7	83.4	90.8	94.5	0.4685	0.5930
1997 max	65.4	206.8	35.4	117.8	7.1	28.20	99.04	9.70	44.20	9.82	52.28	30.3	128.3	95.0	98.4	0.6756	0.7856
1997 min	16.3	62.6	5.9	22.6	6.5	6.09	30.20	0.34	1.31	0.03	0.07	18.5	56.5	83.7	88.5	0.3577	0.4381
Jan-98	18.8	58.2	25.8	79.9	7.1	20.40	63.16	2.28	7.06	0.02	0.05	22.7	70.3	94.8	93.8	0.3888	0.5088
Feb-98	18.1	62.1	21.5	73.7	7.1	20.10	68.94	0.75	2.57	0.04	0.12	20.9	71.6	93.5	92.4	0.4250	0.6050
Mar-98	19.4	62.7	15.2	49.1	7.1	17.50	56.52	0.33	1.07	0.03	0.09	17.9	57.7	95.2	96.5	0.4080	0.5560
Apr-98	28.3	93.3	24.0	79.1	7.1	20.30	66.91	0.70	2.31	0.05	0.17	21.1	69.4	93.4	94.8	0.4204	0.4904
May-98	50.7	179.8	19.3	68.4	6.8	25.10	89.02	0.00	0.00	0.22	0.78	25.3	89.8	87.7	94.4	0.4564	0.5214
Jun-98	42.4	187.9	16.3	72.2	6.2	6.38	28.27	7.72	34.21	11.03	48.88	25.1	111.4	89.3	95.4	0.5668	0.6958
Jul-98	47.4	217.6	10.1	46.4	6.3	9.14	41.95	6.76	31.03	3.74	17.17	19.6	90.1	89.8	97.6	0.5907	0.7287
Aug-98	13.0	61.0	9.8	46.1	6.5	20.50	96.48	4.74	22.31	0.10	0.48	25.3	119.3	96.9	97.5	0.5988	0.7068
Sep-98	19.1	71.9	14.4	54.2	6.8	6.15	23.15	10.50	39.52	1.54	5.80	18.2	68.5	94.5	97.2	0.4814	0.5424
Oct-98	40.3	146.6	8.3	30.2	7.0	27.40	99.69	0.90	3.27	0.30	1.09	28.6	104.1	88.9	98.1	0.4643	0.6133
Nov-98	68.4	207.8	7.4	22.5	7.0	26.20	79.58	1.09	3.31	0.97	2.93	28.3	85.8	88.2	99.4	0.3928	0.4538
Dec-98	42.9	119.6	8.8	24.5	7.0	21.50	59.93	2.17	6.05	0.73	2.03	24.4	68.0	91.3	97.9	0.3598	0.4288
1998 ave	34.1	122.4	15.1	53.9	6.8	18.39	64.47	3.16	12.73	1.56	6.63	23.1	83.8	91.9	96.2	0.4628	0.5709
1998 max	68.4	217.6	25.8	79.9	7.1	27.40	99.69	10.50	39.52	11.03	48.88	28.6	119.3	96.9	99.4	0.5988	0.7287
1998 min	13.0	58.2	7.4	22.5	6.2	6.15	23.15	0.00	0.00	0.02	0.05	17.9	57.7	87.7	92.4	0.3598	0.4288

	Final Effluent																
	BOD		TSS		pH	TKN		NO3-N		NO2-N		Total N		% Removal		Effluent Flow	
Month	(mg/l)	(lb/d)	(mg/l)	(lb/d)	(SU)	(mg/l)	(lb/d)	(mg/l)	(lb/d)	(mg/l)	(lb/d)	(mg/l)	(lb/d)	BOD	TSS	Ave.(mgd)	Peak Day(mgd)
Overall Averages																	
January	26.9	73.2	23.6	66.7	6.9	19.65	52.63	1.88	5.54	0.03	0.09	21.5	58.2	90.6	90.1	0.3371	0.4213
February	33.1	92.7	23.9	69.0	6.9	20.33	57.49	0.86	2.57	0.03	0.10	21.2	60.1	90.5	91.4	0.3517	0.4435
March	40.1	118.9	25.1	74.5	6.9	18.08	53.94	0.94	3.05	0.06	0.21	19.0	57.1	89.2	92.6	0.3758	0.5176
April	40.7	133.1	29.7	96.8	6.8	21.15	66.43	0.56	1.89	0.11	0.43	21.8	68.5	91.1	93.7	0.4076	0.4893
May	49.9	170.3	21.4	71.2	6.7	23.48	78.78	2.20	8.38	0.63	2.36	26.0	88.3	88.7	95.2	0.4396	0.5324
June	42.7	170.7	27.5	105.8	6.5	22.72	87.12	2.78	12.22	5.84	25.87	28.4	112.3	89.3	93.1	0.5151	0.6166
July	32.6	149.0	22.0	95.0	6.4	15.12	64.90	6.61	31.36	6.78	34.72	25.1	113.6	92.6	94.5	0.5859	0.6934
August	22.5	101.1	18.4	82.8	6.5	19.45	87.45	4.72	21.33	0.52	2.36	24.4	110.0	94.5	94.7	0.5749	0.6854
September	22.3	88.2	17.4	69.2	6.7	18.66	74.19	3.95	15.48	0.92	3.48	23.1	91.4	93.0	95.3	0.5010	0.5932
October	31.9	114.3	13.0	46.4	6.8	24.23	86.58	1.25	4.63	0.54	1.84	25.7	92.1	92.0	97.2	0.4606	0.5939
November	47.3	148.0	13.8	43.8	6.8	19.18	60.46	4.12	13.01	0.76	2.33	23.7	74.6	89.6	96.9	0.4027	0.5217
December	33.4	97.9	21.6	63.6	6.9	17.38	50.90	4.18	12.22	0.40	1.12	21.9	64.0	91.4	94.0	0.3726	0.4628
Ave. Daily	35.3	121.4	21.4	73.7	6.7	19.95	68.41	2.84	10.97	0.96	4.28	23.5	82.5	91.0	94.1	0.4437	0.5476
Ave. Max	65.7	216.8	41.3	145.5	7.0	31.10	113.67	7.92	33.65	6.98	33.81	32.0	127.5	96.0	98.4	0.6062	0.7365
Ave. Min	14.6	51.1	6.8	22.1	6.3	8.67	32.69	0.10	0.37	0.04	0.13	16.8	51.3	84.3	86.6	0.3265	0.3921
Overall Max	76.0	258.0	52.6	228.0	7.1	40.40	145.50	10.50	45.08	11.03	52.28	40.7	151.3	96.9	99.4	0.6756	0.7856
Overall Min	10.7	38.3	5.9	17.0	6.2	6.09	23.15	0.00	0.00	0.02	0.05	13.7	37.8	80.0	80.6	0.2621	0.2911

Appendix E

Typical Monthly Report

GROUNDWATER PERMIT MONTHLY REPORT SUMMARY SHEET

PERMIT No: 168-1 PAGE No: 1

NAME OF PROJECT: Falmouth WWTF

FACILITY LOCATION: 154 Blacksmith Shop Road, West Falmouth

DATE SAMPLED: December 1998

PARAMETER	UNITS	INFLUENT	EFFLUENT
Flow	gpd	359,000	304,000
BOD	mg/l	492.8	42.9
TSS	mg/l	413.3	8.8
Total Solids	mg/l	1561.3	1140.7
pH		6.6	7.0
Total Nitrogen	mg/l	Not Done	24.4
Nitrate-N	mg/l	Not Done	2.17
Total Phosphorus as P	mg/l	Not Done	4.93
Oil & Grease	mg/l	Not Done	<5.0
Sodium	mg/l	Not Done	267.2
TKN	mg/l	Not Done	21.5
Nitrite-N	mg/l	Not Done	0.73

Notes:

- Influent WW Flows from totalizer at Jones Palmer Pumping Station.
- Effluent Flows to Infiltration Basins are estimated.

MONTHLY REPORT

WASTEWATER TREATMENT PLANT

City or Town: Falmouth

Month: December 19 98

Chief Operator: Robert L. White Jr.

Date	WEATHER Rainfall (in.) 1	WEATHER Temp. °F 8AM 2	SEWAGE Temp. °F 3	SEWAGE Flow (MGD) SEWAGE 4	SEWAGE Flow (MGD) SEPTAGE 5	SEWAGE Flow (MGD) Total 6	SEWAGE Bypass 7	SEWAGE Grit & Screening (cu. ft.) 8	CHLORINATION Pre Dosage lbs./24 hrs 9	CHLORINATION Pre Residual (mg/L) 10	CHLORINATION Post Dosage lbs./24 hrs 11	CHLORINATION Post Residual (mg/L) 12	SETTLEABLE SOLIDS ml/L Raw 13	SETTLEABLE SOLIDS ml/L Primary Effluent 14	SETTLEABLE SOLIDS ml/L Secondary Effluent 15	SETTLEABLE SOLIDS ml/L Final Effluent 16	Date
1		50		.320	.030	.350							8.5			0	1
2		42		.330	.034	.364							10.5			0	2
3		47		.340	.046	.386							4.0			0	3
4		48		.330	.046	.376							8.0			0	4
5		38		.292	.009	.301							6.5			0	5
6		48		.365	0	.365							8.0			0	6
7		50		.337	.042	.379							9.5			0	7
8	0.15	40		.394	.036	.430							11.0			0	8
9		32		.380	.044	.424							12.0			0	9
10		32		.386	.023	.409							4.5			0	10
11		37		.403	.018	.421							8.0			0	11
12		30		.354	.008	.362							13.0			0	12
13		37		.388	.002	.390							10.0			0	13
14		34		.328	.031	.359							7.0			0	14
15		32		.359	.044	.403							6.5			0	15
16		48		.355	.033	.388							12.0			0	16
17		36		.380	.020	.400							11.0			0	17
18		26		.333	.025	.358							5.5			0	18
19		36		.311	.006	.317							7.0			0	19
20		41		.315	0	.315							5.5			0	20
21		38		.347	.037	.384							22.0			0	21
22		52		.337	.013	.350							19.0			0	22
23		16		.300	.024	.324							9.0			0	23
24		24		.229	.009	.238							13.0			0	24
25		21		.234	0	.234							11.0			0	25
26	0.4	24		.240	.006	.246							6.5			0	26
27		24		.265	.001	.266							8.0			0	27
28	0.6	38		.350	.064	.414							7.5			0	28
29	0.4	34		.355	.050	.405							13.0			0	29
30		33		.301	.050	.351							10.5			0	30
31		14		.401	.022	.423							8.0			0	31
Total	1.55			10.359	0.773	11.132											
Average		36		0.334	0.025	0.359							9.5			0	

Date	DISSOLVED OXYGEN mg/L						SLUDGE														Date
										pH			Gas		Vacuum Filter or Centrifuge						
																	Chemicals		Filter Cake		
	Raw	Pond 1 Center Aeration Tank	Secondary Effluent	Final Effluent	Downstream	Upstream	Sludge to Digester (1000 gals)	Excess Activated Sludge (gals)	Digester Temp. (°F)	Digester Sludge	Overflow to Primary Tank	Supernatant Wasted (1000 gals)	Produced (1000 cu ft)	Used (1000 cu ft)	1000 Gallons	% Solids	lbs. /24 hrs	lbs. /24 hrs	(lbs. /24 hrs	% Solids	
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
1	2.1	7.0		4.0																	1
2	1.5	6.8		4.2																	2
3	1.2	4.5		7.3																	3
4	1.2	2.6		3.7																	4
5	2.1			4.0																	5
6	1.9			3.8																	6
7	2.2	4.6		4.2																	7
8	2.0	4.4		5.1																	8
9	1.2	3.8		4.3																	9
10	1.6	4.0		4.8																	10
11	2.2	3.3		4.8																	11
12	1.3	3.1		6.1																	12
13	1.8	6.3		6.5																	13
14	1.9	6.5		5.9																	14
15	1.8	6.4		6.2																	15
16	2.1	6.4		7.4																	16
17	2.0	4.1		6.2																	17
18	1.7	4.6		6.5																	18
19	2.1			7.0																	19
20	1.9			6.8																	20
21	1.8	6.4		6.8																	21
22	1.6	6.9		6.4																	22
23	1.7	5.9		7.4																	23
24	1.9	6.1		7.0																	24
25	2.1			6.8																	25
26	2.0			6.9																	26
27	2.2			7.0																	27
28	2.4	8.8		8.2																	28
29	1.9	8.6		7.1																	29
30	2.2	8.4		7.0																	30
31	2.0	8.6		7.2																	31
TOTAL																					
Average	1.9	5.8		6.0																	

Please forward this report to the Regional Engineer at the address above by the 10th of each following month.

7200-2-78

MONTHLY REPORT

WASTEWATER TREATMENT PLANT

2

City or Town: Falmouth

Month: December 19 98

Chief Operator: Robert L. White Jr.

Date	pH Raw Sewage 37	pH Primary Effluent 38	pH Mixed Liquor 39	pH Final Effluent 40	AIR SUPPLIED (CFM) 41	42	Effluent Disposal: Sand Beds Total Acres Dosed 43	Sand Beds Unit Numbers 44	Spray Irriga. Areas 45	Effluent Flow (MGD): Sand Beds 46	Spray Irriga. 47	Total 48	Date
1	6.6			6.8	1085		0		3	0	.400	.400	1
2	6.7			7.0	1072		0		4	0	.400	.400	2
3	6.8			7.0	650		0		5	0	.400	.400	3
4	6.8			6.9	615		0		1	0	.400	.400	4
5	6.6			6.9	635		0		2	0	.400	.400	5
6	6.6			6.9	725		0		3	0	.400	.400	6
7	6.6			6.9	615		1.43	7		.259	0	.259	7
8	6.6			6.9	635		1.43	7		.259	0	.259	8
9	6.8			6.9	640		1.43	7		.288	0	.288	9
10	6.7			6.9	650		1.43	7		.288	0	.288	10
11	6.7			6.9	633		0.86	1		.259	0	.259	11
12	6.6			7.0	635		0.86	1		.259	0	.259	12
13	6.6			7.0	635		0.86	1		.259	0	.259	13
14	6.6			7.0	640		0.86	2		.259	0	.259	14
15	6.6			6.9	645		0.86	2		.288	0	.288	15
16	6.7			7.0	640		0.86	2		.288	0	.288	16
17	6.7			7.0	640		0.86	2		.288	0	.288	17
18	6.7			7.1	635		1.43	6		.288	0	.288	18
19	6.7			7.0	640		1.43	6		.288	0	.288	19
20	6.7			7.1	640		1.43	6		.288	0	.288	20
21	6.5			7.1	635		1.43	6		.288	0	.288	21
22	6.4			7.0	625		1.43	7		.288	0	.288	22
23	6.7			7.2	655		1.43	7		.288	0	.288	23
24	6.7			7.1	690		1.43	7		.288	0	.288	24
25	6.7			7.0	680		1.43	7		.288	0	.288	25
26	6.7			6.9	755		0.86	3		.288	0	.288	26
27	6.7			7.0	755		0.86	3		.288	0	.288	27
28	6.5			7.1	730		0.86	3		.288	0	.288	28
29	6.5			7.1	730		1.43	8		.288	0	.288	29
30	6.5			7.1	725		1.43	8		.288	0	.288	30
31	6.5			7.0	755		1.43	8		.288	0	.288	31
Total										7.026	2.400	9.426	
Average	6.			7.0	692					0.227	0.077	0.304	

Date	BOD Raw 49	BOD Primary Effluent 50	BOD % Removed 51	BOD Secondary Effluent 52	BOD % Removed 53	BOD Final Effluent 54	BOD % Removed 55	BOD Downstream 56	BOD Upstream 57	SUSPENDED SOLIDS (mg/L) Raw Total 58	Raw Volatile 59	Effluent Primary Total 60	Effluent Secondary Total 61	Effluent Final Total 62	Aeration Tank Total 63	Aeration Tank Volatile 64	Return Sludge Total 65	Aerated Digester Total 66	Aerated Digester Volatile 67
12/2	600.0					83.9				516.7				4.7					
12/9	326.3					56.2				385.0				7.5					
12/16	442.5					30.0				410.0				6.0					
12/23	505.0					19.4				290.0				18.0					
12/29	590.0					25.2				465.0				7.7					

Date	RAW SLUDGE Total Solids % 68	RAW SLUDGE Volatile Solids % 69	DIGESTER SLUDGE pH 70	DIGESTER SLUDGE Alkalinity (mg/L) 71	DIGESTER SLUDGE Volatile Acids (mg/L) 72	DIGESTER SLUDGE Total Solids % 73	DIGESTER SLUDGE Volatile Solids % 74	SLUDGE BEDS Date Drawn 75	SLUDGE BEDS Volume (gal.) 76	SLUDGE BEDS Date Removed 77	TKN Final 78	Total Nitrogen Final 79	Oil + Grease Final 80	Sodium Final 81	Total Phos. Final 82 "G"	Nitrite Nitrogen Final 83	Nitrate Nitrogen Final 84	Total Solids Raw 85	Total Solids Final 86
12/2																		1483.0	1077.0
12/9																		1883.3	1106.7
12/16											21.5	24.4	<5.0	267.2	4.93	0.730	2.17	1276.7	1130.0
12/23																		1373.3	1156.7
12/29																		1790.0	1233.2

Multiply Value By 1000

PLANT PERSONNEL

Name	Title	Class
Robert L. White Jr.	Chief Operator	6 (2122)
Stephan H. Parsons	Operator	M-4 (3042)
Franklin W. Perry	Operator	M-3 (3033)
M. Scott Austin	Operator	M-3 (3859)

PLANT DESIGN DATA

Type	Aerated Pond System	Present Average Flow	0.359 MGD
Design Capacity	0.810 MGD	Population Served	

89 COMPOSITE SAMPLE INFORMATION

1) Composite from 8:30 AM to 3:30 PM
2) Number of samples in composite 8
3) Interval between samples Approx 1 Hr.
4) Composite made up from:

Samples of equal volume ☒ Proportion to flow ☐

90 GENERAL COMMENTS (Operating Problems or Assistance Desired)

- Influent Flows from totalizer at Jones Palmer Station.
- Effluent Flows to Infiltration Basins are estimated.

'G' = Grab Samples (Note All other samples will be composited)

Appendix F

Inventory of Process Facilities and Equipment

INVENTORY OF PROCESS FACILITIES AND EQUIPMENT
Wastewater Facilities Planning Study
Town of Falmouth, Massachusetts

Septage Equipment	
Type	Sludge Acceptance Plant Septage Screen
Number	1
Capacity, gpm	425
Location	Septage Receiving Area
Manufacturer and model	Lakeside Septage Screen
Year placed in service	1998
Bar Screens	
Type	Coarse – Hand cleaned
Number	4
Location	Septage Receiving Area
Bar Separation, inches	1- 3/8
Year Placed in Service	1986
Septage Receiving Tanks	
Aerated Storage Tanks	
Number	4 (Only two in use)
Location	Adjacent to Control Building
Total tank volume, cubic feet (each)	2,700
Tank dimensions, feet	
Length	24
Width	12
Sidewater depth	10
Septage Blowers	
Type	Rotary Lobe Blower
Number	3
Horsepower	20
Capacity (Range – scfm)	70-340
Blower manufacturer and model	Roots 409 RCS-V
Year placed in service	1986

Inventory of Process Facilities and Equipment

Septage Pumps	
Type	Ejector
Number	2
Capacity (gallons per cycle)	50
Pump manufacturer and model	Carter, P/E 50 gal.
Location	Process Room – Control Building
Year placed in service	1986
Air Compressors for Septage Pumps	
Type	
Number	2
Horsepower	25
Capacity (Range – scfm)	180
Blower manufacturer and model	Quincy Air Compressor - 5120
Year placed in service	1986
Aerated Grit Tank	
Number	1
Location	Headworks
Total tank volume, cubic feet	900
Shape	Triangular
Tank dimensions, feet	
Length	24
Width	6
Sidewater depth	13
Aerated Grit Equipment	
Type	Grit Screw
Number	1
Location	Grit Building
Manufacturer and model	RDP, 12-inch
Year Placed in Service	1986
Aerated Grit Blower	
Type	Rotary Lobe Blower
Number	2
Horsepower	2
Capacity (Range – scfm)	20
Blower manufacturer and model	Roots: 820-184-320
Year placed in service	1986

Inventory of Process Facilities and Equipment

Grit Sump pumps	
Type	Submersible
Location	Grit Building
Number of units	2
Drive, HP	1
Manufacturer and model	Swaby Manufacturing Co.
Year placed in service	1986
Aerated Ponds	
Number of Ponds	3
Total volume, cubic feet	1,900,000
Pond 1	940,000
Ponds 2 & 3 (each)	470,000
Pond 1 dimensions, feet	
Length	600
Width	210
Depth	12
Ponds 2 & 3 dimensions, feet (each)	
Length	290
Width	200
Depth	12.5 and 13, respectively
Hydraulic detention time, days	
Average flow of 0.55 mgd	20
Peak day flow of 0.81 mgd	13
Design Oxy. Utilization Rate (lb O_2/lb BOD removed)	2.2
Aeration Equipment	
Aeration Type	Fine bubble, diffused air
Origional Blowers	
Type	Rotary Lobe, positive displacement
Location	Blower Room – Control Building
Number of units	3
Capacity (scfm)	1500
Motor horsepower, each blower	100
Manufacturer	Roots – RAS Wispair
Year placed in service	1986
Additional Blower	
Type	Rotary Lobe, positive displacement w/VFD

Inventory of Process Facilities and Equipment

Location	Blower Room – Control Building
Number of units	1
Capacity (scfm)	1,070
Motor horsepower, each blower	50
Manufacturer	Sutorbilt
Year placed in service	1996

Pond Recycle Pumps

Number of pumps	2
Motor horsepower, each pump	1.5
Design flow @ TDH	150 gpm @ 15.5 ft
Pump manufacturer and model	Worthington 3MFC-10
Location	Pump Room – Control Building
Year placed in service	1986

Pond Drainage Pump

Number of pumps	1
Motor horsepower, each pump	7.5
Design flow @ TDH	800 gpm @ 23 ft
Pump manufacturer and model	Worthington 6MFC-13
Location	Pump Room – Control Building
Year placed in service	1986

Effluent Flow Measuring (Currently not used)

Flow element	Parshall flume
Number of units	1
Location	Effluent Channel
Throat width, inches	9
Flow meter type	ultrasonic
Flow range, mgd	0.0 – 2.9
Year placed in service	1986

Effluent Disinfection/Odor Control

Type	Sodium Hypochlorite
Storage tank volume, gal.	2000

Sodium Hypochlorite Pump

Number of pumps	3
Type	Diaphragm Metering Pump
Motor horsepower, each pump	0.5
Capacity, gph (each)	13

Inventory of Process Facilities and Equipment

Pump manufacturer and model	BIF Proportioneer Propsuperb – Sodium Hypochlorite 1731-28-9216
Location	Pump Room – Control Building
Year placed in service	1988
<u>Effluent Discharge</u>	
Type	Sand infiltration beds
Beds 1-5	
Number of Beds	5
Surface area, SF	37,500
Beds 6-8	
Number of Beds	3
Surface area, SF	62,500
Depth, feet	5
Application Rate, gpd/sq.ft.	1.1
<u>Additional Effluent Discharge</u>	
Type	Spray Irrigation
Hydraulic loading rate, in/ac/wk	2
Spray Area, acres	65
Number of Areas	5
Irrigation nozzles	
Type	Rainbird
Number	271
Spacing, feet	60-100
Minimum nozzle pressure, psi	30
Orifice diameter, inches	7/32
Irrigation wetwell volume, gal.	15,000
<u>Irrigation Pump</u>	
Number of pumps	2
Motor horsepower, each pump	25
Design flow @ TDH	500 gpm @ 130 ft
Pump manufacturer and model	Worthington D1011
Location	Pump Room – Control Building
Year placed in service	1988
<u>Irrigation Flow Meter</u>	
Number	1
Type	Doppler
Manufacturer and model	Polysonics Doppler Flow # 008312

Inventory of Process Facilities and Equipment

Location	Pump Room – Control Building
Year placed in service	1988
Sludge Drying Beds	
Surface area, SF (each)	20,000
Number of Beds	3
Generator	
Type	Diesel
Number	1
Location	Generator Room – Control Building
Motor horsepower	560
Manufacturer and Model	Cummings – KTA19-G1
Year placed in service	1986
Sump pumps	
Type	Submersible
Location	Process Room – Control Building
Number of units	2
Drive, HP	2
Manufacturer and model	Swaby Manufacturing Co.
Year placed in service	1986
Plant Water System	
Number of pumps	2
Type	Centrifugal
Motor horsepower, each pump	5
Design Pressure (psi)	100
Pump manufacturer and model	Worthington D1011
Location	Pump Room – Control Building
Year placed in service	1986

Revised: April 8, 1999
J:\80284fal\tables\Needs Assessment tables\FalmouthWWTF_EQP.doc

Appendix G

Inventory of Pumping Station Equipment

INVENTORY OF PUMPING STATION EQUIPMENT
Wastewater Facilities Planning Study
Town of Falmouth, Massachusetts

JONES PALMER PUMPING STATION

Wastewater Pumps

Type	Centrifugal
Number	3
Horsepower	150
Design flow @ TDH	1200 gpm @ 175ft.
Actual flow @ TDH	
Pump #1	1330 gpm @ 135 ft.
Pump #2	1680 gpm @ 163 ft.
Pump #3	1275 gpm @ 134 ft.
Pump manufacturer and model	Allis Chalmers 6x6x17 NSWV, 300
Year placed in service	1985
Impellers trimmed in 1993	

Influent Shredding

Type	Comminutor
Number	2
Horsepower	0.75
Manufacturer and model	Worthington:15L – 5 N
Year placed in service	1985

Hoist Equipment

Type	Monorail
Number	1
Capacity, tons	2
Manufactures make and model	Yale : BEW2 – 32PT2202
Year Placed in Service	1985

Chemical Feed Pump

Number of pumps	2
Type	Diaphragm Metering Pump
Motor horsepower, each pump	0.5
Capacity, gph (each)	35.2
Pump manufacturer and model	Milroyal - A
Year placed in service	1988

Inventory of Pumping Station Equipment (continued)

Generator	
Type	Diesel
Number	1
Manufacturer and Model	GMC - 71237305
Year placed in service	1985
Sump Pumps	
Type	Submersible
Number of units	2
Drive,HP	1
Manufacturer and model	Weil Pump Co.: 3A-250116-1
Year placed in service	1991
Odor Control	
Type	Activated Carbon
Number of units	1
Manufacturer and model	Barnebey-Cheney: FJS-22ST-STL
Year placed in service	1987
Flow Measuring	
Type	Doppler
Number of units	1
Flow range, gpm	0-4000
Manufacturer and model	Polysonics:LCTD

FALMOUTH BEACH PUMPING STATION

Wastewater Pumps	
Type	Centrifugal
Number	2
Horsepower	5
Design flow @ TDH	180 gpm @ 46ft.
Actual flow @ TDH	190 gpm @ 46ft.
Pump manufacturer and model	Fairbanks Morse
Year placed in service	1990
Chemical Feed Pump	
Number of pumps	2
Motor horsepower, each pump	0.25
Capacity, gph (each)	6.2

Inventory of Pumping Station Equipment (continued)

Pump manufacturer and model	Milton Ray Co.:R122-117
Year placed in service	1988

Generator

Type	Diesel
Number	1
Motor horsepower	61
Manufacturer and Model	Cummings – 4B-3.9
Year placed in service	1987

INNER HARBOR PUMPING STATION

Wastewater Pumps

Type	Centrifugal
Number	2
Horsepower	10
Design flow @ TDH	550 gpm @ 35 ft.
Actual flow @ TDH	670 gpm @ 28 ft.
Pump manufacturer and model	Fairbanks Morse
Year placed in service	1991

Generator

Type	Diesel
Number	1
Motor horsepower	61
Manufacturer and Model	Cummings – 4B-3.9
Year placed in service	1988

GARDINER ROAD PUMPING STATION

Wastewater Pumps

Type	Centrifugal
Number	2
Horsepower	2
Design flow @ TDH	90 gpm @ 28.5 ft.
Actual flow @ TDH	90 gpm @ 29 ft.
Pump manufacturer and model	Fairbanks Morse
Year placed in service	1991

Inventory of Pumping Station Equipment (continued)

Sump Pumps

Type	Hydramatic Submersible
Number of units	2
Drive,HP	1/3
Manufacturer and model	OSP-33
Year placed in service	1991

Generator

Type	Diesel
Number	1
Manufacturer and Model	Allis Chalmers - 320
Year placed in service	1987

WOODS HOLE PUMPING STATION

Wastewater Pumps

Type	Two-SpeedCentrifugal
Number	2
Horsepower	75
Design flow @ TDH (high speed)	950 gpm @ 146 ft.
Actual flow @ TDH (low speed)	
Pump #1	579 gpm @ 60 ft.
Pump #2	603 gpm @ 60 ft.
Pump manufacturer and model	Fairbanks Morse
Year placed in service	1986

Influent Shredding

Type	Comminutor
Number	1
Horsepower	0.5
Manufacturer and model	Worthington:12L – 5 N
Year placed in service	1991

Hoist Equipment

Type	Monorail
Number	1
Manufactures make and model	Yale : BEW2 – 32PT2202

Inventory of Pumping Station Equipment (continued)

Chemical Feed Pump

Number of pumps	2
Type	Diaphragm Metering Pump
Motor horsepower, each pump	0.5
Capacity, gph (each)	13
Pump manufacturer and model	Milroyal - A
Year placed in service	1988

Generator

Type	Diesel
Number	1
Manufacturer and Model	Catapiller – SR-4
Year placed in service	1986

Sump Pumps

Type	Submersible
Number of units	2
Drive,HP	0.5
Manufacturer and model	Peabody Barnes: 3SE-56
Year placed in service	1991

SHIVERICKS POND PUMPNG STATION

Wastewater Pumps

Type	Centrifugal
Number	3
Horsepower	40
Design flow @ TDH	700 gpm @ 60 ft.
Actual flow @ TDH	
Pump #1	1050 gpm @ 48.4 ft.
Pump #2	900 gpm @ 48.4 ft.
Pump #3	980 gpm @ 43.8 ft.
Pump manufacturer, size and model	Allis Chalmers 6x6x17 NSWV, 300
Year placed in service	1985

Influent Shredding

Type	Comminutor
Number	1
Horsepower	0.75
Manufacturer and model	Worthington:15L – 5 N
Year placed in service	1985

Inventory of Pumping Station Equipment (continued)

Hoist Equipment

Type	Monorail
Number	1
Capacity, tons	2
Manufactures make and model	Yale : BEW2 – 32PT22D2
Year Placed in Service	1985

Chemical Feed Pump

Number of pumps	2
Type	Diaphragm Metering Pump
Motor horsepower, each pump	0.5
Capacity, gph (each)	29.8
Pump manufacturer and model	Milroyal - A
Year placed in service	1987

Generator

Type	Diesel
Number	1
Manufacturer and Model	Consolidated Power :230 D6T
Year placed in service	1985

Sump Pumps

Type	Submersible
Number of units	2
Drive,HP	1
Manufacturer and model	Weil Pump Co.: 3A-250116-1
Year placed in service	1991

Odor Control

Type	Activated Carbon
Number of units	1
Manufacturer and model	Barnebey-Cheney: FJS-22ST-STL
Year placed in service	1991

Flow Measuring

Type	Doppler
Number of units	1
Flow range, gpm	0-280
Manufacturer and model	Polysonics:LCDT

Appendix H

Hydraulic Capacity Calculations

Falmouth WWTF - Collection System
Hydraulic Capacity

Manning Calc. = 1.49/n * A * Rh^2/3 * So^1/2

Location	Study Area	Length (ft)	Diameter (in)	Slope (ft/ft)	Type ---	Radius (ft)	Area (ft^2)	Rh (ft)	n	Capacity Q (cfs)	Q (mgd)	Over 1MGD		Half Q (mgd)	Q (gpm)	Half Q (gpm)
Scranton Ave	DS/IH/SA/CA	356	8	0.004	PVC	0.333	0.349	0.167	0.01	1.00	0.64	No	0	0.32	447	223
Scranton Ave	DS/IH/SA/CA	657	8	0.004	PVC	0.333	0.349	0.167	0.01	1.00	0.64	No	0	0.32	447	223
Davis Straights	DS/IH/SA/CA	741	8	0.004	PVC	0.333	0.349	0.167	0.01	1.00	0.64	No	0	0.32	447	223
Main Street	DS/IH/SA/CA	363	8	0.004	PVC	0.333	0.349	0.167	0.01	1.00	0.64	No	0	0.32	447	223
Benhan Road	DS/IH/SA/CA	203	8	0.0042	PVC	0.333	0.349	0.167	0.01	1.02	0.66	No	0	0.33	458	229
Davis Straights	DS/IH/SA/CA	770	10	0.0029	PVC	0.417	0.545	0.208	0.01	1.54	0.99	No	0	0.50	690	345
Robbins Road	DS/IH/SA/CA	226	8	0.0137	PVC	0.333	0.349	0.167	0.01	1.84	1.19	Yes	1	0.59	827	414
Main Street	DS/IH/SA/CA	165	8	0.017	PVC	0.333	0.349	0.167	0.01	2.05	1.32	Yes	1	0.66	921	461
Davis Straits	DS/IH/SA/CA	274	8	0.0186	PVC	0.333	0.349	0.167	0.01	2.15	1.39	Yes	1	0.69	964	482
Robbins Road	DS/IH/SA/CA	1427	12	0.0022	PVC	0.500	0.785	0.250	0.01	2.18	1.40	Yes	1	0.70	977	489
Davis Straits	DS/IH/SA/CA	214	8	0.0205	PVC	0.333	0.349	0.167	0.01	2.25	1.45	Yes	1	0.73	1,012	506
Main Street	DS/IH/SA/CA	239	8	0.023	PVC	0.333	0.349	0.167	0.01	2.39	1.54	Yes	1	0.77	1,072	536
Robbins Road	DS/IH/SA/CA	136	8	0.053	PVC	0.333	0.349	0.167	0.01	3.62	2.34	Yes	1	1.17	1,627	813
Thomas Lane	Falmouth Beach	35	8	0.003	PVC	0.333	0.349	0.167	0.01	0.86	0.56	No	0	0.28	387	194
Beebe Acres	Falmouth Beach	96	8	0.0032	PVC	0.333	0.349	0.167	0.01	0.89	0.57	No	0	0.29	400	200
Fresh River Lane	Falmouth Beach	169	8	0.0034	PVC	0.333	0.349	0.167	0.01	0.92	0.59	No	0	0.30	412	206
Walker Street	Falmouth Beach	249	8	0.0036	PVC	0.333	0.349	0.167	0.01	0.94	0.61	No	0	0.30	424	212
Seagull Lane	Falmouth Beach	245	8	0.0038	PVC	0.333	0.349	0.167	0.01	0.97	0.63	No	0	0.31	436	218
Fresh River Lane	Falmouth Beach	173	8	0.0038	PVC	0.333	0.349	0.167	0.01	0.97	0.63	No	0	0.31	436	218
Bywater Court	Falmouth Beach	292	8	0.0038	PVC	0.333	0.349	0.167	0.01	0.97	0.63	No	0	0.31	436	218
Bywater Court	Falmouth Beach	221	8	0.0039	PVC	0.333	0.349	0.167	0.01	0.98	0.63	No	0	0.32	441	221
Stratford Lane	Falmouth Beach	305	8	0.0039	PVC	0.333	0.349	0.167	0.01	0.98	0.63	No	0	0.32	441	221
Bywater Court	Falmouth Beach	311	8	0.004	PVC	0.333	0.349	0.167	0.01	1.00	0.64	No	0	0.32	447	223
Bywater Court	Falmouth Beach	72	8	0.004	PVC	0.333	0.349	0.167	0.01	1.00	0.64	No	0	0.32	447	223
Fresh River Lane	Falmouth Beach	139	8	0.004	PVC	0.333	0.349	0.167	0.01	1.00	0.64	No	0	0.32	447	223
Cross Country ROW	Falmouth Beach	274	8	0.004	PVC	0.333	0.349	0.167	0.01	1.00	0.64	No	0	0.32	447	223
Beebe Acres	Falmouth Beach	204	8	0.004	PVC	0.333	0.349	0.167	0.01	1.00	0.64	No	0	0.32	447	223
Beebe Acres	Falmouth Beach	603	8	0.004	PVC	0.333	0.349	0.167	0.01	1.00	0.64	No	0	0.32	447	223
Fresh River Lane	Falmouth Beach	138	8	0.004	PVC	0.333	0.349	0.167	0.01	1.00	0.64	No	0	0.32	447	223
Thomas Lane	Falmouth Beach	219	8	0.004	PVC	0.333	0.349	0.167	0.01	1.00	0.64	No	0	0.32	447	223
Walker Street	Falmouth Beach	291	8	0.004	PVC	0.333	0.349	0.167	0.01	1.00	0.64	No	0	0.32	447	223
Fresh River Lane	Falmouth Beach	139	8	0.0041	PVC	0.333	0.349	0.167	0.01	1.01	0.65	No	0	0.33	452	226
Boyer Road	Falmouth Beach	267	8	0.0041	PVC	0.333	0.349	0.167	0.01	1.01	0.65	No	0	0.33	452	226
Bywater Court	Falmouth Beach	176	8	0.0042	PVC	0.333	0.349	0.167	0.01	1.02	0.66	No	0	0.33	458	229
Thomas Lane	Falmouth Beach	246	8	0.0043	PVC	0.333	0.349	0.167	0.01	1.03	0.67	No	0	0.33	463	232
Walker Street	Falmouth Beach	300	8	0.0044	PVC	0.333	0.349	0.167	0.01	1.04	0.67	No	0	0.34	469	234
Beebe Acres	Falmouth Beach	49	8	0.0045	PVC	0.333	0.349	0.167	0.01	1.06	0.68	No	0	0.34	474	237
Bywater Court	Falmouth Beach	322	8	0.0056	PVC	0.333	0.349	0.167	0.01	1.18	0.76	No	0	0.38	529	264
Herring Brook Lane	Falmouth Beach	86	8	0.006	PVC	0.333	0.349	0.167	0.01	1.22	0.79	No	0	0.39	547	274
Shore St	Falmouth Beach	123	8	0.0063	PVC	0.333	0.349	0.167	0.01	1.25	0.81	No	0	0.40	561	280
Salt Pond Rd	Falmouth Beach	202	8	0.0077	PVC	0.333	0.349	0.167	0.01	1.38	0.89	No	0	0.45	620	310
Salt Pond Rd	Falmouth Beach	207	8	0.0078	PVC	0.333	0.349	0.167	0.01	1.39	0.90	No	0	0.45	624	312
Bywater Court	Falmouth Beach	297	8	0.0083	PVC	0.333	0.349	0.167	0.01	1.43	0.93	No	0	0.46	644	322
Mill Road	Falmouth Beach	215	10	0.0026	PVC	0.417	0.545	0.208	0.01	1.46	0.94	No	0	0.47	653	327
Herring Brook Lane	Falmouth Beach	242	8	0.009	PVC	0.333	0.349	0.167	0.01	1.49	0.96	No	0	0.48	670	335
Salt Pond Rd	Falmouth Beach	58	8	0.009	PVC	0.333	0.349	0.167	0.01	1.49	0.96	No	0	0.48	670	335
Salt Pond Rd	Falmouth Beach	196	8	0.0092	PVC	0.333	0.349	0.167	0.01	1.51	0.97	No	0	0.49	678	339
Mill Road	Falmouth Beach	148	10	0.0028	PVC	0.417	0.545	0.208	0.01	1.51	0.97	No	0	0.49	678	339
Bywater Court	Falmouth Beach	159	8	0.0094	PVC	0.333	0.349	0.167	0.01	1.53	0.98	No	0	0.49	685	343

Location	Study Area	Length (ft)	Diameter (in)	Slope (ft/ft)	Type ---	Radius (ft)	Area (ft^2)	Rh (ft)	n	Capacity Q (cfs)	Q (mgd)	Over 1MGD		Half Q (mgd)	Q (gpm)	Half Q (gpm)
Salt Pond Rd	Falmouth Beach	183	8	0.0096	PVC	0.333	0.349	0.167	0.01	1.54	1.00	No	0	0.50	692	346
Fresh River Lane	Falmouth Beach	31	8	0.01	PVC	0.333	0.349	0.167	0.01	1.57	1.02	Yes	1	0.51	707	353
Shore St	Falmouth Beach	287	8	0.01	PVC	0.333	0.349	0.167	0.01	1.57	1.02	Yes	1	0.51	707	353
Salt Pond Rd	Falmouth Beach	129	8	0.0101	PVC	0.333	0.349	0.167	0.01	1.58	1.02	Yes	1	0.51	710	355
Surf Dr.	Falmouth Beach	300	10	0.0032	PVC	0.417	0.545	0.208	0.01	1.61	1.04	Yes	1	0.52	725	362
Seagull Lane	Falmouth Beach	96	8	0.0113	PVC	0.333	0.349	0.167	0.01	1.67	1.08	Yes	1	0.54	751	376
Mill Road	Falmouth Beach	212	10	0.004	PVC	0.417	0.545	0.208	0.01	1.81	1.16	Yes	1	0.58	810	405
Seagull Lane	Falmouth Beach	201	8	0.0154	PVC	0.333	0.349	0.167	0.01	1.95	1.26	Yes	1	0.63	877	438
Hedge Lane	Falmouth Beach	229	8	0.0167	PVC	0.333	0.349	0.167	0.01	2.03	1.31	Yes	1	0.66	913	457
Surf Dr.	Falmouth Beach	333	12	0.0021	PVC	0.500	0.785	0.250	0.01	2.13	1.37	Yes	1	0.69	955	477
Surf Dr.	Falmouth Beach	285	12	0.0023	PVC	0.500	0.785	0.250	0.01	2.23	1.44	Yes	1	0.72	999	500
Surf Dr.	Falmouth Beach	243	12	0.0023	PVC	0.500	0.785	0.250	0.01	2.23	1.44	Yes	1	0.72	999	500
Surf Dr.	Falmouth Beach	214	12	0.0024	PVC	0.500	0.785	0.250	0.01	2.27	1.47	Yes	1	0.73	1,021	510
Surf Dr.	Falmouth Beach	323	12	0.0025	PVC	0.500	0.785	0.250	0.01	2.32	1.50	Yes	1	0.75	1,042	521
Surf Dr.	Falmouth Beach	149	12	0.0026	PVC	0.500	0.785	0.250	0.01	2.37	1.53	Yes	1	0.76	1,062	531
Surf Dr.	Falmouth Beach	137	12	0.0034	PVC	0.500	0.785	0.250	0.01	2.71	1.75	Yes	1	0.87	1,215	607
Mill Road	Falmouth Beach	184	8	0.038	PVC	0.333	0.349	0.167	0.01	3.07	1.98	Yes	1	0.99	1,377	689
Mill Road	Falmouth Beach	186	8	0.042	PVC	0.333	0.349	0.167	0.01	3.23	2.08	Yes	1	1.04	1,448	724
Beebe Acres	Falmouth Beach	197	8	0.042	PVC	0.333	0.349	0.167	0.01	3.23	2.08	Yes	1	1.04	1,448	724
Surf Dr.	Falmouth Beach	124	12	0.008	PVC	0.500	0.785	0.250	0.01	4.15	2.68	Yes	1	1.34	1,863	932
Mill Road	Falmouth Beach	234	10	0.025	PVC	0.417	0.545	0.208	0.01	4.51	2.91	Yes	1	1.46	2,026	1,013
Town Hall	Main Street	195	8	0.001	PVC	0.333	0.349	0.167	0.01	0.50	0.32	No	0	0.16	223	112
Town Hall	Main Street	264	8	0.004	PVC	0.333	0.349	0.167	0.01	1.00	0.64	No	0	0.32	447	223
Chancery Lane	Main Street	290	8	0.004	PVC	0.333	0.349	0.167	0.01	1.00	0.64	No	0	0.32	447	223
Glenwood Ave	Main Street	382	8	0.004	PVC	0.333	0.349	0.167	0.01	1.00	0.64	No	0	0.32	447	223
Academy Ln Ext	Main Street	253	8	0.004	PVC	0.333	0.349	0.167	0.01	1.00	0.64	No	0	0.32	447	223
Cahoon St	Main Street	129	8	0.004	PVC	0.333	0.349	0.167	0.01	1.00	0.64	No	0	0.32	447	223
Elm Arch Lane	Main Street	182	8	0.004	PVC	0.333	0.349	0.167	0.01	1.00	0.64	No	0	0.32	447	223
Shore St	Main Street	151	8	0.004	PVC	0.333	0.349	0.167	0.01	1.00	0.64	No	0	0.32	447	223
Haddon Ave	Main Street	101	8	0.004	PVC	0.333	0.349	0.167	0.01	1.00	0.64	No	0	0.32	447	223
Town Hall	Main Street	254	8	0.006	PVC	0.333	0.349	0.167	0.01	1.22	0.79	No	0	0.39	547	274
Academy Lane	Main Street	212	8	0.007	PVC	0.333	0.349	0.167	0.01	1.32	0.85	No	0	0.42	591	296
Main Street	Main Street	2986	18	0.0012	RC	0.750	1.766	0.375	0.014	3.39	2.18	Yes	1	1.09	1,520	760
Main Street	Main Street	836	18	0.0012	RC	0.750	1.766	0.375	0.014	3.39	2.18	Yes	1	1.09	1,520	760
Main Street	Main Street	577	21	0.001	RC	0.875	2.404	0.438	0.014	4.66	3.01	Yes	1	1.50	2,093	1,046
Main Street	Main Street	233	18	0.013	RC	0.750	1.766	0.375	0.014	11.15	7.19	Yes	1	3.60	5,002	2,501
Gardiner Road	Woods Hole	63	8	0.0038	PVC	0.333	0.349	0.167	0.01	0.97	0.63	No	0	0.31	436	218
Gardiner/Park Road	Woods Hole	540	8	0.004	PVC	0.333	0.349	0.167	0.01	1.00	0.64	No	0	0.32	447	223
Gardiner Road	Woods Hole	76	8	0.004	PVC	0.333	0.349	0.167	0.01	1.00	0.64	No	0	0.32	447	223
Gardiner Road	Woods Hole	241	8	0.0043	PVC	0.333	0.349	0.167	0.01	1.03	0.67	No	0	0.33	463	232
Gardiner Road	Woods Hole	137	8	0.005	PVC	0.333	0.349	0.167	0.01	1.11	0.72	No	0	0.36	500	250
Gardiner Road	Woods Hole	117	8	0.008	PVC	0.333	0.349	0.167	0.01	1.41	0.91	No	0	0.45	632	316
Gardiner Road	Woods Hole	57	8	0.01	PVC	0.333	0.349	0.167	0.01	1.57	1.02	Yes	1	0.51	707	353
Gardiner Road	Woods Hole	99	8	0.036	PVC	0.333	0.349	0.167	0.01	2.99	1.93	Yes	1	0.96	1,341	670
Millfield Street	Woods Hole	390	8	0.0025	VC	0.333	0.349	0.167	0.017	0.46	0.30	No	0	0.15	208	104
Gardiner Road	Woods Hole	564	8	0.0025	VC	0.333	0.349	0.167	0.017	0.46	0.30	No	0	0.15	208	104
MBL	Woods Hole	561	8	0.002	CI	0.333	0.349	0.167	0.014	0.50	0.32	No	0	0.16	226	113
Interceptor Sewer	Woods Hole	426	10	0.0027	VC	0.417	0.545	0.208	0.017	0.87	0.56	No	0	0.28	392	196
Water Street	Woods Hole	136	8	0.0023	VC	0.333	0.349	0.167	0.017	0.44	0.29	No	0	0.14	199	100
Water Street	Woods Hole	323	8	0.0025	VC	0.333	0.349	0.167	0.017	0.46	0.30	No	0	0.15	208	104
Water Street	Woods Hole	707	8	0.0025	VC	0.333	0.349	0.167	0.017	0.46	0.30	No	0	0.15	208	104

Location	Study Area	Length (ft)	Diameter (in)	Slope (ft/ft)	Type ---	Radius (ft)	Area (ft^2)	Rh (ft)	n	Capacity Q (cfs)	Q (mgd)	Over 1MGD		Half Q (mgd)	Q (gpm)	Half Q (gpm)
Water Street	Woods Hole	179	8	0.0025	VC	0.333	0.349	0.167	0.017	0.46	0.30	No	0	0.15	208	104
Luscombe Ave	Woods Hole	314	8	0.0025	VC	0.333	0.349	0.167	0.017	0.46	0.30	No	0	0.15	208	104
Railroad Ave	Woods Hole	212	8	0.0025	VC	0.333	0.349	0.167	0.017	0.46	0.30	No	0	0.15	208	104
School Street	Woods Hole	261	8	0.0025	VC	0.333	0.349	0.167	0.017	0.46	0.30	No	0	0.15	208	104
Albatross	Woods Hole	135	8	0.0025	VC	0.333	0.349	0.167	0.017	0.46	0.30	No	0	0.15	208	104
Interceptor Sewer	Woods Hole	169	8	0.0025	VC	0.333	0.349	0.167	0.017	0.46	0.30	No	0	0.15	208	104
Gosnold Road	Woods Hole	682	8	0.0025	VC	0.333	0.349	0.167	0.017	0.46	0.30	No	0	0.15	208	104
Spencer Baird Road	Woods Hole	405	8	0.0025	VC	0.333	0.349	0.167	0.017	0.46	0.30	No	0	0.15	208	104
Millfield Street	Woods Hole	738	8	0.0025	VC	0.333	0.349	0.167	0.017	0.46	0.30	No	0	0.15	208	104
Interceptor Sewer	Woods Hole	378	8	0.0032	VC	0.333	0.349	0.167	0.017	0.52	0.34	No	0	0.17	235	118
Bigelow	Woods Hole	229	6	0.016	VC	0.250	0.196	0.125	0.017	0.54	0.35	No	0	0.18	244	122
Oakneck Road	Woods Hole	458	8	0.004	VC	0.333	0.349	0.167	0.017	0.59	0.38	No	0	0.19	263	131
Oakneck Road	Woods Hole	200	8	0.004	VC	0.333	0.349	0.167	0.017	0.59	0.38	No	0	0.19	263	131
Gosnold Road	Woods Hole	239	6	0.02	VC	0.250	0.196	0.125	0.017	0.61	0.39	No	0	0.20	273	136
Gosnold Road	Woods Hole	135	6	0.022	VC	0.250	0.196	0.125	0.017	0.64	0.41	No	0	0.21	286	143
School Street	Woods Hole	233	6	0.023	VC	0.250	0.196	0.125	0.017	0.65	0.42	No	0	0.21	293	146
Albatross	Woods Hole	280	8	0.005	VC	0.333	0.349	0.167	0.017	0.65	0.42	No	0	0.21	294	147
Albatross	Woods Hole	203	6	0.0242	VC	0.250	0.196	0.125	0.017	0.67	0.43	No	0	0.22	300	150
Spencer Baird Road	Woods Hole	191	8	0.0053	VC	0.333	0.349	0.167	0.017	0.67	0.43	No	0	0.22	303	151
Water Street	Woods Hole	160	6	0.0275	VC	0.250	0.196	0.125	0.017	0.71	0.46	No	0	0.23	320	160
School Street	Woods Hole	294	6	0.028	VC	0.250	0.196	0.125	0.017	0.72	0.46	No	0	0.23	323	161
School Street	Woods Hole	128	6	0.0348	VC	0.250	0.196	0.125	0.017	0.80	0.52	No	0	0.26	360	180
Water Street	Woods Hole	60	6	0.041	VC	0.250	0.196	0.125	0.017	0.87	0.56	No	0	0.28	391	195
Bell Tower Lane	Woods Hole	198	8	0.01	VC	0.333	0.349	0.167	0.017	0.93	0.60	No	0	0.30	416	208
School Street	Woods Hole	251	6	0.052	VC	0.250	0.196	0.125	0.017	0.98	0.63	No	0	0.32	440	220
Cross Country ROW	Woods Hole	256	8	0.004	PVC	0.333	0.349	0.167	0.01	1.00	0.64	No	0	0.32	447	223
Oakneck Road	Woods Hole	102	8	0.012	VC	0.333	0.349	0.167	0.017	1.01	0.65	No	0	0.33	455	228
Water Street	Woods Hole	38	6	0.056	VC	0.250	0.196	0.125	0.017	1.02	0.66	No	0	0.33	457	228
Center Street	Woods Hole	90	8	0.02	VC	0.333	0.349	0.167	0.017	1.31	0.84	No	0	0.42	588	294
Oakneck Road	Woods Hole	137	8	0.024	VC	0.333	0.349	0.167	0.017	1.43	0.93	No	0	0.46	644	322
Oakneck Road	Woods Hole	180	8	0.028	VC	0.333	0.349	0.167	0.017	1.55	1.00	No	0	0.50	695	348
Millfield Street	Woods Hole	98	8	0.0416	VC	0.333	0.349	0.167	0.017	1.89	1.22	Yes	1	0.61	848	424
Millfield Street	Woods Hole	36	8	0.0416	VC	0.333	0.349	0.167	0.017	1.89	1.22	Yes	1	0.61	848	424
Railroad Ave	Woods Hole	137	8	0.045	VC	0.333	0.349	0.167	0.017	1.96	1.27	Yes	1	0.63	882	441
Albatross	Woods Hole	139	8	0.05	VC	0.333	0.349	0.167	0.017	2.07	1.34	Yes	1	0.67	929	465
Railroad Ave	Woods Hole	130	8	0.07	VC	0.333	0.349	0.167	0.017	2.45	1.58	Yes	1	0.79	1,100	550
Millfield Street	Woods Hole	134	8	0.0824	VC	0.333	0.349	0.167	0.017	2.66	1.72	Yes	1	0.86	1,193	597

Appendix I

Cape Cod Commission Coastal Embayment Report Excerpts and Nitrogen Loading Calculations

ii. Critical Loads

In order to help determine appropriate nitrogen limits within embayment systems, staff reviewed available coastal water quality classification strategies, information about coastal ecosystem impairment, and water quality monitoring information. Studies of coastal systems around the world have indicated that increased nitrogen loading can dramatically increase the productivity and alter the ecosystem characteristics of coastal waters (USEPA and EOEA, 1991; Nixon, 1983; Nixon, *et al.*, 1986; NRC, 1993; Valiela, *et al.*, 1992).

However, determining the appropriate level of nitrogen loading tends to be rather site-specific and can become more complicated by factors that will alter the expected nitrogen load, its measurement, or its impacts. These factors can include: internal nitrogen loads to the embayment from its sediments (deposited by growth during previous years), carbon-rich soils in the embayment watershed (can allow denitrification of nitrogen loads within groundwater prior to discharge), and coastal wetlands (can denitrify watershed nitrogen loads if they flow through the wetland). Even with these concerns about variability, ultimately, a community needs to make a decision about whether conditions within an embayment are desirable and how much it is willing to spend to either restore the embayment or preserve its condition.

Desirability is a difficult questions for coastal water quality scientists to answer; any ecosystem will adapt to its inputs. In the case of a nitrogen overloaded system, the ecosystem's function will result in: low or absent dissolved oxygen concentrations, loss of shellfish due to lack of oxygen, bottom sediments may start producing hydrogen sulfide (rotten egg) odors, herring will not advance into the system because of low dissolved oxygen, eelgrass will disappear, and macroalgal mats will become the dominant plant species. However, in this system, people will still be able to moor their boats and the water will still look good from a distance, although most people probably would not want to go swimming in this water. On the other hand, a less impacted system will look good close up, shellfish will be abundant, swimming will be inviting, and a more diverse and stable ecosystem will be sustained. The acceptability of the condition of coastal water ecosystems needs to be addressed by the involved communities, hopefully with information from scientists. This type of discussion about the consequences of land use decisions does not regularly occur. Decisions about water quality in coastal waters often are made without considering water quality or ecosystem impacts.

Rather than trying to address the desirability of one system over another, most coastal water quality scientists try to determine what sort of ecosystem conditions will be seen at various nitrogen loading levels. These conditions tend to focus on one parameter or species that is a key determinant for the stability or "health" of the ecosystem. This key factor could be dissolved oxygen, chlorophyll concentrations, or eelgrass coverages. Much research has been focussed on determining the

relationship between these factors and nitrogen loads.

Unfortunately, this research has not been able to provide "crystal clear" results that most people desire. As with most relationships in nature, the factors and nitrogen loads are interrelated in complex and variable ways. Local conditions, such as tidal ranges, watershed geology, or background nitrogen concentrations, will cause different balancing points in different embayments. On Cape Cod, these factors vary within smaller ranges, but there is still variability between embayment systems. A flushing study helps to determine some of the conditions, but other details will still contribute toward some sense of uncertainty. The analyses completed below focus on trying to make recommendations about management with an acknowledgement of the uncertainties and recommendations about where additional information will be useful.

In order to begin the process of defining an appropriate amount of nitrogen for each of the subembayments, staff reviewed available water quality information and recommended nitrogen loading limits in other areas and evaluated qualitative measures of surface waters and their ecosystems.

a. Massachusetts Coastal Water Quality Regulations

Current Massachusetts regulations do not directly address nitrogen limits for coastal water quality, but the Surface Water Classification regulations suggest the use of best available technologies for direct wastewater discharges into the cleanest waters (310 CMR 4.04 (5)) and Title 5 requires density limitations for septic systems within watersheds to "nitrogen sensitive coastal embayments" (310 CMR 15.214-15.217). The surface water regulations (310 CMR 4) also contain a classification system for coastal waters.

The state classification system in 310 CMR 4 designates three types of coastal waters: SA, SB, and SC (Table 1). Each designation has numerical water quality criteria for selected parameters: dissolved oxygen (DO), temperature, pH, fecal coliform, solids, color and turbidity, oil and grease, and taste and odor. These numerical water quality standards tend to focus on conditions surrounding a wastewater outfall and do not correspond to eutrophication impacts, ecosystem health, or the impact of nonpoint source pollution commonly associated with septic systems. Most coastal waters around Cape Cod are designated by the state as SA waters, except for the Cape Cod Canal and Falmouth Inner Harbor, which are classified as SB (310 CMR 4.06).

Table 1. State Coastal Waters Classification System (310 CMR 4.05(4))	
Classification	Criteria
SA	- "suitable for shellfish harvesting without depuration" - "excellent habitat for fish, other aquatic life and wildlife and for primary and secondary contact recreation" - "have excellent aesthetic value"
SB	- "suitable for shellfish harvesting with depuration" - "habitat for fish, other aquatic life and wildlife and for primary and secondary contact recreation" - "have consistently good aesthetic value"
SC	- "habitat for fish, other aquatic life and wildlife and for secondary contact recreation" - "have good aesthetic value" - "suitable for certain industrial cooling and process uses"

In addition to being classified under the SA/SB/SC system, coastal waters can have the added designation of "Outstanding Resource Water" (ORW) (310 CMR 4.04). These waters are recognized as being "an outstanding resource as determined by their outstanding socio-economic, recreational, ecological and/or aesthetic values. The quality of these water shall be protected and maintained." Degradation of these waters is not allowed unless authorized by the Director of the state Division of Water Pollution Control.

As with the SA/SB/SC system, the ORW designation tends to focus on direct point sources, such as outfall pipes. Nonpoint pollution sources of nutrients (such as septic systems) "shall be provided with all reasonable best management practices for nonpoint source control." Coastal ORWs on Cape Cod (310 CMR 4.06) tend to be within special state area designations, such as Areas of Critical Environmental Concern (ACECs) (*e.g.*, "Pleasant Bay and tributaries thereto") or areas within the Cape Cod National Seashore.

In summary, the state regulations include a coastal water quality classification system that tends to focus on point source discharges of pollutants and shellfish bed conditions. These regulations do not include nitrogen standards.

b. Recommended Coastal Nitrogen Limits

Although there is little debate about the impacts of excessive nitrogen in coastal waters, there has been debate about the most appropriate basis for establishing nitrogen loading limits. Some studies of nitrogen sensitivity have recommended that a nitrogen load per unit area of an embayment is the most appropriate measure in determining eutrophication effects (*e.g.*, Nixon, 1983). Other studies have suggested that in rapidly flushed shallow embayments, determining how quickly

water in the embayment is exchanged with the surrounding ocean water is a more appropriate measure for determining coastal eutrophication effects (*e.g.*, Valiela and Costa, 1988; Nixon and Pilson, 1980).

The Buzzards Bay Project (BBP) reviewed existing water quality and ecosystem eutrophication information for many coastal embayments in the process of putting together the Comprehensive Conservation and Management Plan for Buzzards Bay (USEPA and EOEA, 1991). Based on this review, the BBP suggested that effects of nitrogen loads in rapidly-flushed shallow embayments are better correlated with assessments that include measures of flushing or turnover time, while embayments with longer flushing time should have limits based on their area (Costa, *et al.*, in preparation). The turnover time idea is very similar to a concept established by Vollenweider (1976) for determining acceptable phosphorus loads within freshwater lakes and has been supported by water quality monitoring in coastal systems (*e.g.*, Paerl, *et al.*, 1995).

Based on their review, the BBP recommended a tiered nitrogen loading limit system for shallow and deep embayments that incorporates flushing times for rapidly flushed systems and areal measures for less rapidly flushed systems (USEPA and EOEA, 1991) (Table 2). These limits are based on nitrogen added to the system from its watershed, not the total amount of nitrogen within the system. The total amount would include internal nitrogen loads and background nitrogen from the ocean or bay. The BBP used a modified version of the coastal classification system used by the state, but as stated above, coastal nitrogen limits are not included in Massachusetts regulations.

Table 2. Buzzards Bay Project Recommended Nitrogen Loading Limits.

Embayment	ORW/SA	SA	SB
Shallow			
-flushing: 4.5 days or less	100 mg/m^3/Vr	200 mg/m^3/Vr	350 mg/m^3/Vr
-flushing: greater than 4.5 days	5 g/m^2/yr	15 g/m^2/yr	30 g/m^2/yr
Deep			
- select rate resulting in lesser annual loading	130 mg/m^3/Vr 10 g/m^2/yr	260 mg/m^3/Vr 20 g/m^2/yr	500 mg/m^3/Vr 45 g/m^2/yr
Note: Vr= Vollenweider flushing term	Vr= r/(1+sqrt(r))	r= flushing time (yrs) source: USEPA and MA EOEA, 1991	

The tiered limits in Table 2 use the state classification designations, but the meaning of the ORW designation is not similar in both cases. The state uses the ORW designation for "anti-degradation" areas; areas where water quality should not be further degraded by pollutants. Since the BBP used the ORW designation as a limit,

waters that have nitrogen loads below the limit could theoretically accommodate more pollutants up to the limit. This concept is contrary to the state use of the ORW designation.

Once the flushing time for an embayment or subembayment system, the bathymetry, and volume of the system have been established from a flushing study, these values and the appropriate BBP limit are inserted into a calculation form (Table 3). The calculation results in a "critical load" or an annual mass of nitrogen that the system can assimilate at the recommended limit without becoming more eutrophic or impaired. In some cases, the flushing time for an embayment or subembayment is longer than 4.5 days recommended as a cutoff by the BBP (see Table 2). In these cases, the surface area of the embayment determines the critical load (see Method 2 in Table 3).

Table 3. Sample Critical Load Calculation Form.

1. Embayment: Example Embayment	
2. Area of Bay (hectares):	146
3. Mean Depth of Embayment at MLW (meters):	1.03
4. Tidal Prism volume (m^3):	
5. Volume at mid-tide (m^3):	1,510,858
6. Flushing time or residence period (days):	1.5
7. Flushing time or residence period (years):	0.00411
8. Critical loading rate for this embayment (select 8a or 8b):	
8a. Volume-flushing adjusted limit ($mg*m^{-3}*Vr^{-1}$):	200
8b. Area-adjusted limit ($g*m^{-2}*yr^{-1}$):	Not Applicable in this Case

9. Critical loading limit to embayment:

9a. METHOD 1- (volume-flushing adjusted limit as in 8a):

$$\frac{200*1,510,858*(1+\sqrt{0.00411})}{0.00411*1,000,000} =$$

= 172,133 lbs Nitrogen/year to the embayment

= 78,065 kg Nitrogen/year to the embayment 78,239

9b. METHOD 2 - (area adjusted limit as in 8b):

$$0 * 146 * 10 * 2.2 =$$ NOT APPLICABLE IN THIS CASE

= 0 lbs Nitrogen/year to the embayment

= 0 kg Nitrogen/year to the embayment

The idea inherent in the Massachusetts surface water and wastewater regulations is that ORW waters should not be allowed to degrade. This idea runs contrary to the

idea of setting a limit and allowing nitrogen loading up to the limit. Since any additional nitrogen will necessarily enrich or encourage more growth in a coastal ecosystem, a question arises about how much enrichment constitutes degradation.

In order to try to evaluate this question, project staff also evaluated the water quality parameters found by the Falmouth Pond Watchers in their regular monitoring of Falmouth's coastal embayments. Staff focussed on the average nitrogen concentrations, the other ecosystem measures in these ponds (*i.e.*, dissolved oxygen and chlorophyll concentrations), the average nitrogen concentrations under the BBP recommended limits, and how the concentrations relate to the qualitative categories in the state regulatory classification strategy for coastal waters.

If one were to take the average nitrogen concentration along the southern and western coasts of Cape Cod (approximately 0.3 ppm) and add it to the recommended BBP limits, the corresponding concentration limits in Table 2 for shallow quick-flushing embayments would be: ORW, 0.4 ppm; SA, 0.5 ppm; and SB, 0.75 ppm. After reviewing the Pond Watchers data, it appears that waters with average nitrogen concentrations less than or equal 0.35 ppm generally have the highest dissolved oxygen concentrations in bottom waters and ecosystems that are nearly pristine. Nitrogen concentrations between 0.35 and 0.45 ppm are generally associated with relatively high dissolved oxygen concentrations in bottom waters, although depressed concentrations (in the 2 to 4 ppm range) have been detected (Howes and Goehringer, 1995); clearly these waters are impacted. Systems with nitrogen concentrations around 0.5 ppm have more regular occurrences of low dissolved oxygen conditions in bottom waters and nitrogen concentrations greater than 0.75 ppm consistently have low dissolved oxygen concentrations in bottoms waters with occasional anoxic events. Low oxygen concentrations are associated with lower species diversity and less stable ecosystems. Embayments with higher nitrogen concentrations also have relatively low light penetration (~ 3 m) due to extensive phytoplankton populations, which also tend to restrict eelgrass growth.

Comparing the BBP designations and recommended limits to the review of impacts indicated in the Falmouth Pond Watchers data, it would appear that the BBP limits are associated with greater impacts than one would associate with the state regulatory descriptions of coastal water quality. For an additional comparison, the Town of Falmouth uses the Pond Watchers data within its zoning regulations and has the following categories and concentration limits for its embayments: High Quality Areas (< 0.32 ppm), Stabilization Areas (0.32 to 0.5 ppm), Intensive Water Quality Areas (0.5 to 0.75 ppm) (Falmouth Zoning Bylaws, Article IV). Based on these comparisons, if one were to assign adjectives to the BBP limits, they would probably be: "excellent" for the ORW limit; "impacted" for the SA limit; and "impaired" for the SB limit. Clearly, these are different qualitative assessments than one would associate with the state regulatory classifications.

In summary, the BBP ORW limit generally results in a nitrogen load equivalent to

0.1 ppm addition over background concentration. During a review of water quality in Falmouth coastal embayments, this addition seems to be associated with greater impacts than one would associate with waters meant to be the most pristine (*i.e.*, designated ORW). The Falmouth Pond Watchers data tends to support a smaller concentration addition (~0.05 ppm) for the maintenance of water quality in the most pristine waters. Staff have labelled a limit based on this smaller addition as "ORW-N". Similarly, using the state qualitative classifications and the Pond Watchers data, staff have labeled a 0.15 ppm addition a "SA-N" limit, as compared to the BBP SA limit which is generally equivalent to a 0.2 ppm addition over background concentration.

The analyses below have been guided by the idea of preserving water quality in waters that meet the ORW limits and developing management options for those systems that can meet the ORW limits. For systems that cannot attain the ORW limits, management options have been developed to meet the SA limits or maintain existing water quality less than the SA limits. Since none of the waters on Cape Cod have been classified under the state system as SB or SC, recommendations have not been developed to maintain systems above the SA limits.

The details about data and models used in developing flushing times are described in sections below on each of the project embayments. The details and implications of the different nitrogen loading limits, residence time determinations, and expected nitrogen concentrations are included in the Discussion section (Section IV) of this report.

C. Land Use and Nitrogen Loading Analysis

In order to determine the potential water quality impacts of development upon coastal embayments, one needs to estimate the amount of nitrogen (or "load") that is getting into an embayment from current development and then estimate how much nitrogen can get into the embayment once all the land within a watershed is developed (*i.e.*, buildout). In order to estimate the loads, project staff determined the various land uses within the project subwatersheds and projected the potential future development based on current zoning in the towns within the watersheds.

Nitrogen loading analyses can be completed in a number of ways, depending on the information that is available and the tools available to assess the information. Nitrogen loads have been estimated a number of different ways within the coastal watersheds examined in this project: 1) using Technical Bulletin 91-001 (TB91-001) input values (Eichner and Cambareri, 1992) and seasonal occupancy adjustments; 2) using measured water use as a wastewater estimate; 3) using Title 5 wastewater flows as a wastewater estimate; 4) using nitrogen loads based on MacConnell air photo interpretation of land use (Buzzards Bay Project, in preparation); 5) using population estimates; and 6) combinations of these estimates. Data used in these analyses included town assessor and parcel information, MacConnell aerial photo-interpretations, water use, occupancy rates, and estimates of future parcels based on

C. West Falmouth Harbor

West Falmouth Harbor is located on the Buzzards Bay side of Falmouth. West Falmouth Harbor is not specifically listed in the state surface water classification, but is considered a SA water on the basis of Section 314 CMR 4.06(2), which states that coastal and marine waterbodies not listed in the Surface Water Regulation tables, are designated SA waters. As a condition of a 1992 development agreement for the Falmouth Industrial Park between the Falmouth Economic Development Industrial Corporation, a quasi-town agency, and the Cape Cod Commission, no net nitrogen loading could come from the park unless a nitrogen loading assessment of West Falmouth Harbor indicated that additional nitrogen capacity existed within the Harbor. As a result of mutual interest in characterizing the Harbor, a study to determine flushing rates and critical nitrogen loads was jointly funded by the Cape Cod Commission, the Town of Falmouth, and the Buzzards Bay Project.

Aubrey Consulting, Inc. (ACI) began a flushing study by collecting tidal data from five TDRs located throughout the Harbor for a 30 day period in July and August 1994. A sixth TDR was also installed in Snug Harbor, but it was vandalized and no data was collected from it (ACI, 1995). Salinity data were also collected at 40 sites and bathymetric data was collected using a boat-mounted total station and fathometer. Two dye dispersion studies and chlorophyll-*a* sampling were also conducted. Tidal and bathymetric information was incorporated into a two dimensional depth-averaged model to determine system residence times (Table 13) and hydrodynamics within the system and to evaluate potential water quality problems based on data collected by the Falmouth Pond Watchers (Howes and Goehringer, 1995). A subsequent contract by the Commission with ACI resulted in the determination of local residence times. Critical nitrogen loads based on the ORW-N, BBP ORW, SA-N, and BBP SA recommended nitrogen limits have been developed for Snug Harbor, Oyster Pond, Oyster Pond and Harbor Head combined, and the whole West Falmouth Harbor system (see Table 13).

Table 13. Characteristics and Critical Loads of West Falmouth Harbor and Selected Subembayments, Falmouth, MA.

Embayment	Watershed Area (acres)	Volume at Mid-Tide (m^3)	Surface Area (acres)	Residence Time (days) System	Residence Time (days) Local
Whole System	2,245	1,059,168	207	0.57	-----
Snug Harbor	919	181,248	37	4.52	0.85
Oyster Pond/ Harbor Head	733	108,749	18	14.78	1.62
Oyster Pond	229	53,808	7	106.80	6.16

Embayment	BBP Critical N Load (kg/yr)		N Critical Load (kg/yr)		Watershed N Load (kg/yr)	
	BBP ORW	BBP SA	ORW-N	SA-N	Existing	Buildout
	Local Residence	Local Residence	Local Residence	Local Residence		
Whole System	70,346	140,691	33,912	101,736	19,852	28,398
Snug Harbor	8,140	16,281	3,892	11,675	12,109	16,253
Oyster Pond/Harbor Head	2,607	5,213	1,225	3,675	3,170	5,067
Oyster Pond	137	412	159	478	751	1,350

Critical Loads are based on Local Residence times. Watershed N Loads are based on seasonally adjusted occupancy and TB91-001 values. All Watershed N Loads assume that the Town of Falmouth Wastewater Treatment Facility is operating under current conditions (explained in text); if the Facility is expanded to capacity and other treatment factors are the same, Whole System and Snug Harbor Watershed N Loads increase by 6,513 kg/yr for both existing and buildout conditions.

Water quality data within the West Falmouth Harbor system has been collected since 1992, when it was included in the town's Citizens' Monitoring Program. In general, the West Falmouth Harbor monitoring has shown average total nitrogen concentrations of between 0.35 and 0.5 ppm and high (6-10 ppm) dissolved oxygen concentrations (Howes and Goehringer, 1995). ACI (1995) observed that the West Falmouth Harbor system has "the appearance of (a) relatively healthy ecological system." Of particular concern, however, are the average total nitrogen concentrations in upper Snug Harbor, which have increased from 0.42 ppm in 1992 to 0.85 ppm in 1994, with a maximum monthly concentration of 1.35 ppm sampled in 1994. Oyster Pond annual mean total nitrogen concentrations have also increased between 1992 and 1994, but not at the same rate. Oyster Pond has also experienced low dissolved oxygen concentrations in its deeper waters (Fleer, 1992).

ACI (1995) also conducted modeling of expected nitrogen concentrations in the West Falmouth Harbor system. The concentrations were based on four scenarios: 1) existing loading without input from the WWTF, 2) existing loading with current projected input from the WWTF, 3) full build-out with current projected input from the WWTF, and 4) full build-out with no nitrogen treatment at the WWTF.

ACI utilized the flushing model to determine the nitrogen concentrations by distributing calculated nitrogen loads at 17 nodes along the eastern boundary of the West Falmouth Harbor model. The nitrogen loads were calculated based on analyses previously completed for the Falmouth Industrial Park (Howes, *et al.*, 1992). The modeled ACI nitrogen concentrations agree fairly well with the Citizens' Monitoring Program mean concentrations.

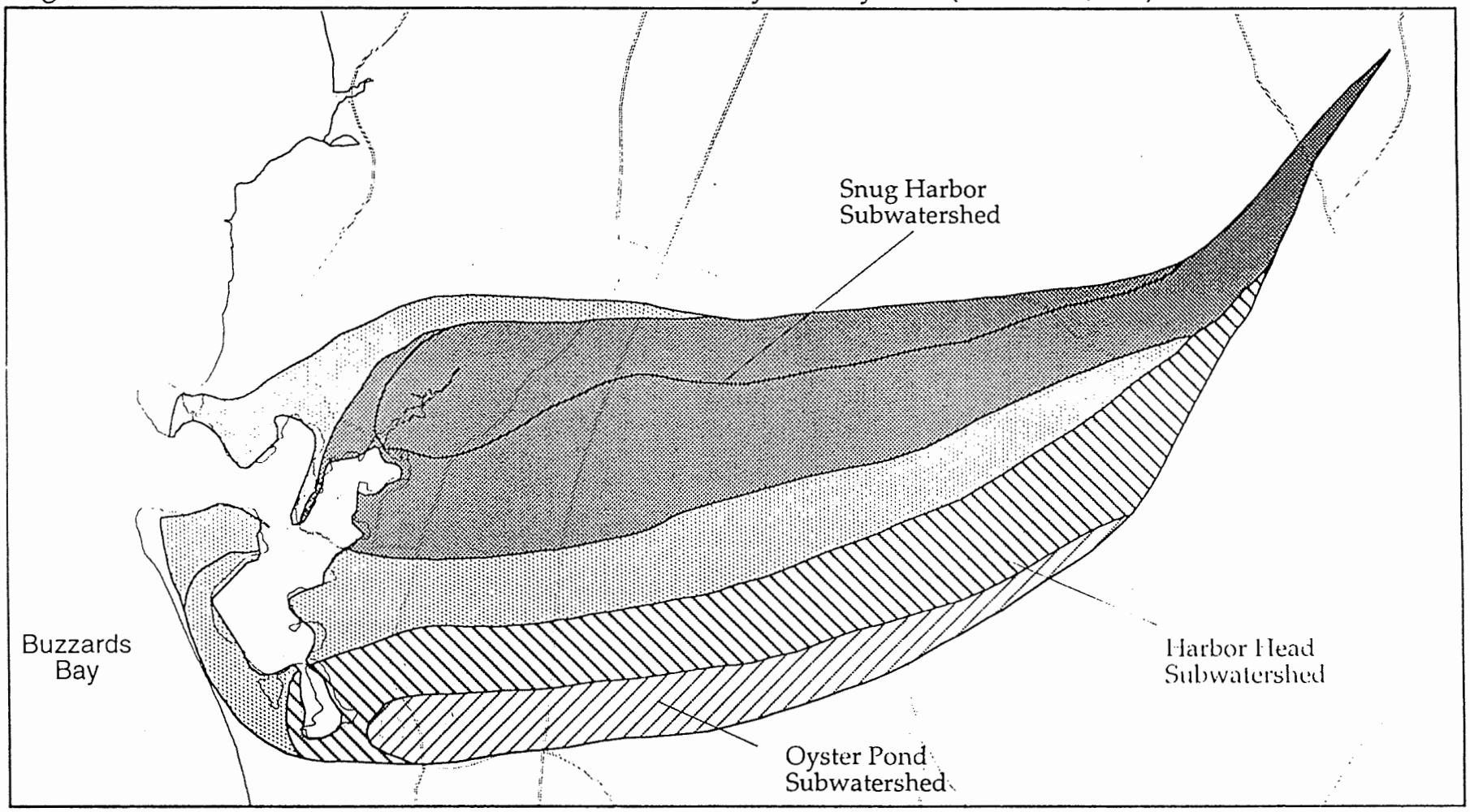
Project staff delineated subwatersheds to the various portions of the Harbor based on the segmentation of the Harbor completed by ACI (1995) (Figure 13). The water table used to delineate the watersheds was completed using water table information from a variety of sources: DEP files; Town of Falmouth files; DeFeo, Wait and Paré, 1994; LeBlanc and Guswa, 1977; LeBlanc, *et al.*, 1986; Masterson and Barlow, 1994; E.C. Jordan, Inc., 1989; Guswa and LeBlanc, 1985; and Saunders Associates, 1989 (see CCC, 1995a for details).

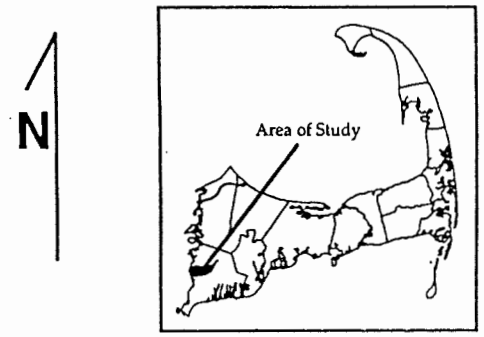
Project staff prepared nitrogen loading analyses within the subwatersheds based on three sources of data: 1) Title 5 wastewater flows, 2) TB91-001 wastewater estimates, and 3) water use information supplied by the Falmouth Planning Department and Department of Public Works (DPW). Wastewater flow and water quality information for the Falmouth Wastewater Treatment Facility (WWTF), landfill, and septage lagoons are also incorporated into the nitrogen loading assessments (sources: DEP, Falmouth DPW, laboratory tests from the BCDHE, the BBP, and numerous reports (Jordan, 1991; Howes, *et al.*, 1992; DeFeo, Wait and Paré, 1994; ACI, 1995)). TB91-001 nitrogen loading estimates assume that year-round dwellings are occupied at 1990 census occupancy (2.48 people/house), seasonal dwellings (37.9% of the residential units) are occupied with 5 people for 3 months. The following analyses focus on the TB91-001 nitrogen loading estimates.

Existing nitrogen loading within all three subembayments (Snug Harbor, Oyster Pond, and Oyster Pond/Harbor Head) exceed the ORW-N and BBP ORW critical loads based on local residence times (Figure 14). Existing loading within the Oyster Pond subwatershed exceeds both the BBP SA and SA-N local critical loads, while existing loading exceeds the Snug Harbor SA-N critical load. In addition, if the Town of Falmouth WWTF is brought up to full capacity (880,000 gpd), nitrogen loading exceeds the Snug Harbor BBP SA critical load (see Figure 14). All estimates of existing nitrogen loading within whole West Falmouth watershed are at least 14,060 kg/yr less than the Harbor's lowest critical load (ORW-N) and are not included in Figure 14.

All buildout nitrogen load estimates within the Snug Harbor, Oyster Pond, and Oyster Pond/Harbor Head subwatersheds cause further exceedance of the BBP ORW and ORW-N critical loads (Figure 15). All SA-N critical loads are also exceeded and the BBP SA limit is exceeded for Oyster Pond. The Snug Harbor load is 28 kg less than its BBP SA limit and the Oyster Pond/Harbor Head load is 146 kg less than its BBP SA limit. If the Town of Falmouth WWTF is brought up to its full capacity (880,000 gpd), all Snug Harbor critical limits are exceeded and the ORW-N limit for

Figure 13. Watersheds to West Falmouth Harbor Embayment System (Falmouth,MA).





0.3 0 0.3 0.6 0.9 Miles

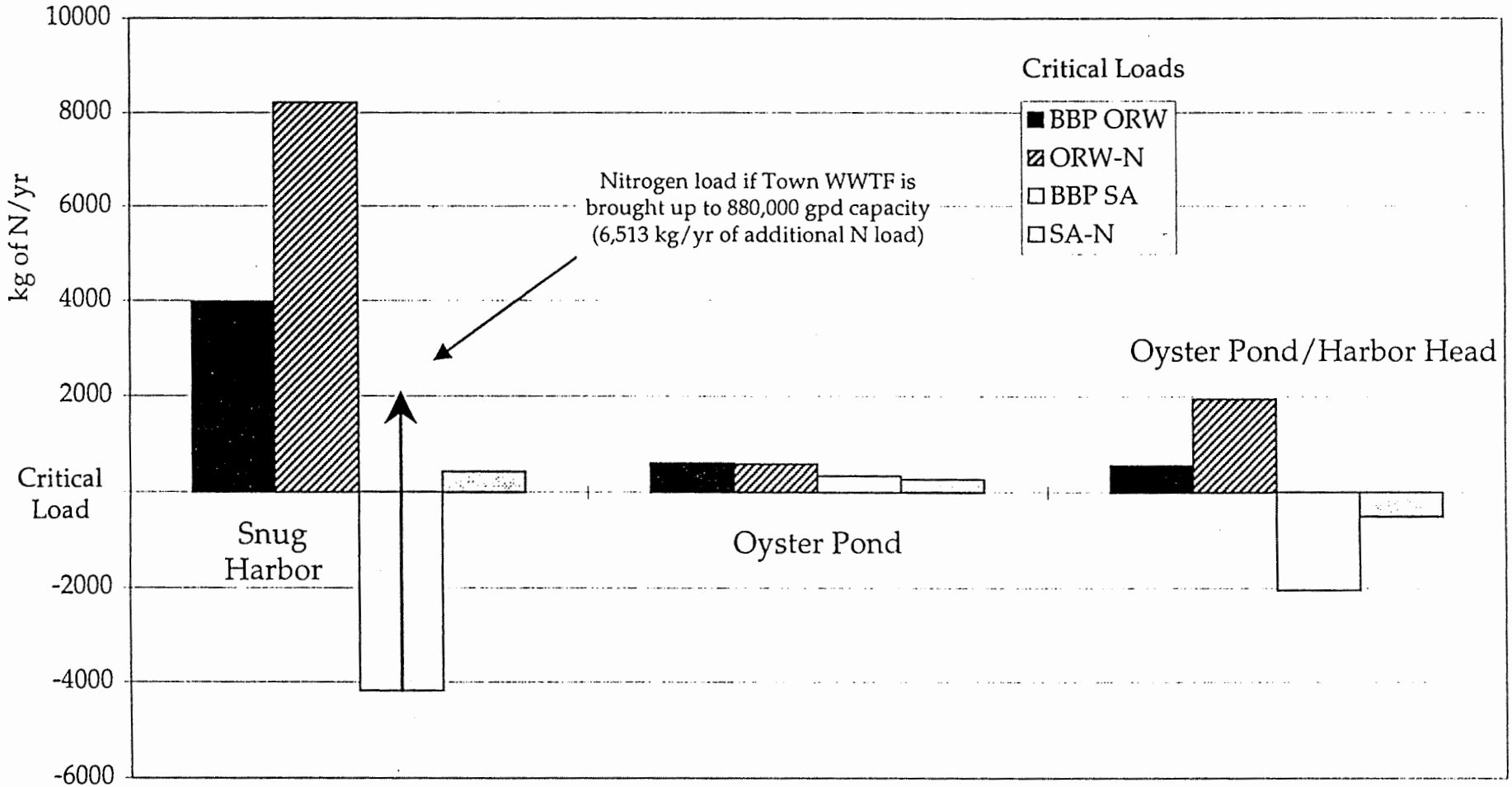
Cape Cod Commission, 1998

Figure 14.

Existing Nitrogen Loading

West Falmouth Harbor, MA

TB91-001 Nitrogen Loads



Note: All analyses assume current seasonal development. Whole system loads at least 14,060 kg below critical load. BBP ORW = Buzzard Bay Project Outstanding Resource Water Recommended Critical Load = 0.1 ppm nitrogen addition. ORW-N = Critical Load based on Falmouth Pond Watcher data = 0.05 ppm nitrogen addition. BBP SA = Buzzard Bay Project SA Recommended Critical Load = 0.2 ppm nitrogen addition. SA-N = Critical Load based on Falmouth Pond Watcher data = 0.15 ppm nitrogen addition.

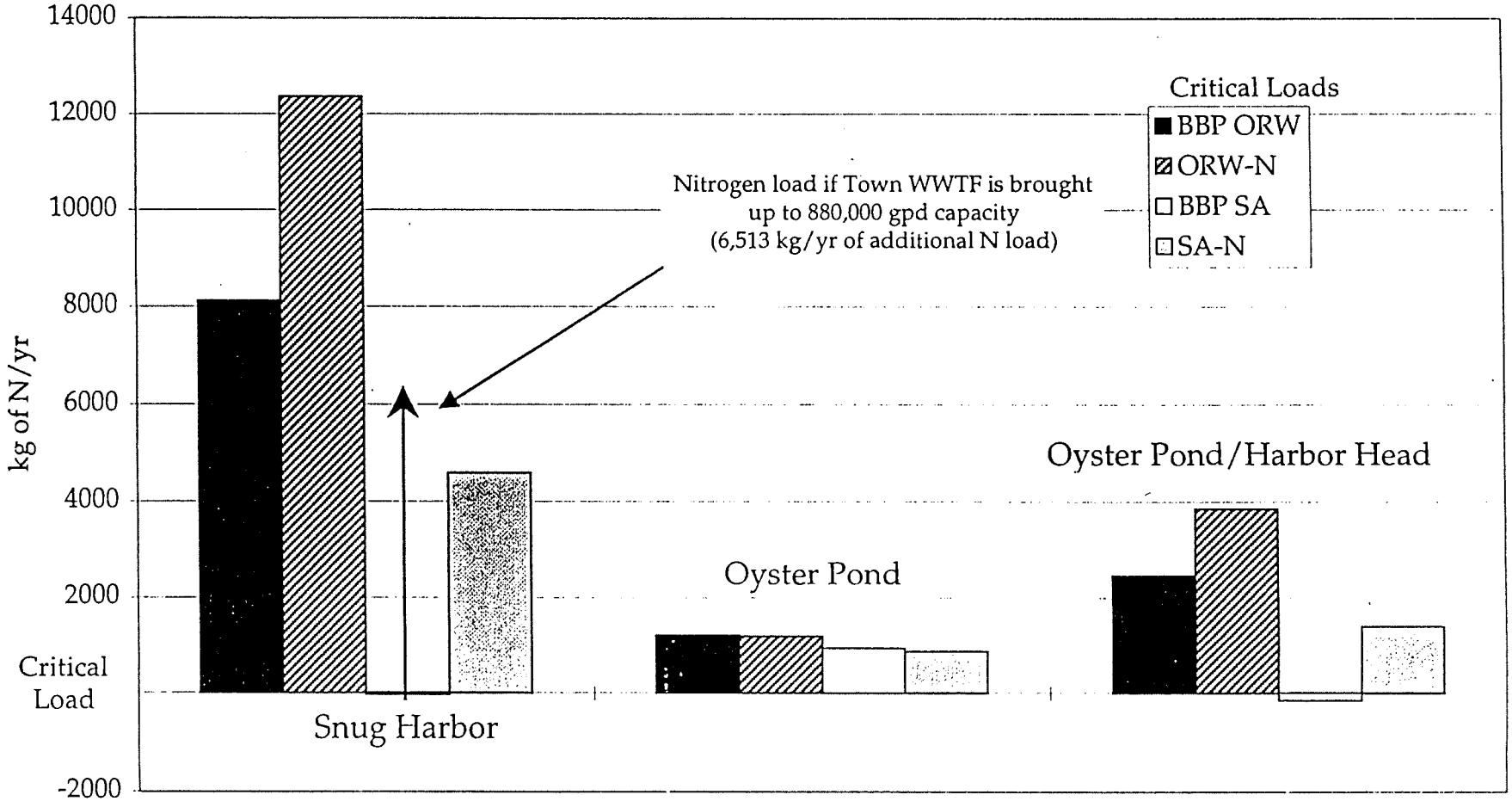
Cape Cod Commission, 1998

Figure 15.

Buildout Nitrogen Loading

West Falmouth Harbor, MA

TB91-001 Nitrogen Loads



Note: All analyses assume current seasonal development. Whole system loads at least 5,500 kg below critical load, except for full capacity at WWTF when ORW-N load is exceeded by ~1,000 kg. BBP ORW = Buzzard Bay Project Outstanding Resource Water Recommended Critical Load = 0.1 ppm nitrogen addition. ORW-N = Critical Load based on Falmouth Pond Watcher data = 0.05 ppm nitrogen addition. BBP SA = Buzzard Bay Project SA Recommended Critical Load = 0.2 ppm nitrogen addition. SA-N = Critical Load based on Falmouth Pond Watcher data = 0.15 ppm nitrogen addition.

Cape Cod Commission, 1998

the whole West Falmouth Harbor system is exceeded (see Figure 15).

Since water quality data was available through the Falmouth Pond Watchers, staff compared average observed concentrations at the various sampling stations in West Falmouth Harbor to the predicted concentrations based on the TB91-001 nitrogen loads within each of the subwatersheds. The match between these data is good; the average difference between predicted and observed concentrations is 4% (Figure 16). As a point of comparison, expected variability/error in the flushing calculations is estimated to be approximately 10% (personal communication, John Ramsey, ACI).

Since Figure 16 has only four points of comparison, more refined comparison between observed and predicted concentrations should occur using the above nitrogen loading estimates, updated monitoring data, and the flushing model.

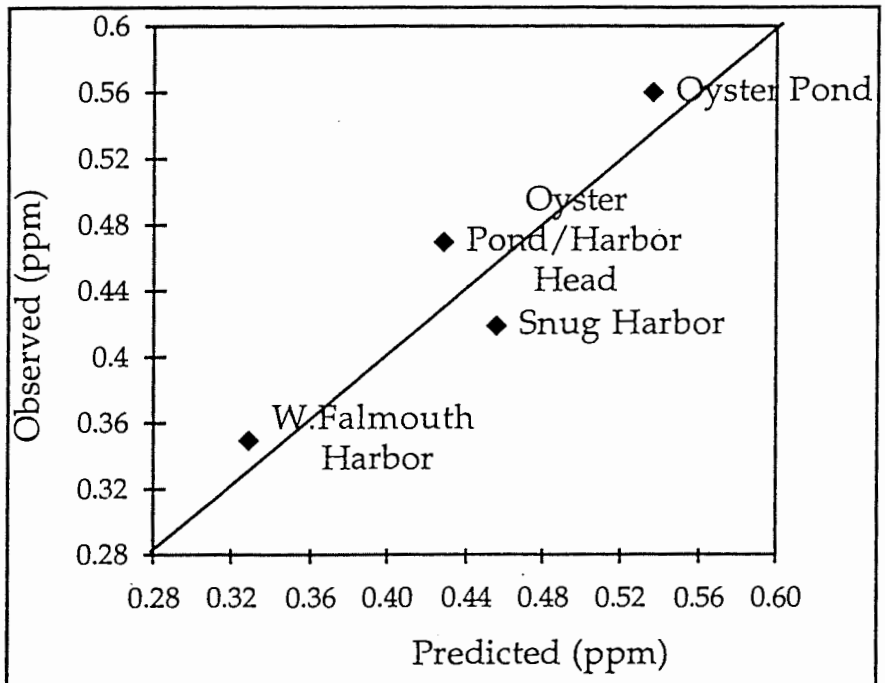


Figure 16. Comparison of Average Nitrogen Concentrations in West Falmouth Harbor

As can be seen in Figures 14 and 15, the Town WWTF can have significant impacts on both Snug Harbor and the whole West Falmouth Harbor system. However, the ~ 1/2 mile distance from the WWTF to Snug Harbor can slow the measurement of these impacts and complicate their assessment. The above analyses utilize a steady-state assumption that nitrogen loads within the watershed are currently being expressed in the Harbor. In reality, these loads travel with the groundwater until they reach the Harbor. The impacts of the Falmouth WWTF on Snug Harbor can help to explain this situation. The WWTF began discharging effluent in October 1986. A simple calculation using a 1 ft/day groundwater flow rate predicts that it will take a little over 7 years, or roughly January 1994 for the effluent discharged in October 1986 to reach Snug Harbor. Water quality sampling in upper Snug Harbor's ebb flows taken during the summer of 1994 showed dramatic increases in nitrogen concentrations, from approximately 0.4 to approximately 0.8 ppm (ACI, 1995). The concentration in 1993 matches the estimated average concentration in Figure 16. Given the whole length of the West

Falmouth Harbor watershed, this analysis suggests that many of the impacts associated with the landfill, the septage lagoons, newer houses, and houses far from the Harbor have yet to be expressed.

i. Management Options

a. Snug Harbor

Management of the nitrogen loads from the Town WWTF and landfill are keys to developing management options for Snug Harbor. Since the WWTF load is added from outside of the subwatershed, control of this load is related to the flows added to the sewer system in downtown Falmouth and the treatment level at the WWTF. The existing WWTF flow is approximately 56% of the total nitrogen load within the subwatershed, while the landfill represents another 10%. Among the variables that are important for calculating the WWTF impact are: 1) the nitrogen concentration in the effluent, 2) the nitrogen concentration in the effluent groundwater plume at discharge into the Harbor, 3) the wastewater flow, 4) the split of the flow between the irrigation areas and the rapid infiltration beds, and 5) the denitrifying capacity in the irrigation area.

Jordan (1991) completed the only in-depth review of WWTF performance. This assessment, which began when the irrigation fields were first utilized in 1988, provides the majority of the WWTF performance data that has been used in the nitrogen loading assessments completed to date. Jordan (1991) measured an annual average inorganic nitrogen concentration in effluent from the treatment plant of 19.88 ppm in 1988 and 14.68 ppm in 1989, with a range of weekly readings between 8.59 and 30.46 ppm. Jordan (1991) also measured 1988 effluent organic nitrogen, which increased the annual average total nitrogen to 22.58 ppm. Howes, *et al.* (1992), BBP analyses, and the analysis in this report utilize 17.37 ppm as the average effluent nitrogen concentration, which is the 1989 inorganic nitrogen average plus the 1988 average organic nitrogen concentration.

Jordan (1991) also evaluated the performance of the spray irrigation field and found that 28% of the applied nitrogen leached beyond the root zone in 1988 and 55% leached in 1989. Most nitrogen loading analyses have utilized the 55% leaching for the spray irrigation. Given the near doubling in the percentage of nitrogen leaching from 1988 to 1989, this parameter is among the most uncertain for assessing the nitrogen impacts from the WWTF. The analysis in this report assumes 55% of the nitrogen applied in the spray irrigation area at the Falmouth WWTF leaches to the groundwater. The rapid infiltration beds are assumed to leach 98% of the nitrogen.

Another difficulty in assessing the impact of the WWTF has been the location of downgradient monitoring wells, most of which were installed at depths and locations that did not allow complete assessment of the WWTF impacts. In order to address this situation, the Town of Falmouth requested the assistance of Commission staff in selecting locations and depths for additional wells in areas thought to be within the WWTF effluent plume. These wells, which were installed in September 1996, have provided useful additional data. Water quality samples

have been collected four times from these wells (Ray Jack, Utilities Manager, Town of Falmouth, DEP reporting) and results generally seem to support the nitrogen concentrations discussed above. Staff recommends that additional samples from these wells and corresponding samples from the WWTF effluent be collected to better establish the impacts of the WWTF. In addition, sampling points near Snug Harbor can also help to better determine the impacts of the WWTF; UMASS-D/CMAST is currently collecting more refined water quality data in different portions of Snug Harbor to assist in this effort.

The landfill parcel is partially located within the subwatershed to Snug Harbor and partially within the subwatershed to the portion of the Harbor just to the north of the Harbor Head, sometimes called "South Cove" (see Figure 13). As with the WWTF, staff reviewed available water quality monitoring data (BCDHE records; Woodard & Curran, 1995) for wells installed downgradient of the landfill and used the following parameters in the nitrogen loading analysis: 15 ppm nitrogen flowing from the landfill; 20 acres of the 40 acre landfill area is assumed to be located within the Snug Harbor subwatershed; and 40 inches of recharge per year is assumed to percolate through the landfill. The recharge amount is multiplied by the nitrogen concentration to determine the nitrogen load coming from the landfill. The town is preparing the necessary documentation to place a state-mandated impervious cap on the landfill. Once the cap is in place, the annual nitrogen load from the landfill should approach zero and remove the current load of approximately 1,200 kg/yr from the Snug Harbor subwatershed.

Management options have been developed to meet the critical loads that are exceeded by existing and buildout nitrogen loads. Since the landfill and the WWTF are such important components of the nitrogen load to Snug Harbor, management options to meet the various critical loads must address these two sources. The management options presented in Table 14 assume that the landfill is capped and no nitrogen reaches the Harbor from the landfill. In addition, the options in Table 14 assume that the flow from the WWTF is fixed at the current flow of 447,150 gpd.

Increasing the WWTF flows from 447,150 gpd used in the above analyses up to its capacity of 880,000 gpd causes Snug Harbor existing and buildout nitrogen loads to exceed all nitrogen limits (see Figures 14 and 15). Table 15 presents management options to meet the various nitrogen limits for Snug Harbor when the wastewater flow to the Town of Falmouth WWTF is 880,000 gpd.

Table 14. Selected Nitrogen Management Options Reviewed (Snug Harbor) with current Town of Falmouth WWTF flows (assumed to be 447,150 gpd)

Nitrogen Limit	Existing or Buildout	% Nitrogen Reduction Necessary		Falmouth WWTF Nitrogen Discharge (current = 17.37 ppm)
		Wastewater Concentration	Fertilizer Load	
BBP ORW	Existing			10 ppm
BBP ORW	Existing	29% (25 ppm discharge)		12 ppm
BBP ORW	Existing	29% (25 ppm discharge)	50%	13 ppm
BBP ORW	Buildout	29% (25 ppm discharge)	50%	5 ppm
ORW-N	Existing	71% (10 ppm discharge)	60%	5 ppm
ORW-N	Buildout	71% (10 ppm discharge)	100%	2.5 ppm
SA-N	Existing	Cap the landfill		
SA-N	Buildout		60%	10 ppm

All analyses assume current seasonal development and no nitrogen load from a capped landfill. BBP ORW = Buzzard Bay Project Outstanding Resource Water Recommended Critical Load = 0.1 ppm nitrogen addition. ORW-N = Critical Load based on Falmouth Pond Watcher data = 0.05 ppm nitrogen addition. BBP SA = Buzzard Bay Project SA Recommended Critical Load = 0.2 ppm nitrogen addition. SA-N = Critical Load based on Falmouth Pond Watcher data = 0.15 ppm nitrogen addition.

Table 15. Selected Nitrogen Management Options Reviewed (Snug Harbor) with Town of Falmouth WWTF flows increased to capacity (assumed to be 880,000 gpd)

Nitrogen Limit	Existing or Buildout	% Nitrogen Reduction Necessary		Falmouth WWTF Nitrogen Discharge (current = 17.37 ppm)	Future residential parcels preserved as open space
		Wastewater Concentration	Fertilizer Load		
BBP ORW	Existing			5 ppm	
BBP ORW	Existing	29% (25 ppm discharge)	50%	6.5 ppm	
BBP ORW	Buildout	49% (18 ppm discharge)	100%	5 ppm	
BBP ORW	Buildout	49% (18 ppm discharge)	100%	5 ppm	
BBP ORW	Buildout	46% (19 ppm discharge)	100%	5 ppm	46/90
ORW-N	Existing	71% (10 ppm discharge)	100%	2.5 ppm	
ORW-N	Buildout	83% (6 ppm discharge)	100%	2 ppm	
SA-N	Existing		20%	10 ppm	
SA-N	Buildout	46% (19 ppm discharge)	50%	9 ppm	
BBP SA	Existing			15 ppm	
BBP SA	Buildout			10 ppm	

All analyses assume current seasonal development and no nitrogen load from a capped landfill. BBP ORW = Buzzard Bay Project Outstanding Resource Water Recommended Critical Load = 0.1 ppm nitrogen addition. ORW-N = Critical Load based on Falmouth Pond Watcher data = 0.05 ppm nitrogen addition. BBP SA = Buzzard Bay Project SA Recommended Critical Load = 0.2 ppm nitrogen addition. SA-N = Critical Load based on Falmouth Pond Watcher data = 0.15 ppm nitrogen addition.

The above management strategies treat Snug Harbor as one system, while the highest nitrogen concentrations have been measured in the upper portion of the Harbor, while the lower portion has generally seen concentrations similar to those in Figure 16. The higher concentrations in the upper portion are similar to those seen in the Mashpee River, which has seen significant public dissatisfaction with water quality due to odors and siltation. The town may want to consider a management strategy for Snug Harbor that accounts for the greater impacts in the upper portion of the Harbor.

Almost all the management strategies in Tables 14 and 15 indicate that significant improvements in the existing nitrogen effluent from the Town of Falmouth WWTF are warranted. Additional data collection from the downgradient monitoring wells is necessary to determine if recent modifications to the WWTF design have reduced nitrogen loads from the plant.

b. Oyster Pond

Because of Oyster Pond's comparatively long local residence time, the critical loads determined using the BBP recommended limits are based on the surface area rather than the residence time. Thus, the critical load is the same using either the system or local residence time (see Table 13). The ORW-N and SA-N limits are based on the length of the local residence time. As stated previously, existing and buildout TB91-001 nitrogen loads within the watershed exceed the all the recommended nitrogen loading limits (ORW-N, BBP ORW, SA-N and BBP SA) (see Figures 14 and 15). Table 16 presents management options to meet the various nitrogen limits under both existing and buildout conditions.

Table 16. Selected Nitrogen Management Options Reviewed (Oyster Pond)

Nitrogen Limit	Existing or Buildout	% Nitrogen Reduction Necessary			Future residential parcels preserved as open space
		Wastewater Concentration	Fertilizer Load	Pavement Runoff Load	
BBP ORW	Existing	100% (no discharge)	100%	50%	
BBP ORW	Buildout	100% (no discharge)	100%	50%	47/58
ORW-N	Existing	100% (no discharge)	100%	46%	
ORW-N	Buildout	100% (no discharge)	100%	46%	55/58
BBP SA	Existing	66% (12 ppm discharge)	50%		
BBP SA	Buildout	71% (10 ppm discharge)	50%		50/58
SA-N	Existing	54% (16 ppm discharge)	50%		
SA-N	Buildout	71% (10 ppm discharge)	50%		31/58

All analyses assume current seasonal development. BBP ORW = Buzzard Bay Project Outstanding Resource Water Recommended Critical Load = 0.1 ppm nitrogen addition. ORW-N = Critical Load based on Falmouth Pond Watcher data = 0.05 ppm nitrogen addition. BBP SA = Buzzard Bay Project SA Recommended Critical Load = 0.2 ppm nitrogen addition. SA-N = Critical Load based on Falmouth Pond Watcher data = 0.15 ppm nitrogen addition.

An additional consideration to improve the water quality in Oyster Pond may be

increasing the flushing between Oyster Pond and Harbor Head. Harbor Head has a tidal range of approximately 4 ft, while the pipe connecting Oyster Pond and Harbor Head limits the tidal range in Oyster Pond to approximately 1 ft (ACI, 1995). If the opening between Oyster Pond and Harbor Head is increased enough to reduce the local flushing time by 37% (from 6.16 to 3.88 days), the existing load would meet the SA-N limit without applying any nitrogen reduction strategies. Additional study of reconfiguring this connection should be undertaken.

Because of the limited tidal range in Oyster Pond, the Pond appears to be acting as a trap for nutrients. Fleer (1992) observed that the bottom waters of Oyster Pond were hypoxic and ACI (1995) hypothesized that the underprediction of nitrogen concentrations by their water quality model was due to internal loading of nitrogen from the sediments in Oyster Pond. Since this source will take extensive time to flush out even with improved flushing, the Town may also want to consider activities to reduce the internal load. Options such as alum treatments or dredging of sediments could reduce the internal nitrogen load.

c. Oyster Pond and Harbor Head

The Harbor Head/Oyster Pond subwatershed and subembayment are actually two systems: Harbor Head and Oyster Pond. Because Harbor Head is closer to the mouth of West Falmouth Harbor (*i.e.*, has greater flushing), it can tolerate a greater nitrogen load than Oyster Pond. The watershed to Harbor Head produces 76% of the existing nitrogen load to the combined subembayment.

TB91-001 nitrogen loads from existing development within the Oyster Pond/Harbor Head watershed exceed both the ORW-N and BBP ORW limits, but are less than the SA-N and BBP SA limits (see Figure 14). Nitrogen loading from buildout causes the SA-N to be exceeded and is within 146 kg/yr of the BBP SA limit (see Figure 15). Since the management options to meet the nitrogen limits for Oyster Pond are fairly stringent, options to address the combined Oyster Pond/Harbor Head nitrogen limits are based on the assumption that the Oyster Pond limits are met (Table 17).

d. Whole System

As stated above, the nitrogen loading analyses indicate that sufficient capacity exists within the whole West Falmouth Harbor system to accommodate all estimates of existing and future potential loading except for the exceedance of the ORW-N limit where the treatment plant flows increase to 880,000 gpd and effluent nitrogen concentrations are not decreased (see Figure 15). As with the nitrogen management relationship between Harbor Head and Oyster Pond, this analysis does not account for the sensitivity of the more constricted portions of the whole Harbor, so the nitrogen loading capacity of the main portion of the whole Harbor is able to accommodate more load if nitrogen reductions are implemented in the more sensitive upper reaches. For example, if nitrogen reductions in Snug Harbor total more than 1,200 kg/yr, which would need to be achieved to meet the any of the Snug Harbor limits under the WWTF-at-capacity scenario, total nitrogen loading to the West Falmouth Harbor system would be below all of the nitrogen loading limits.

Table 17. Selected Nitrogen Management Options Reviewed (Harbor Head/Oyster Pond)

Overall Nitrogen Limit	Nitrogen Limit for Oyster Pond	Existing or Buildout	% Nitrogen Reduction Necessary		Future residential parcels preserved as open space
			Wastewater Concentration	Fertilizer Load	
ORW-N	ORW-N	Existing	71% (10 ppm discharge)	50%	
ORW-N	ORW-N	Buildout	71% (10 ppm discharge)	100%	63/126
BBP ORW	BBP ORW	Existing		10%	
BBP ORW	BBP ORW	Buildout	37% (22 ppm discharge)	50%	
BBP ORW	BBP ORW	Buildout	29% (25 ppm discharge)	50%	31/126
SA-N	SA-N	Buildout		50%	30/126
SA-N	SA-N	Buildout		100%	5/126

All analyses assume current seasonal development. BBP ORW = Buzzard Bay Project Outstanding Resource Water Recommended Critical Load = 0.1 ppm nitrogen addition. ORW-N = Critical Load based on Falmouth Pond Watcher data = 0.05 ppm nitrogen addition. BBP SA = Buzzard Bay Project SA Recommended Critical Load = 0.2 ppm nitrogen addition. SA-N = Critical Load based on Falmouth Pond Watcher data = 0.15 ppm nitrogen addition.

Concentrations within the main part of the Harbor are generally around 0.35 ppm (Howes and Goehringer, 1995). The maximum projected nitrogen load (*i.e.*, full capacity at the WWTF and full buildout within the watershed) even without implementation of nitrogen management strategies would cause only a small increase (< 0.05 ppm) in the average nitrogen concentration within the whole Harbor (ACI, 1995).

The location of the septage lagoons within the South Cove subwatershed has been identified as a concern for the ecological health of the West Falmouth Harbor system. Although the lagoons are no longer used for the disposal of septage, groundwater monitoring data suggests that they are still a source of nitrogen within the watershed. As part of determining the overall nitrogen load to the Harbor, staff reviewed available water quality information near the septage lagoons and utilized the following parameters to estimate a 197 kg/yr nitrogen load coming from the lagoons: 32 ppm nitrogen comes from the lagoons (mean concentration of 10 downgradient monitoring wells; range = 1.9 to 107 ppm), the lagoons cover 0.6 acres, and 40 in/yr of recharge also flows through them (*i.e.*, they are treated as rapid infiltration beds or impervious surfaces). These recharge amounts are multiplied by the assigned nitrogen concentrations to determine the nitrogen load coming from the lagoons, which was included in the above assessments.

It has been suggested that the groundwater nitrogen load coming from past use of the septage lagoons will be more significant than the calculated loads based on the above assumptions (Costa, 1996). The range of annual septage discharge into these lagoons between 1981 and 1987 was 5.5 million gallons to 9.5 million gallons. The review by Costa (1996) of monitoring data found concentrations of up to 124 ppm ammonia-nitrogen seven years (1995) after the septage lagoons were abandoned.

Costa (1996) also suggested that average groundwater nitrogen impacts from the lagoons could be calculated at 240 ppm (based on 40% of EPA average septage design concentration). At a 124 ppm concentration, the septage discharge range would account for between 2,581 and 4,459 kg/yr. At a 240 ppm concentration, the septage discharge range would account for between 4,996 and 8,630 kg/yr. These loads are significantly higher than the 197 kg/yr estimates based on current observed concentrations.

At the existing loading rate in the system, 13,863 kg/yr of nitrogen loading capacity exists for the whole system at the lowest, most restrictive, limit (ORW-N) (see Figure 14). At this limit, even the highest estimated nitrogen load from the septage lagoons can be accommodated. The highest septage nitrogen load can be accommodated at the ORW-N limit if the WWTF flows remain below 795,000 gpd (90% of capacity) at the current treatment level. At buildout, the highest septage nitrogen load would cause the ORW-N limit to be exceeded even without any increase in the capacity of the WWTF. However, the buildout nitrogen load with full capacity at the WWTF and the highest possible nitrogen load from the septage lagoons is less than all the other nitrogen limits for the whole system.

Project staff estimate that the groundwater flow (using 1 ft/day) from the septage lagoons should take approximately 34 years to reach the Harbor. Based on this estimate, the flow from 1987, the last year of operation of the septage lagoons, will be reaching the Harbor in 2021. After that point, the impact from the lagoons would be eliminated.

The worst case type of analysis for the impact of the septage lagoons suggest that the water quality of West Falmouth Harbor will not be significantly impacted by the nitrogen loads from the septage lagoons, especially if nitrogen load reductions occur in the more sensitive subembayments of the Harbor system. The difficulties in accurately estimating the nitrogen loads, however, support the on-going water quality monitoring of the system to ensure that the impacts are well understood.

ii. Discussion

The keys to addressing water quality in West Falmouth Harbor are: 1) treatment levels and wastewater flows at the Town of Falmouth Wastewater Treatment Facility, 2) nitrogen loading within the Snug Harbor subwatershed, and 3) nitrogen loading within the Oyster Pond subwatershed. Increases in flows at the WWTF have the potential to impact the whole West Falmouth Harbor system, unless improvements are made in the nitrogen treatment at the plant. However, existing and potential land use within the Snug Harbor system are also a concern since limits are also exceeded even without increases in WWTF flows. Water quality in Oyster Pond could be addressed by improving tidal flushing into the pond, but the analysis of the combined Harbor Head/Oyster Pond system indicates that nitrogen reductions are necessary to meet selected limits.

Data being collected by UMASS-D/CMAST around Snug Harbor, additional water quality monitoring around the Town WWTF, and additional Pond Watcher data

could be combined with the ACI hydrodynamic model and the above nitrogen loading estimates to help evaluate additional management options and selection of nitrogen loading limits for West Falmouth Harbor and its subembayments. A facilities planning process has been suggested by the DEP to assist the Town in development of management strategies of nitrogen management strategies. Discussion of the appropriateness of management options will have to occur among all involved parties: local boards, homeowners, business owners, and state officials. Commission staff are available to assist the Town in the development of management strategies.

iii. Conclusions

The waters of West Falmouth Harbor, including Snug Harbor, South Cove, Harbor Head, and Oyster Pond, are classified as SA waters by the Commonwealth of Massachusetts. With the Town of Falmouth WWTF at its current discharge of 447,359 gpd, existing nitrogen loading within the Oyster Pond subwatershed exceeds the SA-N and BBP SA nitrogen limits and existing loading exceeds the SA-N limit for Snug Harbor, while buildout nitrogen loading causes the combine Oyster Pond/Harbor Head SA-N limit to be exceeded. Existing nitrogen loads in all subembayments exceed ORW-N and BBP ORW limits. Increasing the flow at the WWTF to its full capacity of 880,000 gpd causes the SA-N and BBP SA limits for Snug Harbor to be exceeded under both existing and buildout conditions and causes the ORW-N limit for the whole West Falmouth Harbor system to be exceeded. Management options to meet the various limits are presented above and the spreadsheets developed to analyze the nitrogen loads can be used to evaluate additional options.

The current water quality monitoring effort underway by the town Pond Watchers should be continued regardless of which nitrogen management options are selected; this information can help to assess the effectiveness of the management efforts. In addition, the current UMASS-D/CMAST study of Snug Harbor should also help to provide additional insights into the selection of appropriate nitrogen management activities. All of this work, including the above nitrogen loading analysis and the previously completed hydrodynamic model, should be used as tools under a process to select appropriate activities to protect and improve water quality in the West Falmouth Harbor system. A facilities planning process could help to secure the necessary funding for these activities.

iv. Implementation Status

Project staff have participated with BBP and Town of Falmouth staff in the review of BBP and ACI nitrogen loading calculations completed for the whole watershed. The above information on nitrogen loading within the subwatersheds has not been presented to the town.

Since quantifying the impact of the WWTF is a key to developing appropriate management options for Snug Harbor and the WWTF, town officials dedicated funds for the installation of monitoring wells to better measure the impacts. At the request of the town, project staff prepared a draft scope of work for the installation of

additional monitoring wells downgradient of the WWTF to better assess its relative contribution to the WWTF. This scope of work was approved by the Town and the installation of the wells was accomplished between June and December 1996. Water quality samples began to be taken from these wells during the regular quarterly sampling of WWTF monitoring wells in February 1997 (personal communication, Ray Jack, Falmouth Department of Public Works).

A draft scope of work for a facilities plan to address nitrogen loading within the West Falmouth Harbor watershed is being discussed between the Town and DEP, with comments being solicited from the Commission and the BBP.

Embayment Parcel Total	423	34974609	0	
Ponds		950044	0	
Roads		3550576		
Embayment Area	1	1620432	0	
		41095660	0	
Critical Loading Level		GIS area to Parcel Area difference	39475228	-7.38
GIS Area		% difference between GIS and Parcel Area		
LAND USE SUMMARY	**Snug Harbor**			
LAND USE DESCRIPTION	**STATE CLASS CODE**	**# OF PARCELS**	**AREA (sq. ft.)**	
Single Family Residential	101/103	240	8,182,246	
Two-Family Residential	104/109	13	591,950	
Multi-Family Residential	105/111/112/121	3	107,979	
Condominium Units	102	0	-	
Other Residential	106	6	353,412	
Commercial				
Motels	301	1	43,315	
Inns/Bed and Breakfasts	302	1	56,765	
Hotel	301	1	43315	
Warehouse Construction Supply Stores	321	0	-	
Lumber Yards	313	0	0	
Supermarkets	324	0	-	
Small Retail/Service Stores	318/322/323/325/343/364	3	60,416	
Restaurant	326	1	144,330	
Automotive/Marine	310/315/330/331/332/333 338/334/337/354/384	3	33,331	
Car Wash	335	0	-	
Office Building	13/31/340/341/342/ 350/402	1	10,569	
Day Care Centers	352	0	0	
Fraternal Organizations/Museums	353/360	0	0	
Funeral Home	355	0	-	
Golf Courses/Cranberry Bogs/Agricultural	380/393/710/712/717/ 718/719/805	2	135,750	
Manufacturing	316/400/401	5	1174436	
Research and Development Facility	404	2	388,110	
Mining Sand/Gravel	410	6	2,392,802	
Other Commercial (No Bldgs.)	366/369/375/381/386/ 424//425/431/814	0	-	
Beaches/Swimming Pools	383	0	0	
Federal Owned	900	0	-	
State Owned	901	2	101,235	
County Owned	902	0	-	
Town-Owned	903/907/908	33	14,965,670	
Nursing Home	303/304	0	-	
Colleges/Private School/Summer Camps	123/351/374/387/904	0	-	
Non-Profit Organizations	905/909/910/920	8	371,823	
Churches, Synagogues	906	3	84,108	
DEVELOPABLE				
-Residential	130/131	55	2,810,265	
-Commercial	390/391/440/441	14	2,536,494	
UNDEVELOPABLE	132/201/202/220/301/392/423/42 8/430/433/442/720/801/803/807	21	707,618	
Roads	R		3,550,576	
Ponds	P		950,044	
	TOTAL	424	39,796,558	
NOTE: Total figures for # of parcels and area are based upon a residential parcel criteria of >50% located within recharge area and the inclusion of all other parcels.				
Difference in GIS area to parcel area (acres):	-7.38			
% difference in GIS area to parcel area:	0.00%			
Bedrooms Assumed:	3	/residential (1X for 13/31/101) (2x for 104/109) (3x for 105/111)		
1990 Census Average Occupancy:	2.48	ppl/house (1X for 13/31/101) (2x for 104/109) (3x for 105/111)		
%Year Round Residences (1990 Census):	62.1%			
Year Round Occupancy (1990 Census):	2.48	ppl/house (1X for 13/31/101) (2x for 104/109) (3x for 105/111)		
Seasonal Occupancy (1990 Census):	5.00	ppl/house (1X for 13/31/101) (2x for 104/109) (3x for 105/111)		
AREAS USED IN NITROGEN LOADING				
	(Sq. ft.)			
TOTAL CONTRIBUTING AREA	39,796,558			
Roads	3,550,576			
Paved	855,815	Residential (500 ft2/lot); 1/3 of Commercial		
Roof	1,248,815	Residential (2000 ft2/lot); 1/3 of Commercial		
Lawn	2,129,840	Residential (5000 ft2/lot); 70% of Golf Course & Agriculture		
NATURAL AREA	32,011,512	All State code 410 parcels are natural land		
DEVELOPABLE AREA	5,346,759			
UNDEVELOPABLE AREA (132/202/442/910/920)	1,079,441			
EMBAYMENT WATER SURFACE AREA	1,620,432			
ASSUMED VALUES FOR NITROGEN LOADING				
Impervious Recharge Rate (in/yr) =	40	Average Lawn Size (ft.2) =	5000	
Roof Runoff Concentration (mg/l) =	0.75	Recharge Rate (in./yr.) =	21	

Road Runoff Concentration (mg/l) =	1.50	Fertilizer Applic. Rate (lbs./1000ft2*yr) =	3	
Lawn Nitrogen Leaching (%)	25%	Natural Area Concentration (mg./l) =	0.05	
Wastewater Concentration (mg/l) =	35	Precipitation Rate (in/yr) =	44.44444444	
WWTP Irrigation Conc. (mg/l)=	17	WWTP Irrigation Leaching (%)=	55%	
WWTP Bed Conc. (mg/l)=	17	WWTP Bed Leaching (%)=	98%	
Landfill (mg/l) =	15	WWTP Flow to Irrigation (%) =	82%	
Landfill Area (acres) =	20	WWTP Flow to Beds (%)=	18%	
Median Septage Concentration (mg/l) =		Treatment Plant (mg/l)=	10	
Recharge Values				
Lawn Recharge (gal/yr)=	27,881,543	Impervious Recharge (gal/yr)=	141,012,928	
Natural Area Recharge (gal/yr)=	440,272,755	Roof Recharge (gal/yr)=	31,139,285	
Precipitaiton on Embayment Surface (gal/yr) =	44895089	Road and Paved Recharge (gal/yr)=	109,873,643	
WASTEWATER ESTIMATES				
Title 5	**(Gallons/Day)**	**Technical Bulletin**	**(Gallons/Day)**	
Total Title 5 Residential	67,678	Technical Bulletin Residential	49,081	
Total Title 5 Commercial	10,271	Total 1993 Commercial Water Use	2,802	
Motels		Motels		
Inns/Bed and Breakfasts		Inns/Bed and Breakfasts	-	
Nursing Homes		Nursing Homes	-	
Small Retail/Service Stores		Small Retail/Service Stores	-	
Veterinary Clinic		Veterinary Clinic	-	
Restaurant		Restaurant	-	
Automotive/Marine		Automotive/Marine	-	
Office Building		Office Building	-	
Funeral Home		Funeral Home	-	
Manufacturing/ Storage Facilities		Manufacturing/ Storage Facilities	-	
Golf Course/Agricultural		Golf Course/Agricultural	-	
Group Homes, Churches, Non-Profit		Group Homes, Churches, Non-Profit	-	
Research and Development Facility		Research and Development Facility	-	
Theater		Tennis Club	-	
Recreation Facility		Recreation Facility	-	
Fire Dept.		Fire Dept.	-	
Total Title 5 Flow	**77,949**	**Total Technical Bulletin Flow**	**51,883**	
Landfill Facility	59,516	Landfill Facility	59,516	
Wastewater Treatment Facility	447,359	Wastewater Treatment Facility	447,359	
Total Title 5 Flow and Wastewater Flow	**584,825**	**Total Tech Bul. Flow and Wastewater Flow**	**558,759**	
Roof Recharge	85,313	Roof Recharge	85,313	Roof Area * 40 in/yr
Road and Paved Recharge	301,024	Paved Recharge	301,024	Paved Area * 40 in/yr
Lawn Recharge	76,388	Lawn Recharge	76,388	Lawn Area * 21 in/yr
Natural Area Recharge	1,206,227	Natural Area Recharge	1,206,227	Natural Area * 21 in/yr
Total Recharge	**2,253,776**	**Total Recharge**	**2,227,710**	
NITROGEN LOADING (EXISTING CONDITIONS)				
	(kg/yr)		(kg/yr)	
Title 5 Wastewater Loading	3,769	Tech. Bul. Wastewater Loading	2,509	
Total Impervious Loading	712	Total Impervious Loading	712	
Roof Loading	88	Roof Loading	88	Roof Area Recharge*Concentration
Paved Loading	624	Paved Loading	624	Paved Area*Recharge*Concentration
Lawn Loading	725	Lawn Loading	725	Lawn Area*Fertilizer Rate*Leaching Rate
Natural Area Loading	211	Natural Area Loading	211	Natural Area*Recharge*Concentration
Title 5 Total Loading	**5,417**	**Technical Bulletin Total Loading**	**4,156**	
Landfill Loading	1,217	Landfill Loading	1,217	
WWTF (Beds)	1,894	WWTF (Beds)	1,894	
WWTF (Irrigation)	4,842	WWTF (Irrigation)	4,842	
WWTF Loading	6,735	WWTF Loading	6,735	
Septage Lagoon Loading	-	Septage Lagoon Loading	-	0.10049977
Title 5 Loading w/ WWTF + Landfill	**13,369**	**Tech. Bul. w/ WWTF+Landfill**	**12,109**	**0.556247944**
CRITICAL LOADING CAPACITY (kg/yr)	**-**	**CRITICAL LOADING CAPACITY (kg/yr)**	**-**	
CAPACITY TO LOAD (kg/yr)	**(13,369)**	**CAPACITY TO LOAD (kg/yr)**	**(12,109)**	18622 at 880,000 gpd @ WWTF
gpd to load @ stated wastewater concentration	(276,483)	gpd to load @ stated wastewater concentration	(250,417)	
ALTERNATIVE SCENARIOS				
POTENTIAL DEVELOPMENT EFFECTS				
DEVELOPABLE RESIDENTIAL PARCELS				
State Class Codes	130/131			
Total Developable Area (ft2)=	2,810,265			
Zoning Required Lot Size (ft2)=				
# of buildable lots=		90		
%BUILDOUT	100%			
% Year Round Units	62%			
	Title 5 Assumptions	**Technical Bulletin Assumptions**		
Potential Additional Water Used (gpd)=	22,149	15,652		
Potential Additional Wastewater Recharge (gal/yr)=	8,084,442	5,713,035		
Potential Addnl. NO3 @ Res. Build-out (kg/yr)=	1,243	929		
Roof Loading (kg/yr)=	13		13	
Road Loading (kg/yr)=	6		6	
Lawn Loading (kg/yr)=	153		153	
Wastewater NO3 Loading (kg/yr)=	1,071	757		
NO3 Loading @ Residential Buildout (kg/yr)=	**14,612**	**13,038**		
Capacity to Further Load (kg/yr)	**(14,612)**	**(13,038)**		
DEVELOPABLE COMMERCIAL PARCELS				
State Class Codes	# of Parcels			

390/391	14			
% BUILDOUT=	100%			
Developable Commercial Area (ft2) =	2,536,494			
Average Developable Parcel Size (ft2) =	181,178	Maximums		
Average 300's (gpd)=	75	150		gpd (Maximum Commercial Water Use)
Potential Water Use of Com. Parcels (gpd)=	62,778	2,100		gpd
Potential Addnl. Nitrogen (kg/yr, based on 35mg/L)	3,215	281		kg/yr (based on 35mg/L)
NO3 Loading @ Comm. Build-out (kg/yr)	15,324	12,390		kg/yr
Nitrogen Loading at Buildout Scenario				
% BUILDOUT:	**100%**			
	Nitrogen (kg/yr)			
Potential New Commercial:	3,215	**Technical Bulletin assumptions.**		
Potential New Residential:	929	**Technical Bulletin assumptions.**		
Potential New Comm. and Resid.:	4,144	**Technical Bulletin assumptions.**		
Total @ Buildout Levels:	**16,253**	**Technical Bulletin assumptions.**		
Capacity to Load (kg/yr):	**(16,253)**	**Technical Bulletin assumptions.**		
NITROGEN LOADING RESULTS				
PRESENT CONDITIONS				
Residential nitrogen loading (kg/yr):	2,373			
Commercial nitrogen loading (kg/yr):	135			
Nitrogen Loading (kg/yr):	**12,109**			
Capacity to Load (kg/yr):	**(12,109)**			
gpd to load at stated wastewater concentration:	(250,417)			
FUTURE CONDITIONS				
Buildout Scenario:	100%			
% Year Round Units:	62%			
Residential nitrogen loading (kg/yr):	3,302			
Commercial nitrogen loading (kg/yr):	3,351			
Nitrogen Loading (kg/yr):	**16,253**	22767 @ 880,000 gpd @ WWTF		
% Change from current conditions:	**34%**			
Capacity to Load (kg/yr):	**(16,253)**			

Embayment Parcel Total	347	26695670	0	
Ponds		686506	0	
Roads		3106264		
Embayment Area	1	794534	0	
		31282974	0	
Critical Loading Level		GIS area to Parcel Area difference	30488440	-2.63
GIS Area		% difference between GIS and Parcel Area		

LAND USE SUMMARY — Oyster Pond and Harbor Head

LAND USE DESCRIPTION	STATE CLASS CODE	# OF PARCELS	AREA (sq. ft.)
Single Family Residential	101/102	159	7,360,107
Two-Family Residential	104/109	15	577,482
Multi-Family Residential	105/111/112/121	0	-
Condominium Units	102	1	20,865
Other Residential	106	0	-
Commercial			
Motels	301	0	-
Inns/Bed and Breakfasts	302	2	203,215
Hotel	301	0	0
Warehouse Construction Supply Stores	321	0	-
Lumber Yards	313	0	0
Supermarkets	324	0	-
Small Retail/Service Stores	318/322/323/325/343/364	0	-
Restaurant	326	0	-
Automotive/Marine	310/315/330/331/332/333 338/334/337/354/384	0	-
Car Wash	335	0	-
Office Building	13/31/340/341/342/ 350/402	0	-
Day Care Centers	352	0	0
Fraternal Organizations/Museums	353/360	0	0
Funeral Home	355	0	-
Golf Courses/Cranberry Bogs/Agricultural	380/393/710/712/717/ 718/719/805	0	-
Manufacturing	316/400/401	0	0
Research and Development Facility	404	0	-
Mining Sand/Gravel	410	6	2,897,527
Other Commercial (No Bldgs.)	366/369/375/381/386/ 424//425/431/814	0	-
Beaches/Swimming Pools	383	0	0
Federal Owned	900	0	-
State Owned	901	3	793,660
County Owned	902	0	-
Town-Owned	903/907/908	13	4,923,534
Nursing Home	303/304	0	-
Colleges/Private School/Summer Camps	123/351/374/387/904	1	121,556
Non-Profit Organizations	905/909/910/920	8	792,039
Churches, Synagogues	906	0	-
DEVELOPABLE			
-Residential	130/131	110	6,958,563
-Commercial	390/391/440/441	0	-
UNDEVELOPABLE	132/201/202/220/301/392/423 /428/430/433/442/720/801/80 3/807	29	2,161,871
Roads	R		3,106,264
Ponds	P		686,506
	TOTAL	347	30,603,188

NOTE: Total figures for # of parcels and area are based upon a residential parcel criteria of >50% located within recharge area and the inclusion of all other parcels.

Difference in GIS area to parcel area (acres):	-2.63	
% difference in GIS area to parcel area:	0.00%	
Bedrooms Assumed:	3	/residential (1X for 13/31/101) (2x for 104/109) (3x for 105/111)
1990 Census Average Occupancy:	2.48	ppl/house (1X for 13/31/101) (2x for 104/109) (3x for 105/111)
%Year Round Residences (1990 Census):	62.1%	
Year Round Occupancy (1990 Census):	2.48	ppl/house (1X for 13/31/101) (2x for 104/109) (3x for 105/111)
Seasonal Occupancy (1990 Census):	5.00	ppl/house (1X for 13/31/101) (2x for 104/109) (3x for 105/111)

AREAS USED IN NITROGEN LOADING

	(Sq. ft.)
TOTAL CONTRIBUTING AREA	30,603,188

Roads	3,106,264			
Paved	155,238	Residential (500 ft2/lot); 1/3 of Commercial		
Roof	417,738	Residential (2000 ft2/lot); 1/3 of Commercial		
Lawn	942,738	Residential (5000 ft2/lot); 70% of Golf Course & Agriculture		
NATURAL AREA	25,981,209	All State code 410 parcels are natural land		
DEVELOPABLE AREA	6,958,563			
UNDEVELOPABLE AREA (132/202/442/910/920)	2,953,910			
EMBAYMENT WATER SURFACE AREA	794,534			
ASSUMED VALUES FOR NITROGEN LOADING				
Impervious Recharge Rate (in/yr) =	40	Average Lawn Size (ft.2) =	5000	
Roof Runoff Concentration (mg/l) =	0.75	Recharge Rate (in./yr.) =	21	
Road Runoff Concentration (mg/l) =	1.50	Fertilizer Applic. Rate (lbs./1000ft2*yr) =	3	
Lawn Nitrogen Leaching (%)	25%	Natural Area Concentration (mg./1) =	0.05	
Wastewater Concentration (mg/l) =	35	Precipitation Rate (in/yr) =	44.44444444	
WWTP Irrigation Conc. (mg/l)=	0	WWTP Irrigation Leaching (%)=	55%	
WWTP Bed Conc. (mg/l)=	0	WWTP Bed Leaching (%)=	98%	
Landfill (mg/l) =	15	WWTP Flow to Irrigation (%) =	82%	
Landfill Area (acres) =	0	WWTP Flow to Beds (%)=	18%	
Median Septage Concentration (mg/l) =		Treatment Plant (mg/l)=	10	
Recharge Values				
Lawn Recharge (gal/yr)=	12,341,304	Impervious Recharge (gal/yr)=	91,742,108	
Natural Area Recharge (gal/yr)=	350,518,851	Roof Recharge (gal/yr)=	10,416,337	
[redacted]	[redacted]	Road and Paved Recharge (gal/yr)=	81,325,772	
WASTEWATER ESTIMATES				
Title 5	**(Gallons/Day)**	**Technical Bulletin**	**(Gallons/Day)**	
Total Title 5 Residential	46,513	Technical Bulletin Residential	33,617	
Total Title 5 Commercial	10,271	Total 1993 Commercial Water Use	12,494	
Motels		Motels		
Inns/Bed and Breakfasts		Inns/Bed and Breakfasts	-	
Nursing Homes		Nursing Homes	-	
Small Retail/Service Stores		Small Retail/Service Stores	-	
Veterinary Clinic		Veterinary Clinic	-	
Restaurant		Restaurant	-	
Automotive/Marine		Automotive/Marine	-	
Office Building		Office Building	-	
Funeral Home		Funeral Home	-	
Manufacturing/ Storage Facilities		Manufacturing/ Storage Facilities	-	
Golf Course/Agricultural		Golf Course/Agricultural	-	
Group Homes, Churches, Non-Profit		Group Homes, Churches, Non-Profit	-	
Research and Development Facility		Research and Development Facility	-	
Theater		Tennis Club	-	
Recreation Facility		Recreation Facility	-	
Fire Dept.		Fire Dept.	-	
Total Title 5 Flow	**56,785**	**Total Technical Bulletin Flow**	**46,111**	
Landfill Facility	-	Landfill Facility	-	
Wastewater Treatment Facility	-	Wastewater Treatment Facility	-	
Total Title 5 Flow and Wastewater Flow	**56,785**	**Total Tech Bul. Flow and Wastewater Flow**	**46,111**	
Roof Recharge	28,538	Roof Recharge	28,538	Roof Area * 40 in/yr
Road and Paved Recharge	222,810	Paved Recharge	222,810	Paved Area * 40 in/yr
Lawn Recharge	33,812	Lawn Recharge	33,812	Lawn Area * 21 in/yr
Natural Area Recharge	960,326	Natural Area Recharge	960,326	Natural Area * 21 in/yr
Total Recharge	**1,302,270**	**Total Recharge**	**1,291,597**	
NITROGEN LOADING (EXISTING CONDITIONS)				
	(kg/yr)		(kg/yr)	
Title 5 Wastewater Loading	2,746	Tech. Bul. Wastewater Loading	2,230	
Total Impervious Loading	491	Total Impervious Loading	491	
Roof Loading	30	Roof Loading	30	Roof Area Recharge*Concentration
Paved Loading	462	Paved Loading	462	Paved Area*Recharge*Concentration
Lawn Loading	321	Lawn Loading	321	Lawn Area*Fertilizer Rate*Leaching Rate
Natural Area Loading	[redacted]	Natural Area Loading	129	Natural Area*Recharge*Concentration
Title 5 Total Loading	**3,687**	**Technical Bulletin Total Loading**	**3,170**	
Landfill Loading	-	Landfill Loading	-	
WWTF (Beds)	-	WWTF (Beds)	-	
WWTF (Irrigation)	-	WWTF (Irrigation)	-	
WWTF Loading	-	WWTF Loading	-	
Septage Lagoon Loading	-	Septage Lagoon Loading	-	
Title 5 Loading w/ WWTF + Landfill	**3,687**	**Tech. Bul. w/ WWTF+Landfill**	**3,170**	

CRITICAL LOADING CAPACITY (kg/y	-	**CRITICAL LOADING CAPACITY (kg/yr)**	-	
CAPACITY TO LOAD (kg/yr)	**(3,687)**	**CAPACITY TO LOAD (kg/yr)**	**(3,170)**	
gpd to load @ stated wastewater concentration	(76,242)	gpd to load @ stated wastewater concentration	(65,568)	
ALTERNATIVE SCENARIOS				
POTENTIAL DEVELOPMENT EFFECTS				
DEVELOPABLE RESIDENTIAL PARCELS				
State Class Codes	130/131			
Total Developable Area (ft2)=	6,958,563			
Zoning Required Lot Size (ft2)=				
# of buildable lots=	184			
%BUILDOUT	100%			
% Year Round Units	62%			
	Title 5 Assumptions	**Technical Bulletin Assumptions**		
Potential Additional Water Used (gpd)=	45,209	31,948		
Potential Additional Wastewater Recharge (gal/yr)=	16,501,245	11,660,939		
Potential Addnl. NO3 @ Res. Build-out (kg/yr)=	2,538	1,897		
Roof Loading (kg/yr)=	26	26		
Road Loading (kg/yr)=	13	13		
Lawn Loading (kg/yr)=	313	313		
Wastewater NO3 Loading (kg/yr)=	2,186	1,545		
NO3 Loading @ Residential Buildout (kg/yr)=	6,224	5,067		
Capacity to Further Load (kg/yr)	(6,224)	(5,067)		
DEVELOPABLE COMMERCIAL PARCELS				
State Class Codes	# of Parcels			
390/391	-			
% BUILDOUT=	100%			
Developable Commercial Area (ft2) =	-			
Average Developable Parcel Size (ft2) =	-	**Maximums**		
Average 300's (gpd)=	75	150	gpd (Maximum Commercial Water Use)	
Potential Water Use of Com. Parcels (gpd)=	-	-	gpd	
Potential Addnl. Nitrogen (kg/yr, based on 35mg/L)	-	-	kg/yr (based on 35mg/L)	
NO3 Loading @ Comm. Build-out (kg/yr)	3,170	3,170	kg/yr	
Nitrogen Loading at Buildout Scenario				
% BUILDOUT:	100%			
	Nitrogen (kg/yr)			
Potential New Commercial:	-	**Technical Bulletin assumptions.**		
Potential New Residential:	1,897	**Technical Bulletin assumptions.**		
Potential New Comm. and Resid.:	1,897	**Technical Bulletin assumptions.**		
Total @ Buildout Levels:	5,067	**Technical Bulletin assumptions.**		
Capacity to Load (kg/yr):	(5,067)	**Technical Bulletin assumptions.**		
NITROGEN LOADING RESULTS				
PRESENT CONDITIONS				
Residential nitrogen loading (kg/yr):	1,625			
Commercial nitrogen loading (kg/yr):	604			
Nitrogen Loading (kg/yr):	**3,170**			
Capacity to Load (kg/yr):	**(3,170)**			
gpd to load at stated wastewater concentration:	(65,568)			
FUTURE CONDITIONS				
Buildout Scenario:	100%			
% Year Round Units:	62%			
Residential nitrogen loading (kg/yr):	3,522			
Commercial nitrogen loading (kg/yr):	604			
Nitrogen Loading (kg/yr):	**5,067**			
% Change from current conditions:	**60%**			
Capacity to Load (kg/yr):	**(5,067)**			

Embayment Parcel Total	94	8575172	0	
Ponds		0	0	
Roads		1198771		
Embayment Area	1	296208	0	
		10070151	0	
Critical Loading Level		GIS area to Parcel Area difference	9773943	-0.03
GIS Area		% difference between GIS and Parcel Area		
LAND USE SUMMARY	**Oyster Pond**			
LAND USE DESCRIPTION	**STATE CLASS CODE**	**# OF PARCELS**	**AREA (sq. ft.)**	
Single Family Residential	101/103	22	789,619	
Two-Family Residential	104/109	7	313,239	
Multi-Family Residential	105/111/112/121	0	-	
Condominium Units	102	0	-	
Other Residential	106	0	-	
Commercial				
Motels	301	0	-	
Inns/Bed and Breakfasts	302	0	-	
Hotel	301	0	0	
Warehouse Construction Supply Stores	321	0	-	
Lumber Yards	313	0	0	
Supermarkets	324	0	-	
Small Retail/Service Stores	318/322/323/325/343/364	0	-	
Restaurant	326	0	-	
Automotive/Marine	310/315/330/331/332/333 338/334/337/354/384	0	-	
Car Wash	335	0	-	
Office Building	13/31/340/341/342/ 350/402	0	-	
Day Care Centers	352	0	0	
Fraternal Organizations/Museums	353/360	0	0	
Funeral Home	355	0	-	
Golf Courses/Cranberry Bogs/Agricultural	380/393/710/712/717/ 718/719/805	0	-	
Manufacturing	316/400/401	0	0	
Research and Development Facility	404	0	-	
Mining Sand/Gravel	410	0	-	
Other Commercial (No Bldgs.)	366/369/375/381/386/ 424//425/431/814	0	-	
Beaches/Swimming Pools	383	0	0	
Federal Owned	900	0	-	
State Owned	901	1	621,306	
County Owned	902	0	-	
Town-Owned	903/907/908	6	2,278,035	
Nursing Home	303/304	0	-	
Colleges/Private School/Summer Camps	123/351/374/387/904	0	-	
Non-Profit Organizations	905/909/910/920	2	555,388	
Churches, Synagogues	906	0	-	
DEVELOPABLE				
-Residential	130/131	50	2,574,115	
-Commercial	390/391/440/441	0	-	
UNDEVELOPABLE	132/201/202/220/301/392/4 23/428/430/433/442/720/80 1/803/807	6	1,444,822	
Roads	R		1,198,771	
Ponds	P		-	
	TOTAL	94	9,775,296	
NOTE: Total figures for # of parcels and area are based upon a residential parcel criteria of >50% located within recharge area and the inclusion of all other parcels.				
Difference in GIS area to parcel area (acres):	-0.03			
% difference in GIS area to parcel area:	0.00%			
Bedrooms Assumed:	3	/residential (1X for 13/31/101) (2x for 104/109) (3x for 105/111)		
1990 Census Average Occupancy:	2.48	ppl/house (1X for 13/31/101) (2x for 104/109) (3x for 105/111)		
%Year Round Residences (1990 Census):	62.1%			
Year Round Occupancy (1990 Census):	2.48	ppl/house (1X for 13/31/101) (2x for 104/109) (3x for 105/111)		
Seasonal Occupancy (1990 Census):	5.00	ppl/house (1X for 13/31/101) (2x for 104/109) (3x for 105/111)		
AREAS USED IN NITROGEN LOADING				
	(Sq. ft.)			
TOTAL CONTRIBUTING AREA	9,775,296			

Roads	1,198,771			
Paved	14,500	Residential (500 ft2/lot); 1/3 of Commercial		
Roof	58,000	Residential (2000 ft2/lot); 1/3 of Commercial		
Lawn	145,000	Residential (5000 ft2/lot); 70% of Golf Course & Agriculture		
NATURAL AREA	8,359,025	All State code 410 parcels are natural land		
DEVELOPABLE AREA	2,574,115			
UNDEVELOPABLE AREA (132/202/442/910/92	2,000,211			
EMBAYMENT WATER SURFACE AREA	296,208			
ASSUMED VALUES FOR NITROGEN LOADING				
Impervious Recharge Rate (in/yr) =	40	Average Lawn Size (ft.2) =	5000	
Roof Runoff Concentration (mg/l) =	0.75	Recharge Rate (in./yr.) =	21	
Road Runoff Concentration (mg/l) =	1.50	Fertilizer Applic. Rate (lbs./1000ft2*yr) =	3	
Lawn Nitrogen Leaching (%)	25%	Natural Area Concentration (mg./l) =	0.05	
Wastewater Concentration (mg/l) =	35	Precipitation Rate (in/yr) =	44.44444444	
WWTP Irrigation Conc. (mg/l)=	0	WWTP Irrigation Leaching (%)=	55%	
WWTP Bed Conc. (mg/l)=	0	WWTP Bed Leaching (%)=	98%	
Landfill (mg/l) =	15	WWTP Flow to Irrigation (%) =	82%	
Landfill Area (acres) =	0	WWTP Flow to Beds (%)=	18%	
Median Septage Concentration (mg/l) =		Treatment Plant (mg/l)=	10	
Recharge Values				
Lawn Recharge (gal/yr)=	1,898,182	Impervious Recharge (gal/yr)=	31,699,232	
Natural Area Recharge (gal/yr)=	113,304,874	Roof Recharge (gal/yr)=	1,446,234	
[redacted]	[redacted]	Road and Paved Recharge (gal/yr)=	30,252,998	
WASTEWATER ESTIMATES				
Title 5	**(Gallons/Day)**	**Technical Bulletin**	**(Gallons/Day)**	
Total Title 5 Residential	8,860	Technical Bulletin Residential	6,156	
Total Title 5 Commercial	10,271	Total 1993 Commercial Water Use	3,784	
Motels		Motels		
Inns/Bed and Breakfasts		Inns/Bed and Breakfasts	-	
Nursing Homes		Nursing Homes	-	
Small Retail/Service Stores		Small Retail/Service Stores	-	
Veterinary Clinic		Veterinary Clinic	-	
Restaurant		Restaurant	-	
Automotive/Marine		Automotive/Marine	-	
Office Building		Office Building	-	
Funeral Home		Funeral Home	-	
Manufacturing/ Storage Facilities		Manufacturing/ Storage Facilities	-	
Golf Course/Agricultural		Golf Course/Agricultural	-	
Group Homes, Churches, Non-Profit		Group Homes, Churches, Non-Profit	-	
Research and Development Facility		Research and Development Facility	-	
Theater		Tennis Club	-	
Recreation Facility		Recreation Facility	-	
Fire Dept.		Fire Dept.	-	
Total Title 5 Flow	**19,131**	**Total Technical Bulletin Flow**	**9,941**	
Landfill Facility	-	Landfill Facility	-	
Wastewater Treatment Facility	-	Wastewater Treatment Facility	-	
Total Title 5 Flow and Wastewater Flow	**19,131**	**Total Tech Bul. Flow and Wastewater Flow**	**9,941**	
Roof Recharge	3,962	Roof Recharge	3,962	Roof Area * 40 in/yr
Road and Paved Recharge	82,885	Paved Recharge	82,885	Paved Area * 40 in/yr
Lawn Recharge	5,200	Lawn Recharge	5,200	Lawn Area * 21 in/yr
Natural Area Recharge	310,424	Natural Area Recharge	310,424	Natural Area * 21 in/yr
Total Recharge	**421,603**	**Total Recharge**	**412,413**	
NITROGEN LOADING (EXISTING CONDITIONS)				
	(kg/yr)		(kg/yr)	
Title 5 Wastewater Loading	925	Tech. Bul. Wastewater Loading	481	
Total Impervious Loading	176	Total Impervious Loading	176	
Roof Loading	4	Roof Loading	4	Roof Area Recharge*Concentration
Paved Loading	172	Paved Loading	172	Paved Area*Recharge*Concentration
Lawn Loading	49	Lawn Loading	49	Lawn Area*Fertilizer Rate*Leaching Rate
Natural Area Loading	[redacted]	Natural Area Loading	45	Natural Area*Recharge*Concentration
Title 5 Total Loading	**1,195**	**Technical Bulletin Total Loading**	**751**	
Landfill Loading	-	Landfill Loading	-	
WWTF (Beds)	-	WWTF (Beds)	-	
WWTF (Irrigation)	-	WWTF (Irrigation)	-	
WWTF Loading	-	WWTF Loading	-	
Septage Lagoon Loading	-	Septage Lagoon Loading	-	

Title 5 Loading w/ WWTF + Landfill	**1,195**	**Tech. Bul. w/ WWTF+Landfill**	**751**	
CRITICAL LOADING CAPACITY (kg	**-**	**CRITICAL LOADING CAPACITY (kg/yr**	**-**	
CAPACITY TO LOAD (kg/yr)	**(1,195)**	**CAPACITY TO LOAD (kg/yr)**	**(751)**	
gpd to load @ stated wastewater concentration	(24,713)	gpd to load @ stated wastewater concentration	(15,523)	
ALTERNATIVE SCENARIOS				
POTENTIAL DEVELOPMENT EFFECTS				
DEVELOPABLE RESIDENTIAL PARCELS				
State Class Codes	130/131			
Total Developable Area (ft2)=	2,574,115			
Zoning Required Lot Size (ft2)=				
# of buildable lots=	58			
%BUILDOUT	100%			
% Year Round Units	62%			
	Title 5 Assumptions	**Technical Bulletin Assumptions**		
Potential Additional Water Used (gpd)=	14,299	10,104		
Potential Additional Wastewater Recharge (gal/yr)	**5,218,957**	**3,688,081**		
Potential Addnl. NO3 @ Res. Build-out (kg/yr)=	**803**	**600**		
Roof Loading (kg/yr)=	8	8		
Road Loading (kg/yr)=	4	4		
Lawn Loading (kg/yr)=	99	99		
Wastewater NO3 Loading (kg/yr)=	691	489		
NO3 Loading @ Residential Buildout (kg/yr)=	**1,998**	**1,350**		
Capacity to Further Load (kg/yr)	**(1,998)**	**(1,350)**		
DEVELOPABLE COMMERCIAL PARCELS				
State Class Codes	# of Parcels			
390/391	-			
% BUILDOUT=	100%			
Developable Commercial Area (ft2) =	-			
Average Developable Parcel Size (ft2) =	-	**Maximums**		
Average 300's (gpd)=	75	150	gpd (Maximum Commercial Water Use)	
Potential Water Use of Com. Parcels (gpd)=	-	-	gpd	
Potential Addnl. Nitrogen (kg/yr, based on 35mg/L	-	-	kg/yr (based on 35mg/L)	
NO3 Loading @ Comm. Build-out (kg/yr)	**751**	**751**	kg/yr	
Nitrogen Loading at Buildout Scenario				
% BUILDOUT:	**100%**			
	Nitrogen (kg/yr)			
Potential New Commercial:	-	**Technical Bulletin assumptions.**		
Potential New Residential:	600	**Technical Bulletin assumptions.**		
Potential New Comm. and Resid.:	600	**Technical Bulletin assumptions.**		
Total @ Buildout Levels:	**1,350**	**Technical Bulletin assumptions.**		
Capacity to Load (kg/yr):	**(1,350)**	**Technical Bulletin assumptions.**		
NITROGEN LOADING RESULTS				
PRESENT CONDITIONS				
Residential nitrogen loading (kg/yr)	298			
Commercial nitrogen loading (kg/yr)	183			
Nitrogen Loading (kg/yr):	**751**			
Capacity to Load (kg/yr):	**(751)**			
gpd to load at stated wastewater concentration:	(15,523)			
FUTURE CONDITIONS				
Buildout Scenario:	100%			
% Year Round Units:	62%			
Residential nitrogen loading (kg/yr)	898			
Commercial nitrogen loading (kg/yr)	183			
Nitrogen Loading (kg/yr):	**1,350**			
% Change from current conditions:	**80%**			
Capacity to Load (kg/yr):	**(1,350)**			

Ponds		686506	0	
Roads		1907492		
Embayment Area	1	498326	0	
		21212823	0	
Critical Loading Level		GIS area to Parcel Area difference	20714497	-2.60
GIS Area		% difference between GIS and Parcel Area		
LAND USE SUMMARY	**Hbr Hd-Oyster Pond**			
LAND USE DESCRIPTION	**STATE CLASS CODE**	**# OF PARCELS**	**AREA (sq. ft.)**	
Single Family Residential	101/103	137	6,570,488	
Two-Family Residential	104/109	8	264,243	
Multi-Family Residential	105/111/112/121	0	-	
Condominium Units	102	1	20,865	
Other Residential	106	0	-	
Commercial				
Motels	301	0	-	
Inns/Bed and Breakfasts	302	2	203,215	
Hotel	301	0	0	
Warehouse Construction Supply Stores	321	0	-	
Lumber Yards	313	0	0	
Supermarkets	324	0	-	
Small Retail/Service Stores	318/322/323/325/343/364	0	-	
Restaurant	326	0	-	
Automotive/Marine	310/315/330/331/332/333 338/334/337/354/384	0	-	
Car Wash	335	0	-	
Office Building	~~13/31/340/341/342/ 350/402~~	0	-	
Day Care Centers	352	0	0	
Fraternal Organizations/Museums	353/360	0	0	
Funeral Home	355	0	-	
Golf Courses/Cranberry Bogs/Agricultural	380/393/710/712/717/ 718/719/805	0	-	
Manufacturing	316/400/401	0	0	
Research and Development Facility	404	0	-	
Mining Sand/Gravel	410	6	2,897,527	
Other Commercial (No Bldgs.)	366/369/375/381/386/ 424//425/431/814	0	-	
Beaches/Swimming Pools	383	0	0	
Federal Owned	900	0	-	
State Owned	901	2	172,354	
County Owned	902	0	-	
Town-Owned	903/907/908	7	2,645,499	
Nursing Home	303/304	0	-	
Colleges/Private School/Summer Camps	123/351/374/387/904	1	121,556	
Non-Profit Organizations	905/909/910/920	6	236,651	
Churches, Synagogues	906	0	-	
DEVELOPABLE				
-Residential	130/131	60	4,384,448	
-Commercial	390/391/440/441	0	-	
UNDEVELOPABLE	132/201/202/220/301/392/423 /428/430/433/442/720/801/80 3/807	23	717,049	
Roads	R		1,907,492	
Ponds	P		686,506	
	TOTAL	253	20,827,892	
NOTE: Total figures for # of parcels and area are based upon a residential parcel criteria of >50% located within recharge area and the inclusion of all other parcels.				
Difference in GIS area to parcel area (acres):	-2.60			
% difference in GIS area to parcel area:	0.00%			
Bedrooms Assumed:	3	/residential (1X for 13/31/101) (2x for 104/109) (3x for 105/111)		
1990 Census Average Occupancy:	2.48	ppl/house (1X for 13/31/101) (2x for 104/109) (3x for 105/111)		
%Year Round Residences (1990 Census):	62.1%			
Year Round Occupancy (1990 Census):	2.48	ppl/house (1X for 13/31/101) (2x for 104/109) (3x for 105/111)		
Seasonal Occupancy (1990 Census):	5.00	ppl/house (1X for 13/31/101) (2x for 104/109) (3x for 105/111)		
AREAS USED IN NITROGEN LOADING				
	(Sq. ft.)			
TOTAL CONTRIBUTING AREA	20,827,892			
Roads	1,907,492			
Paved	140,738	Residential (500 ft2/lot); 1/3 of Commercial		
Roof	359,738	Residential (2000 ft2/lot); 1/3 of Commercial		
Lawn	797,738	Residential (5000 ft2/lot); 70% of Golf Course & Agriculture		
NATURAL AREA	17,622,184	All State code 410 parcels are natural land		
DEVELOPABLE AREA	4,384,448			
UNDEVELOPABLE AREA (132/202/442/910/920)	953,699			
EMBAYMENT WATER SURFACE AREA	498,326			
ASSUMED VALUES FOR NITROGEN LOADING				
Impervious Recharge Rate (in/yr) =	40	Average Lawn Size (ft.2) =	5000	

Roof Runoff Concentration (mg/l) =	0.75	Recharge Rate (in./yr.) =	21	
Road Runoff Concentration (mg/l) =	1.50	Fertilizer Applic. Rate (lbs./1000ft2*yr) =	3	
Lawn Nitrogen Leaching (%)	25%	Natural Area Concentration (mg./l) =	0.05	
Wastewater Concentration (mg/l) =	35	Precipitation Rate (in/yr) =	44.44444444	
WWTP Irrigation Conc. (mg/l)=	0	WWTP Irrigation Leaching (%)=	55%	
WWTP Bed Conc. (mg/l)=	0	WWTP Bed Leaching (%)=	98%	
Landfill (mg/l) =	15	WWTP Flow to Irrigation (%) =	82%	
Landfill Area (acres) =	0	WWTP Flow to Beds (%)=	18%	
Median Septage Concentration (mg/l) =		Treatment Plant (mg/l)=	10	
Recharge Values				
Lawn Recharge (gal/yr)=	10,443,123	Impervious Recharge (gal/yr)=	60,042,876	
Natural Area Recharge (gal/yr)=	237,213,977	Roof Recharge (gal/yr)=	8,970,103	
[redacted]		Road and Paved Recharge (gal/yr)=	51,072,773	
WASTEWATER ESTIMATES				
Title 5	**(Gallons/Day)**	**Technical Bulletin**	**(Gallons/Day)**	
Total Title 5 Residential	37,654	Technical Bulletin Residential	27,460	
Total Title 5 Commercial	10,271	Total 1993 Commercial Water Use	8,710	
Motels		Motels		
Inns/Bed and Breakfasts		Inns/Bed and Breakfasts	-	
Nursing Homes		Nursing Homes	-	
Small Retail/Service Stores		Small Retail/Service Stores	-	
Veterinary Clinic		Veterinary Clinic	-	
Restaurant		Restaurant	-	
Automotive/Marine		Automotive/Marine	-	
Office Building		Office Building	-	
Funeral Home		Funeral Home	-	
Manufacturing/ Storage Facilities		Manufacturing/ Storage Facilities	-	
Golf Course/Agricultural		Golf Course/Agricultural	-	
Group Homes, Churches, Non-Profit		Group Homes, Churches, Non-Profit	-	
Research and Development Facility		Research and Development Facility	-	
Theater		Tennis Club	-	
Recreation Facility		Recreation Facility	-	
Fire Dept.		Fire Dept.	-	
Total Title 5 Flow	**47,925**	**Total Technical Bulletin Flow**	**36,170**	
Landfill Facility	-	Landfill Facility	-	
Wastewater Treatment Facility	-	Wastewater Treatment Facility	-	
Total Title 5 Flow and Wastewater Flow	**47,925**	**Total Tech Bul. Flow and Wastewater Flow**	**36,170**	
Roof Recharge	24,576	Roof Recharge	24,576	Roof Area * 40 in/yr
Road and Paved Recharge	139,925	Paved Recharge	139,925	Paved Area * 40 in/yr
Lawn Recharge	28,611	Lawn Recharge	28,611	Lawn Area * 21 in/yr
Natural Area Recharge	649,901	Natural Area Recharge	649,901	Natural Area * 21 in/yr
Total Recharge	**890,939**	**Total Recharge**	**879,184**	
NITROGEN LOADING (EXISTING CONDITIONS)				
	(kg/yr)		(kg/yr)	
Title 5 Wastewater Loading	2,317	Tech. Bul. Wastewater Loading	1,749	
Total Impervious Loading	315	Total Impervious Loading	315	
Roof Loading	25	Roof Loading	25	Roof Area Recharge*Concentration
Paved Loading	290	Paved Loading	290	Paved Area*Recharge*Concentration
Lawn Loading	271	Lawn Loading	271	Lawn Area*Fertilizer Rate*Leaching Rate
Natural Area Loading	[redacted]	Natural Area Loading	84	Natural Area*Recharge*Concentration
Title 5 Total Loading	**2,988**	**Technical Bulletin Total Loading**	**2,420**	
Landfill Loading	-	Landfill Loading	-	
WWTF (Beds)	-	WWTF (Beds)	-	
WWTF (Irrigation)	-	WWTF (Irrigation)	-	
WWTF Loading	-	WWTF Loading	-	
Septage Lagoon Loading	-	Septage Lagoon Loading	-	
Title 5 Loading w/ WWTF + Landfill	**2,988**	**Tech. Bul. w/ WWTF+Landfill**	**2,420**	**2470**
CRITICAL LOADING CAPACITY (kg/yr	-	**CRITICAL LOADING CAPACITY (kg/yr)**	-	
CAPACITY TO LOAD (kg/yr)	**(2,988)**	**CAPACITY TO LOAD (kg/yr)**	**(2,420)**	
gpd to load @ stated wastewater concentration	(61,800)	gpd to load @ stated wastewater concentration	(50,045)	
ALTERNATIVE SCENARIOS				
POTENTIAL DEVELOPMENT EFFECTS				
DEVELOPABLE RESIDENTIAL PARCELS				
State Class Codes	130/131			
Total Developable Area (ft2)=	4,384,448			
Zoning Required Lot Size (ft2)=				
# of buildable lots=	126			
%BUILDOUT	100%			
% Year Round Units	62%			
	Title 5 Assumptions	**Technical Bulletin Assumptions**		
Potential Additional Water Used (gpd)=	30,910	21,843		
Potential Additional Wastewater Recharge (gal/yr)=	**11,282,289**	**7,972,857**		
Potential Addnl. NO3 @ Res. Build-out (kg/yr)=	**1,735**	**1,297**		
Roof Loading (kg/yr)=	18	18		
Road Loading (kg/yr)=	9	9		
Lawn Loading (kg/yr)=	214	214		

Wastewater NO3 Loading (kg/yr)=	1,495	1,056		
NO3 Loading @ Residential Buildout (kg/yr)=	**4,723**	**3,717**		
Capacity to Further Load (kg/yr)	**(4,723)**	**(3,717)**		
DEVELOPABLE COMMERCIAL PARCELS				
State Class Codes	# of Parcels			
390/391	-			
% BUILDOUT=	100%			
Developable Commercial Area (ft2) =	-			
Average Developable Parcel Size (ft2) =	-	**Maximums**		
Average 300's (gpd)=	75	150	gpd (Maximum Commercial Water Use)	
Potential Water Use of Com. Parcels (gpd)=	-	-	gpd	
Potential Addnl. Nitrogen (kg/yr, based on 35mg/L)	-	-	kg/yr (based on 35mg/L)	
NO3 Loading @ Comm. Build-out (kg/yr)	**2,420**	**2,420**	kg/yr	
Nitrogen Loading at Buildout Scenario				
% BUILDOUT:	**100%**			
	Nitrogen (kg/yr)			
Potential New Commercial:	-	**Technical Bulletin assumptions.**		
Potential New Residential:	1,297	**Technical Bulletin assumptions.**		
Potential New Comm. and Resid.:	1,297	**Technical Bulletin assumptions.**		
Total @ Buildout Levels:	**3,717**	**Technical Bulletin assumptions.**		
Capacity to Load (kg/yr):	**(3,717)**	**Technical Bulletin assumptions.**		
NITROGEN LOADING RESULTS				
PRESENT CONDITIONS				
Residential nitrogen loading (kg/yr):	1,328			
Commercial nitrogen loading (kg/yr):	421			
Nitrogen Loading (kg/yr):	**2,420**			
Capacity to Load (kg/yr):	**(2,420)**			
gpd to load at stated wastewater concentration:	(50,045)			
FUTURE CONDITIONS				
Buildout Scenario:	100%			
% Year Round Units:	62%			
Residential nitrogen loading (kg/yr):	2,625			
Commercial nitrogen loading (kg/yr):	421			
Nitrogen Loading (kg/yr):	**3,717**	2470		
% Change from current conditions:	**54%**			
Capacity to Load (kg/yr):	**(3,717)**			

Embayment Parcel Total	1152	84822027	0	
Ponds		1687950	0	
Roads		9081389		
Embayment Area	1	9008644	0	
		104600009	0	
Critical Loading Level		GIS area to Parcel Area difference	95591366	-12.58
GIS Area		% difference between GIS and Parcel Area		

LAND USE SUMMARY — West Falmouth Harbor (whole)

LAND USE DESCRIPTION	STATE CLASS CODE	# OF PARCELS	AREA (sq. ft.)
Single Family Residential	101/103	620	23,417,759
Two-Family Residential	104/109	34	2,650,455
Multi-Family Residential	105/111/112/121	6	195,058
Condominium Units	102	3	385,820
Other Residential	106	12	528,967
Commercial			
Motels	301	2	93,419
Inns/Bed and Breakfasts	302	3	259,981
Hotel	301	2	93419
Warehouse Construction Supply Stores	321	0	-
Lumber Yards	313	0	0
Supermarkets	324	0	-
Small Retail/Service Stores	318/322/323/325/343/364	4	93,314
Restaurant	326	1	144,330
Automotive/Marine	310/315/330/331/332/333 338/334/337/354/384	3	33,331
Car Wash	335	0	-
Office Building	13/31/340/341/342/ 350/402	1	10,569
Day Care Centers	352	0	0
Fraternal Organizations/Museums	353/360	0	0
Funeral Home	355	1	57,673
Golf Courses/Cranberry Bogs/Agricultural	380/393/710/712/717/ 718/719/805	2	135,750
Manufacturing	316/400/401	7	1223693
Research and Development Facility	404	2	388,110
Mining Sand/Gravel	410	16	6,385,552
Other Commercial (No Bldgs.)	366/369/375/381/386/ 424//425/431/814	1	155,582
Beaches/Swimming Pools	383	0	0
Federal Owned	900	0	-
State Owned	901	8	2,775,304
County Owned	902	0	-
Town-Owned	903/907/908	66	23,432,113
Nursing Home	303/304	0	-
Colleges/Private School/Summer Camps	123/351/374/387/904	2	141,955
Non-Profit Organizations	905/909/910/920	29	1,966,478
Churches, Synagogues	906	5	196,261
DEVELOPABLE			
-Residential	130/131	211	12,446,304
-Commercial	390/391/440/441	20	3,865,456
UNDEVELOPABLE	132/201/202/220/301/392/4 23/428/430/433/442/720/80 1/803/807	93	4,293,252
Roads	R		9,081,389
Ponds	P		1,687,950
	TOTAL	1154	96,139,242

NOTE: Total figures for # of parcels and area are based upon a residential parcel criteria of >50% located within recharge area and the inclusion of all other parcels.

Difference in GIS area to parcel area (acres):	-12.58	
% difference in GIS area to parcel area:	0.00%	
Bedrooms Assumed:	3	/residential (1X for 13/31/101) (2x for 104/109) (3x for 105/111)
1990 Census Average Occupancy:	2.48	ppl/house (1X for 13/31/101) (2x for 104/109) (3x for 105/111)
%Year Round Residences (1990 Census):	62.1%	
Year Round Occupancy (1990 Census):	2.48	ppl/house (1X for 13/31/101) (2x for 104/109) (3x for 105/111)
Seasonal Occupancy (1990 Census):	5.00	ppl/house (1X for 13/31/101) (2x for 104/109) (3x for 105/111)

AREAS USED IN NITROGEN LOADING

	(Sq. ft.)
TOTAL CONTRIBUTING AREA	96,139,242

Roads	9,081,389			
Paved	1,247,449	Residential (500 ft2/lot); 1/3 of Commercial		
Roof	2,259,949	Residential (2000 ft2/lot); 1/3 of Commercial		
Lawn	4,379,974	Residential (5000 ft2/lot); 70% of Golf Course & Agriculture		
NATURAL AREA	79,170,481	All State code 410 parcels are natural land		
DEVELOPABLE AREA	16,311,760			
UNDEVELOPABLE AREA (132/202/442/910/920	6,259,730			
EMBAYMENT WATER SURFACE AREA	9,008,644			
ASSUMED VALUES FOR NITROGEN LOADING				
Impervious Recharge Rate (in/yr) =	40	Average Lawn Size (ft.2) =	5000	
Roof Runoff Concentration (mg/l) =	0.75	Recharge Rate (in./yr.) =	21	
Road Runoff Concentration (mg/l) =	1.50	Fertilizer Applic. Rate (lbs./1000ft2*yr) =	3	
Lawn Nitrogen Leaching (%)	25%	Natural Area Concentration (mg./l) =	0.05	
Wastewater Concentration (mg/l) =	35	Precipitation Rate (in/yr) =	44.44444444	
WWTP Irrigation Conc. (mg/l)=	17	WWTP Irrigation Leaching (%)=	55%	
WWTP Bed Conc. (mg/l)=	17	WWTP Bed Leaching (%)=	98%	
Landfill (mg/l) =	15	WWTP Flow to Irrigation (%) =	82%	
Landfill Area (acres) =	40	WWTP Flow to Beds (%)=	18%	
Median Septage Concentration (mg/l) =	32	Treatment Plant (mg/l)=	10	
Recharge Values				
Lawn Recharge (gal/yr)=	57,337,848	Impervious Recharge (gal/yr)=	313,902,250	
Natural Area Recharge (gal/yr)=	1,154,344,981	Roof Recharge (gal/yr)=	56,351,985	
Precipitation on Embayment Surface (gal/yr)=	2,959,013	Road and Paved Recharge (gal/yr)=	257,550,265	
WASTEWATER ESTIMATES				
Title 5	(Gallons/Day)	**Technical Bulletin**	(Gallons/Day)	
Total Title 5 Residential	173,748	Technical Bulletin Residential	126,170	
Total Title 5 Commercial	10,271	Total 1993 Commercial Water Use	11,225	
Motels		Motels		
Inns/Bed and Breakfasts		Inns/Bed and Breakfasts	-	
Nursing Homes		Nursing Homes	-	
Small Retail/Service Stores		Small Retail/Service Stores	-	
Veterinary Clinic		Veterinary Clinic	-	
Restaurant		Restaurant	-	
Automotive/Marine		Automotive/Marine	-	
Office Building		Office Building	-	
Funeral Home		Funeral Home	-	
Manufacturing/ Storage Facilities		Manufacturing/ Storage Facilities	-	
Golf Course/Agricultural		Golf Course/Agricultural	-	
Group Homes, Churches, Non-Profit		Group Homes, Churches, Non-Profit	-	
Research and Development Facility		Research and Development Facility	-	
Theater		Tennis Club	-	
Recreation Facility		Recreation Facility	-	
Fire Dept.		Fire Dept.	-	
Total Title 5 Flow	**184,019**	**Total Technical Bulletin Flow**	**137,395**	
Landfill Facility	119,032	Landfill Facility	119,032	
Wastewater Treatment Facility	447,359	Wastewater Treatment Facility	447,359	
Total Title 5 Flow and Wastewater Flow	**750,411**	**Total Tech Bul. Flow and Wastewater Flow**	**703,787**	
Roof Recharge	154,389	Roof Recharge	154,389	Roof Area * 40 in/yr
Road and Paved Recharge	705,617	Paved Recharge	705,617	Paved Area * 40 in/yr
Lawn Recharge	157,090	Lawn Recharge	157,090	Lawn Area * 21 in/yr
Natural Area Recharge	3,162,589	Natural Area Recharge	3,162,589	Natural Area * 21 in/yr
Total Recharge	**4,930,096**	**Total Recharge**	**4,883,472**	
NITROGEN LOADING (EXISTING CONDITIONS)				
	(kg/yr)		(kg/yr)	
Title 5 Wastewater Loading	8,898	Tech. Bul. Wastewater Loading	6,644	
Total Impervious Loading	1,622	Total Impervious Loading	1,622	
Roof Loading	160	Roof Loading	160	Roof Area Recharge*Concentration
Paved Loading	1,462	Paved Loading	1,462	Paved Area*Recharge*Concentration
Lawn Loading	1,490	Lawn Loading	1,490	Lawn Area*Fertilizer Rate*Leaching Rate
Natural Area Loading	927	Natural Area Loading	927	Natural Area*Recharge*Concentration
Title 5 Total Loading	**12,937**	**Technical Bulletin Total Loading**	**10,683**	
Landfill Loading	2,434	Landfill Loading	2,434	12M used in Swing Harbor ✓
WWTF (Beds)	1,894	WWTF (Beds)	1,894	
WWTF (Irrigation)	4,842	WWTF (Irrigation)	4,842	
WWTF Loading	6,735	WWTF Loading	6,735	11968
Septage Lagoon Loading	197	Septage Lagoon Loading	197	
Title 5 Loading w/ WWTF + Landfill	**22,303**	**Tech. Bul. w/ WWTF+Landfill**	**20,049**	

20,049 - 197 = 19852
See Table 13 of CCC, 1998

CRITICAL LOADING CAPACITY (k	-	CRITICAL LOADING CAPACITY (kg/y	-	
CAPACITY TO LOAD (kg/yr)	(22,303)	CAPACITY TO LOAD (kg/yr)	(20,049)	
gpd to load @ stated wastewater concentration	(461,253)	gpd to load @ stated wastewater concentration	(414,630)	
ALTERNATIVE SCENARIOS				
POTENTIAL DEVELOPMENT EFFECTS				
DEVELOPABLE RESIDENTIAL PARCELS				
State Class Codes	130/131			
Total Developable Area (ft2)=	12,446,304			
Zoning Required Lot Size (ft2)=				
# of buildable lots=	353			
%BUILDOUT	100%			
% Year Round Units	62%			
	Title 5 Assumptions	**Technical Bulletin Assumptions**		
Potential Additional Water Used (gpd)=	86,923	61,426		
Potential Additional Wastewater Recharge (gal/yr)=	31,726,945	22,420,487		
Potential Addnl. NO3 @ Res. Build-out (kg/yr)=	4,879	3,646		
Roof Loading (kg/yr)=	50	50		
Road Loading (kg/yr)=	25	25		
Lawn Loading (kg/yr)=	601	601		
Wastewater NO3 Loading (kg/yr)=	4,203	2,970		
NO3 Loading @ Residentinl Buildout (kg/yr)=	**27,183**	**23,695**		
Capacity to Further Load (kg/yr)	**(27,183)**	**(23,695)**		
DEVELOPABLE COMMERCIAL PARCELS				
State Class Codes	# of Parcels			
390/391	20			
% BUILDOUT=	100%			
Developable Commercial Area (ft2) =	3,865,456			
Average Developable Parcel Size (ft2) =	193,273	**Maximums**		
Average 300's (gpd)=	75	150	gpd (Maximum Commercial Water Use)	
Potential Water Use of Com. Parcels (gpd)=	95,670	3,000	gpd	
Potential Addnl. Nitrogen (kg/yr, based on 35mg/L)	4,900	419	kg/yr (based on 35mg/L)	
NO3 Loading @ Comm. Build-out (kg/yr)	**24,948**	**20,468**	kg/yr	
Nitrogen Loading at Buildout Scenario				
% BUILDOUT:	**100%**			
	Nitrogen (kg/yr)			
Potential New Commercial:	4,900	**Technical Bulletin assumptions.**		
Potential New Residential:	3,646	**Technical Bulletin assumptions.**		
Potential New Comm. and Resid.:	8,546	**Technical Bulletin assumptions.**		
Total @ Buildout Levels:	**28,595**	**Technical Bulletin assumptions.**		
Capacity to Load (kg/yr):	**(28,595)**	**Technical Bulletin assumptions.**		
NITROGEN LOADING RESULTS				
PRESENT CONDITIONS				
Residential nitrogen loading (kg/yr):	6,101			
Commercial nitrogen loading (kg/yr):	543			
Nitrogen Loading (kg/yr):	**20,049**			
Capacity to Load (kg/yr):	**(20,049)**			
gpd to load at stated wastewater concentration:	(414,630)			
FUTURE CONDITIONS				
Buildout Scenario:	100%			
% Year Round Units:	62%			
Residential nitrogen loading (kg/yr):	9,747			
Commercial nitrogen loading (kg/yr):	5,442			
Nitrogen Loading (kg/yr):	**28,595**			
% Change from current conditions:	**43%**			
Capacity to Load (kg/yr):	**(28,595)**			

28,595 − 197 = 28,398 See Table 13 of CCC, 1998

Appendix J

The Impact of Fringing Wetlands in West Falmouth Harbor on Nitrogen Levels in Intercepted Groundwater

The Impact of Fringing Wetlands in West Falmouth Harbor on Nitrogen Levels in Intercepted Groundwater

Henry M. Rines
Applied Science Associates, Inc.

One component of an ongoing Wastewater Facilities Planning Study taking place in the Town of Falmouth is a nitrogen loading assessment of West Falmouth Harbor. In order to assess the assimilation capacity of the Harbor, there is interest in evaluating the nitrogen uptake that may be taking place in the wetland areas surrounding the Harbor that intercept the groundwater flow through the watershed into the Harbor.

On March 19, 1999, a visit was made to the West Falmouth Harbor area to get an overview of the Harbor and the surrounding salt marsh areas. In most cases, only spot evaluations were made of areas easily accessible from the road or from the railroad bed passing through the area, east of most of the Harbor system, but separating Oyster Pond from Harbor Head. The areas of salt marsh surrounding most of the open area of the Harbor, where present, appear to occur in rather narrow bands consisting of a thin layer of marsh peat over a bed of sand. This type of coverage extends into parts of Mashapaquit Creek, which leads to the northeast from Snug Harbor, where there is a greater lateral extent of marsh and a somewhat thicker peat coverage, but the underlying substrate continues to be sand or muddy sand. In Harbor Head and Oyster Pond, as well, the lateral extent of the surrounding marsh is wider, but where accessible it still appeared to be a thin layer of peat over sand.

Based on these observations, it seems very unlikely that most of the marsh areas surrounding the Harbor system are intercepting the groundwater flow to the Harbor in any meaningful way. The high porosity of the underlying sand (assuming that the sand substrate is part of a more extensive layer, as it appears to be) will easily conduct groundwater flow directly into the subtidal regions of the Harbor passing below the dense, low porosity salt marsh peat. The possibility remains, of course, that the areas of marsh in the Harbor system are able to perform some functionality in mitigating nutrient levels in the Harbor through direct contact of the tidal waters with the marsh system during the rise and fall of the tides. To this end, a brief review of some of the literature on wetland processing of nitrogenous nutrients was undertaken to determine if this mitigative effect could be quantified.

A variety of published papers, and some gray literature reports, were reviewed as part of this evaluation. Very few of these proved to provide direct bearing on the question at hand of how fringing salt marsh areas might reduce nitrogen concentrations in adjacent tidal waters. Two, however, proved particularly valuable, being reviews of work carried out previously.

Nixon and Lee (1986), in an extensive review prepared for the US Army Corps of Engineers, describe recent research on wetlands as transformers of nitrogen, among other things, in each of seven regions in the United States. They conclude that while we are starting to acquire the needed information, their "reviews clearly emphasize the need for much additional research on the uptake, storage, and release of materials by wetlands before quantitative assessment will be possible." With regard to nitrogen, they conclude that there appears to be a general trend in marsh systems to import oxidized forms of nitrogen (such as nitrate) and to export reduced forms such as ammonia and particulate organic nitrogen, with a net export of total nitrogen, but that there are exceptions to this pattern.

A more recent review by Howes et al. (1996) focuses on the results of studies in Great Sippewissett Marsh in Falmouth, MA, and Namskaket Marsh in Orleans, MA. They propose a new model of the cycling of nitrogen in intercepted groundwater in which the import of oxidized nitrogen by the system is not the result of uptake by the marsh vegetation. It is proposed that the nitrogen for vegetative growth and the reduced forms of nitrogen observed to be exported from the marsh system are derived from nitrogen fixation and rain, rather than direct uptake of oxidized nitrogen. This makes up one of two linked components within the salt marsh system, the other being the creek bottoms.

In Great Sippewisset Marsh, measured denitrification of nitrate in creek bottoms is equal or greater in magnitude to system nitrate import over most of the year (except in winter). They also found that increased nitrate concentrations resulted in nearly proportional increases in denitrification rates, so that rates were highest in areas where nitrate-laden groundwater entered the creek beds and fell off with dilution of these waters with tidal waters. Thus, they state, "The ability of saltmarshes to intercept terrestrially derived nutrients is ultimately controlled by their ability to intercept freshwater flows and the denitrification capacity of marsh creekbottom sediments."

The marsh systems described in these studies are characterized as "mature", with thick peat layers and well-developed creek systems. This does not appear to generally be the case in West Falmouth Harbor. We were unable to evaluate the condition of the bottom of the Harbor in any but the shallow areas along the shore. There is an impression, however, that most of the Harbor bottom would not qualify as "creek bottom," that is, depositional areas where organic matter could accumulate for providing the required reduced carbon to carry out denitrification. Over much of the Harbor area, any inflowing groundwater would be rapidly diluted, reducing the efficiency with which any denitrification could occur, thus futher reducing the likelihood that this mechanism would be operational in the Harbor.

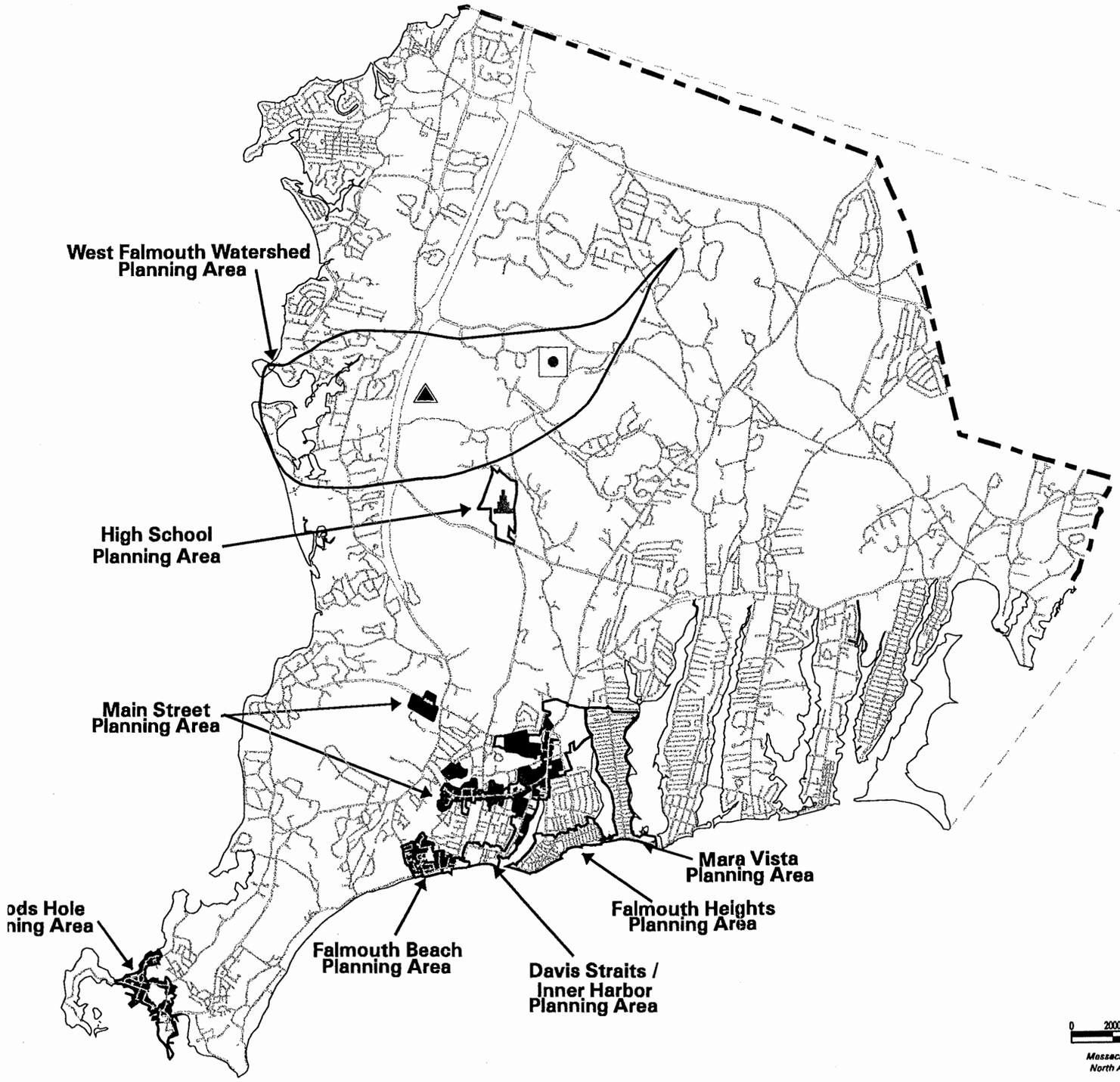
There are two exceptions to these observations: Oyster Pond and Mashapaquit Creek. In Oyster Pond, the flushing is low, and there are reported to be hypoxic conditions (Cape Cod Commission report on West Falmouth Harbor). While such conditions indicate the presence of reduced carbon, it has been proposed that they result in internal loading of nitrogen, explaining the underprediction of nitrogen concentrations there in a modeling study by Aubrey Consulting. Mashapaquit Creek

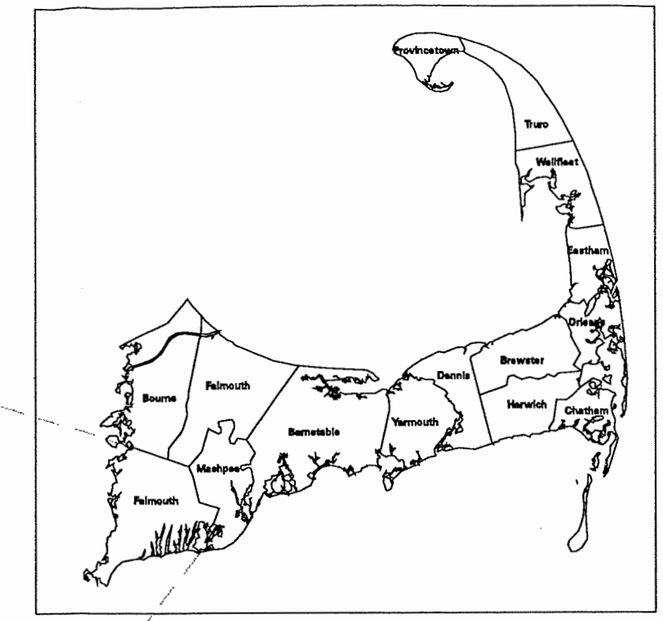
was not explored in detail, but it seems probable that the upper extent of the creek is more like a mature marsh system. It is here where we might expect to see the kind of linked systems processing nutrients in incoming groundwater in the manner described by Howes et al. (1996). Given that this represents only a small part of the watershed draining to the Harbor, any benefit would be small.

It is concluded from this review that we have insufficient information, at best, to quantify any mitigation of groundwater nitrogen inputs by the fringing marshes around West Falmouth Harbor. Given the conditions observed, however, it seems unlikely that any significant benefit is obtained, especially if the model proposed by Howes et al. (1996) is a valid description of salt marsh function. It is recommended that the salt marsh not be considered a sink of available nitrogen when evaluating the nitrogen assimilation capacity of the Harbor.

Howes, B. L., P. K. Weiskel, D. D. Goehringer, and J. M. Teal, 1996. Chapter Twelve. Interception of freshwater and nitrogen transport from uplands to coastal waters: the role of saltmarshes. pp. 287-310 *in* K. F. Nordstrom and C. T. Roman (eds.) *Estuarine Shores: Evolution, Environments and Human Alterations*. John Wiley & sons.

Nixon, S. W., and V. Lee, 1986. Wetlands and water quality, a regional review of recent research in the United States on the role of freshwater and saltwater wetlands as sources, sinks and transformers of nitrogen, phosphorus, and various heavy metals. US Army Corps of Engineers Wetlands Research Program Technical Report Y-86-2.





Legend

- Sewered Areas
- Coastline (Fresh & Saltwater)
- Town Boundary
- Roads
- Falmouth High School
- Falmouth Wastewater Treatment Facility
- Falmouth Sanitary Landfill

N

0 2000 4000 8000 feet

Massachusetts State Plane Feet
North American Datum - 1927

March 30, 1999

FIGURE 1-1
LOCATION MAP

Wastewater Facilities Planning Study
Town of Falmouth, MA

Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS & SCIENTISTS

Map prepared by Harvard Design and Mapping Company, Inc.
Base map prepared by the Cape Cod Commission, GIS Department

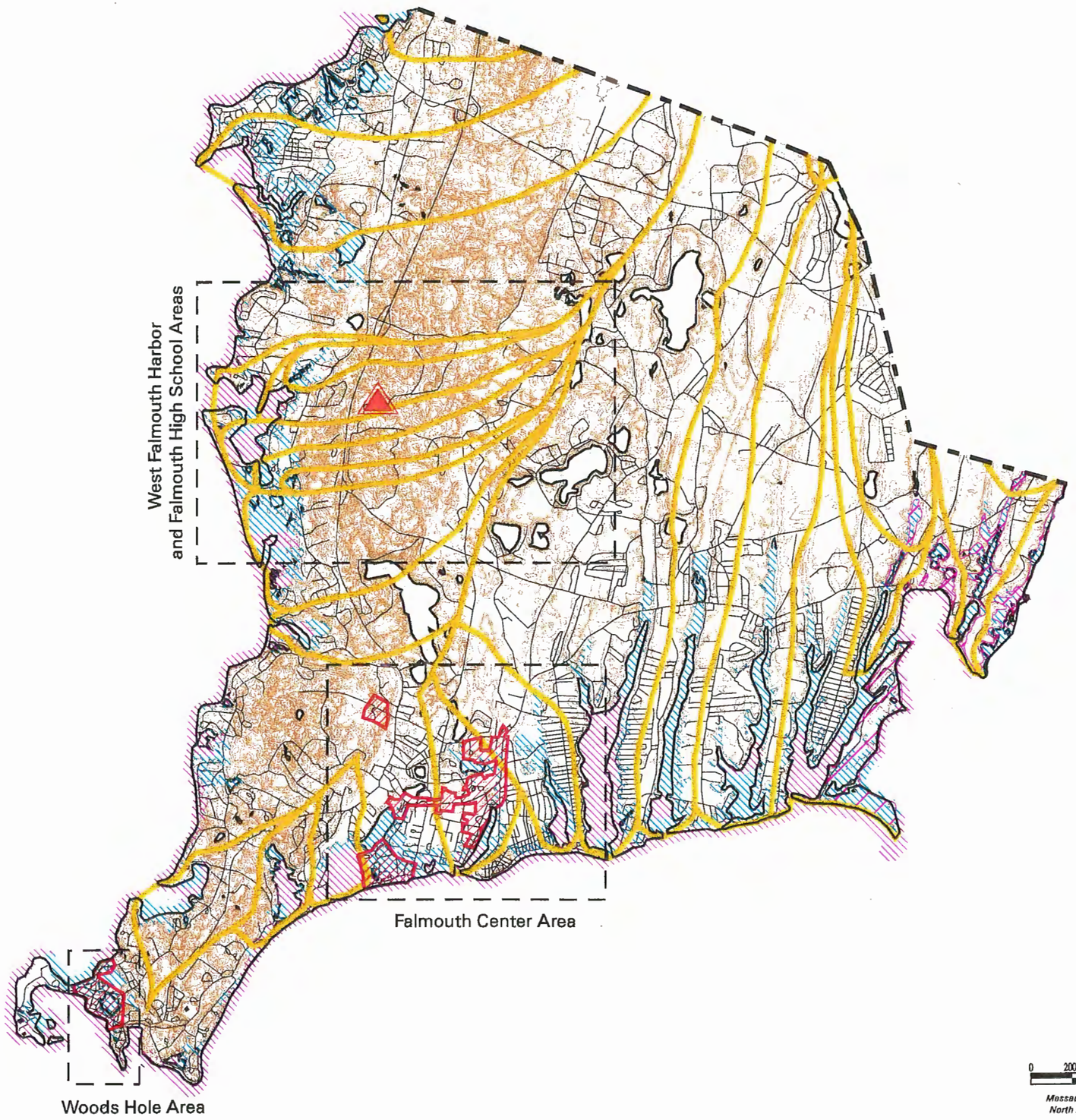
Town of Falmouth
Coastal Issue Areas

This map was developed by Stearns & Wheler, LLC, Environmental Engineers & Scientists for the purpose of studying Falmouth's wastewater management needs. Sewered parcels, and the Water Pollution Control Facility were digitized in 1990 for the Cape Cod Commission's Regional Policy Plan. Other base map features such as coastlines, water bodies, coastal embayment recharge areas, water supply protection areas, groundwater elevation, roads and road names were automated by the Cape Cod Commission GIS department. Special technical assistance and data was provided by MassGIS of Boston, MA; and the Town of Falmouth.

Flood hazards were digitized by the Cape Cod Commission from 1986 Flood Insurance Rate Maps produced by the Federal Emergency Management Agency, and rubber-sheeted to match MassGIS 1:25,000 road network.

The three-meter surface contours are based on USGS Mapping, and converted to GIS format by MassGIS.

The map has been developed as a planning tool to investigate problems related to wastewater treatment and disposal. Much Town-wide and regional information has been intergrated to produce this map. The source information comes from a variety of dates, as noted above, and therefore, may not reveal more recent changes. Also, the source information was digitized with a regional prespective, and this may show inherant inaccuracies pertaining to individual properties. This map does not intend to provide design information or regulatory enforcement for individual properties.



Legend

- A Flood Zone
- V Flood Zone
- Surface Water Bodies (MassGIS)
- Area of Critical Environmental Concern (ACEC)
- Sewered Areas
- Coastline (Fresh & Saltwater) (MassGIS)
- Town Boundary (MassGIS)
- Perimeter of Costal Embayment Recharge Areas
- Roads (MassGIS)
- 3-Meter Surface Contours (MassGIS)
- Falmouth Wastewater Treatment Facility

FIGURE 4-1
COASTAL ISSUE AREAS

Wastewater Facilities Planning Study
Town of Falmouth, MA

Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS & SCIENTISTS

Map prepared by Harvard Design and Mapping Company, Inc.
Base map prepared by the Cape Cod Commission, GIS Department

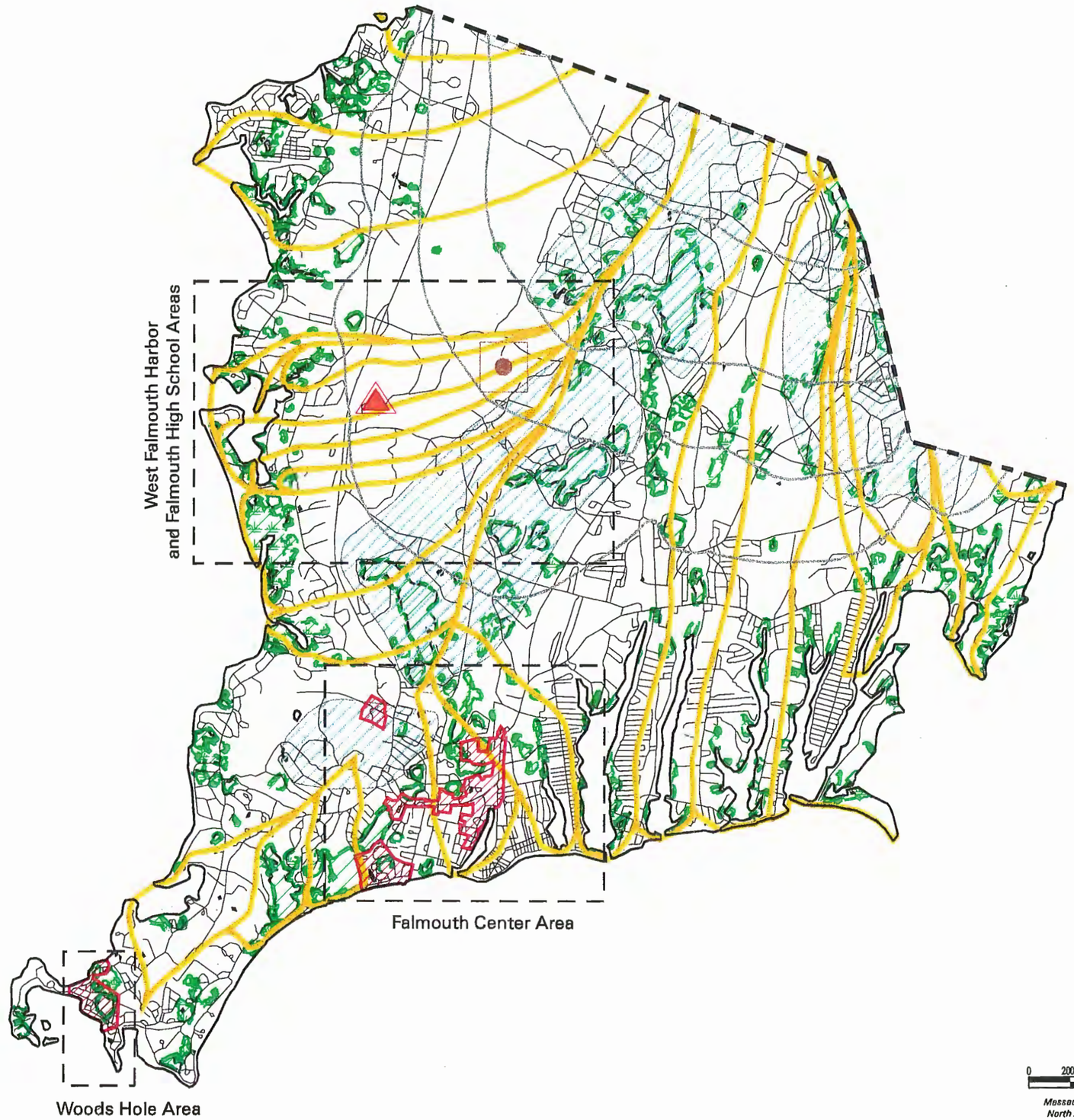
March 30, 1999

Town of Falmouth
Water Resource Areas

This map was developed by Stearns & Wheler, LLC, Environmental Engineers & Scientists for the purpose of studying Falmouth's wastewater management needs. Sewered parcels, and the Water Pollution Control Facility were digitized in 1990 for the Cape Cod Commission's Regional Policy Plan. Other base map features such as coastlines, water bodies, coastal embayment recharge areas, water supply protection areas, groundwater elevation, roads and road names were automated by the Cape Cod Commission GIS department. Special technical assistance and data was provided by MassGIS of Boston, MA; and the Town of Falmouth.

Wetlands were digitized by Cape Cod Commission GIS and orginated from 1990 MacConnell Aerial Photo Land Use and 1982 Mass DEP wetland restriction maps. Wetland restriction areas were provided by the Town of Falmouth, digitized by Cape Cod Commission.

The map has been developed as a planning tool to investigate problems related to wastewater treatment and disposal. Much Town-wide and regional information has been intergrated to produce this map. The source information comes from a variety of dates, as noted above, and therefore, may not reveal more recent changes. Also, the source information was digitized with a regional prespective, and this may show inherent inaccuracies pertaining to individual properties.
This map does not intend to provide design information or regulatory enforcement for individual properties.



Legend

- Wetland Restriction Area
- Wetlands
- Surface Water Bodies (MassGIS)
- Water Suppy Protection Area
- Water Resource Protection Overlay District
- Sewered Areas
- Coastline (Fresh & Saltwater) (MassGIS)
- Town Boundary (MassGIS)
- Perimeter of Costal Embayment Recharge Areas
- Roads (MassGIS)
- Groundwater Contours
- Falmouth Wastewater Treatment Facility
- Falmouth Sanitary Landfill

FIGURE 4-2
WATER RESOURCE AREAS

Wastewater Facilities Planning Study
Town of Falmouth, MA

Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS & SCIENTISTS

Map prepared by Harvard Design and Mapping Company, Inc.
Base map prepared by the Cape Cod Commission, GIS Department

March 30, 1999

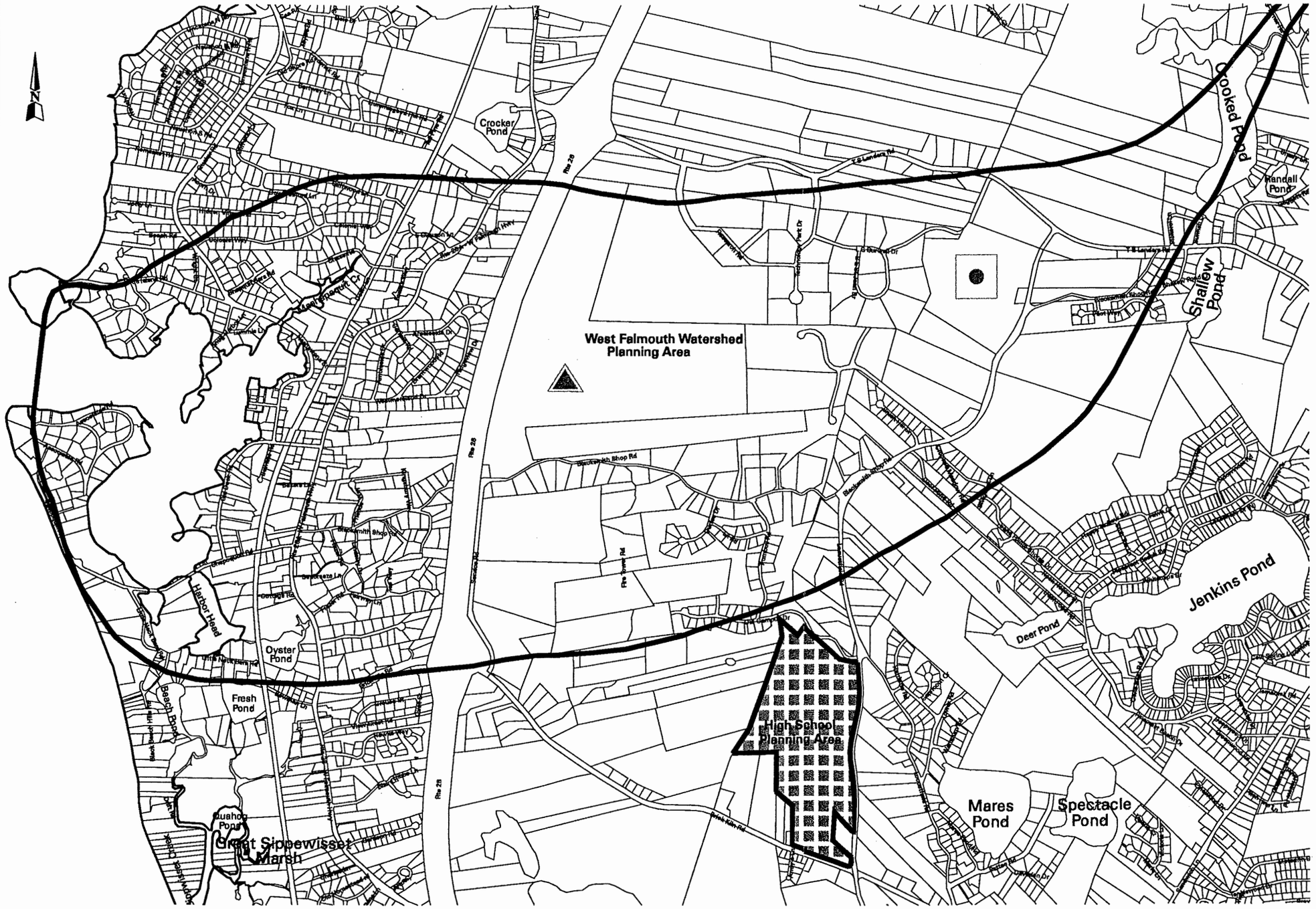
Town of Falmouth

West Falmouth Harbor & Falmouth High School Areas

This map was developed by Stearns & Wheler, LLC, Environmental Engineers &Scientists for the purpose of studying Falmouth's wastewater management needs. Base map features such as coastlines, water bodies, roads and road names were automated by the Cape Cod Commission GIS department. Special technical assistance and data was provided by MassGIS of Boston, MA; and the Town of Falmouth.

Parcels were digitized by the Cap Cod Commission GIS Department for use by the Town of Falmouth from Falmouth 1994 Assessors Maps at the original scale of 1:1200 and 1:2400.

The map has been developed as a planning tool to investigate problems related to wastewater treatment and disposal. Much Town-wide and regional information has been intergrated to produce this map. The source information comes from a variety of dates, as noted above, and therefore, may not reveal more recent changes. Also, the source information was digitized with a regional prespective, and this may show inherent inaccuracies pertaining to individual properties. This map does not intend to provide design information or regulatory enforcement for individual properties.



Legend

- Parcels
- Coastline
- Town Boundaries
- Planning Area Boundaries
- Falmouth High School
- Falmouth Wastewater Treatment Plant
- Falmouth Sanitary Landfill

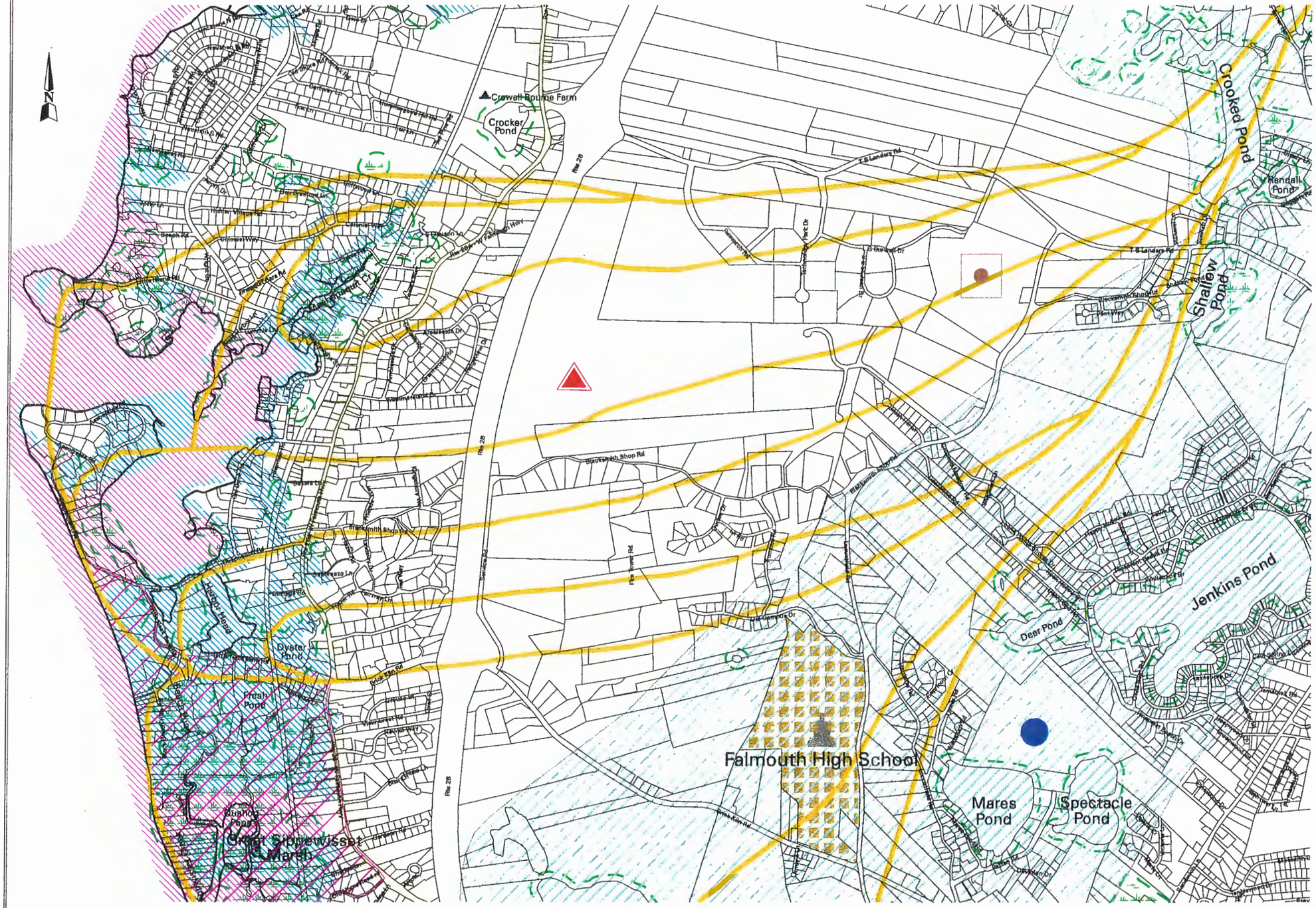
February 19, 1999

FIGURE 6-1
PLANNING AREAS

Wastewater Facilities Planning Study
Town of Falmouth, MA

Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS & SCIENTISTS

Map prepared by Harvard Design and Mapping Company, Inc.



Town of Falmouth

West Falmouth Harbor & Falmouth High School Areas

This map was developed by Stearns & Wheler, LLC, Environmental Engineers &Scientists for the purpose of studying Falmouth's wastewater management needs. Sewered parcels, and the Water Pollution Control Facility were digitized in 1990 for the Cape Cod Commission's Regional Policy Plan. Other base map features such as coastlines, water bodies, coastal embayment recharge areas, water supply protection areas, roads and road names were automated by the Cape Cod Commission GIS department. Special technical assistance and data was provided by MassGIS of Boston, MA; and the Town of Falmouth.

Parcels were digitized by the Cap Cod Commission GIS Department for use by the Town of Falmouth from Falmouth 1994 Assessors Maps at the original scale of 1:1200 and 1:2400. Wetlands were digitized by Cape Cod Commission GIS and orginated from 1990 MacConnell Aerial Photo Land Use and 1982 Mass DEP wetland restriction maps. Wetland restriction areas were provided by the Town of Falmouth, digitized by Cape Cod Commission. Flood hazards were digitized by the Cape Cod Commission from 1986 Flood Insurance Rate Maps produced by the Federal Emergency Management Agency, and rubber-sheeted to match MassGIS 1:25,000 road network.

The map has been developed as a planning tool to investigate problems related to wastewater treatment and disposal. Much Town-wide and regional information has been intergrated to produce this map. The source information comes from a variety of dates, as noted above, and therefore, may not reveal more recent changes. Also, the source information was digitized with a regional prespective, and this may show inherent inaccuracies pertaining to individual properties. This map does not intend to provide design information or regulatory enforcement for individual properties.

Legend

- — Parcels
- — Coastline
- ▬ Town Boundaries
- ▬ Perimeter of Coastal Embayment Recharge Areas
- — Wetland Restriction Area
- Wetlands
- Surface Water Bodies
- ▨ A Flood Zone
- ▨ V Flood Zone
- ▤ Sewered Parcels
- Water Supply Protection Areas
- Falmouth High School
- Historic Districts
- / Great Sippewisset Marsh D.C.P.C.
- ▲ Historic Sites
- ● Existing Municipal Wells
- ▲ Falmouth Wastewater Treatment Plant
- ▣ Falmouth Sanitary Landfill

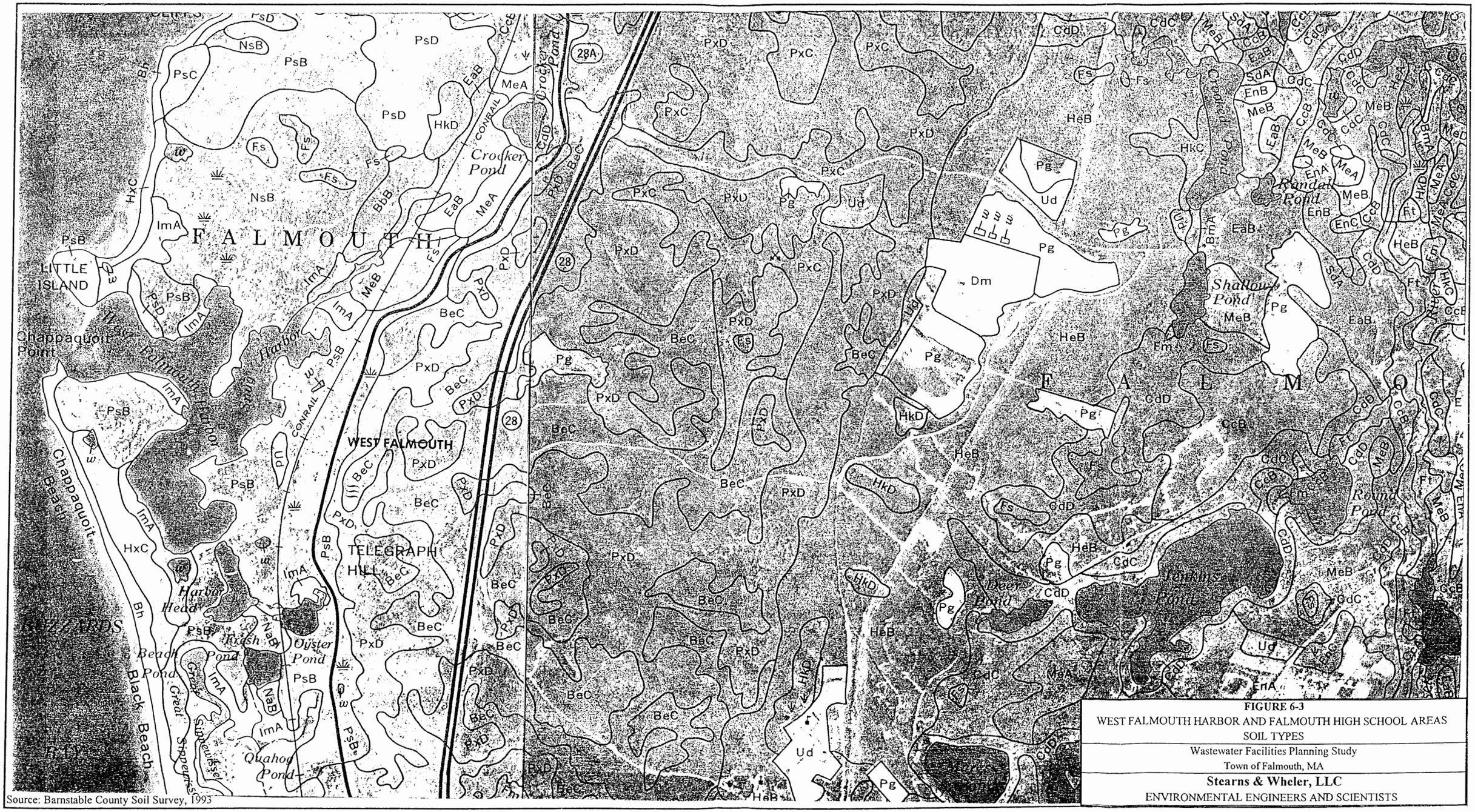
FIGURE 6-2
EXISTING CONDITIONS

Wastewater Facilities Planning Study
Town of Falmouth, MA

Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS & SCIENTISTS

Map prepared by Harvard Design and Mapping Company, Inc.

February 12, 1999

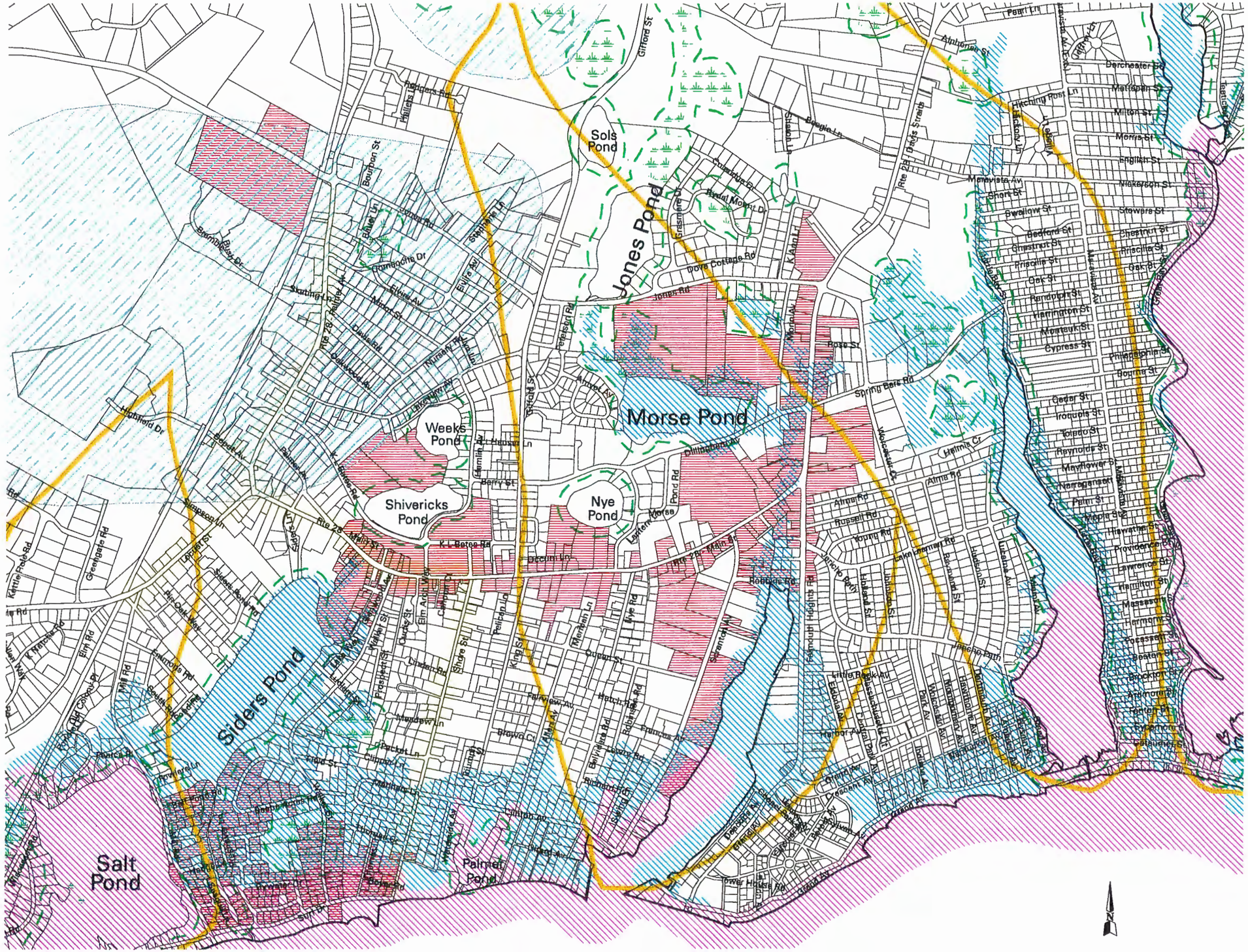


Source: Barnstable County Soil Survey, 1993

FIGURE 6-3
WEST FALMOUTH HARBOR AND FALMOUTH HIGH SCHOOL AREAS
SOIL TYPES

Wastewater Facilities Planning Study
Town of Falmouth, MA

Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS AND SCIENTISTS



Town of Falmouth
Falmouth Center Area

This map was developed by Stearns & Wheler, LLC, Environmental Engineers &Scientists for the purpose of studying Falmouth's wastewater management needs. Sewered parcels were digitized in 1990 for the Cape Cod Commission's Regional Policy Plan. Other base map features such as coastlines, water bodies, coastal embayment recharge areas, water supply protection areas, roads and road names were automated by the Cape Cod Commission GIS department. Special technical assistance and date was provided by MassGIS of Boston, MA; and the Town of Falmouth.

Parcels were digitized by the Cap Cod Commission GIS Department for use by the Town of Falmouth from Falmouth 1994 Assessors Maps at the original scale of 1:1200 and 1:2400. Wetlands were digitized by Cape Cod Commission GIS and orginated from 1990 MacConnell Aerial Photo Land Use and 1982 Mass DEP wetland restriction maps. Wetland restriction areas were provided by the Town of Falmouth, digitized by Cape Cod Commission. Flood hazards were digitized by the Cape Cod Commission from 1986 Flood Insurance Rate Maps produced by the Federal Emergency Management Agency, and rubber-sheeted to match MassGIS 1:25,000 road network.

The map has been developed as a planning tool to investigate problems related to wastewater treatment and disposal. Much Town-wide and regional information has been intergrated to produce this map. The source information comes from a variety of dates, as noted above, and therefore, may not reveal more recent changes. Also, the source information was digitized with a regional prespective, and this may show inherent inaccuracies pertaining to individual properties. This map does not intend to provide design information or regulatory enforcement for individual properties.

Legend

- — Parcels
- — Coastline
- ▬ Town Boundaries
- ▬ Perimeter of Coastal Embayment Recharge Areas
- — Wetland Restriction Area
- Wetlands
- Surface Water Bodies
- ▨ A Flood Zone
- ▨ V Flood Zone
- ▤ Sewered Parcels
- Water Supply Protection Areas
- Historic Districts
- ▲ Historic Sites

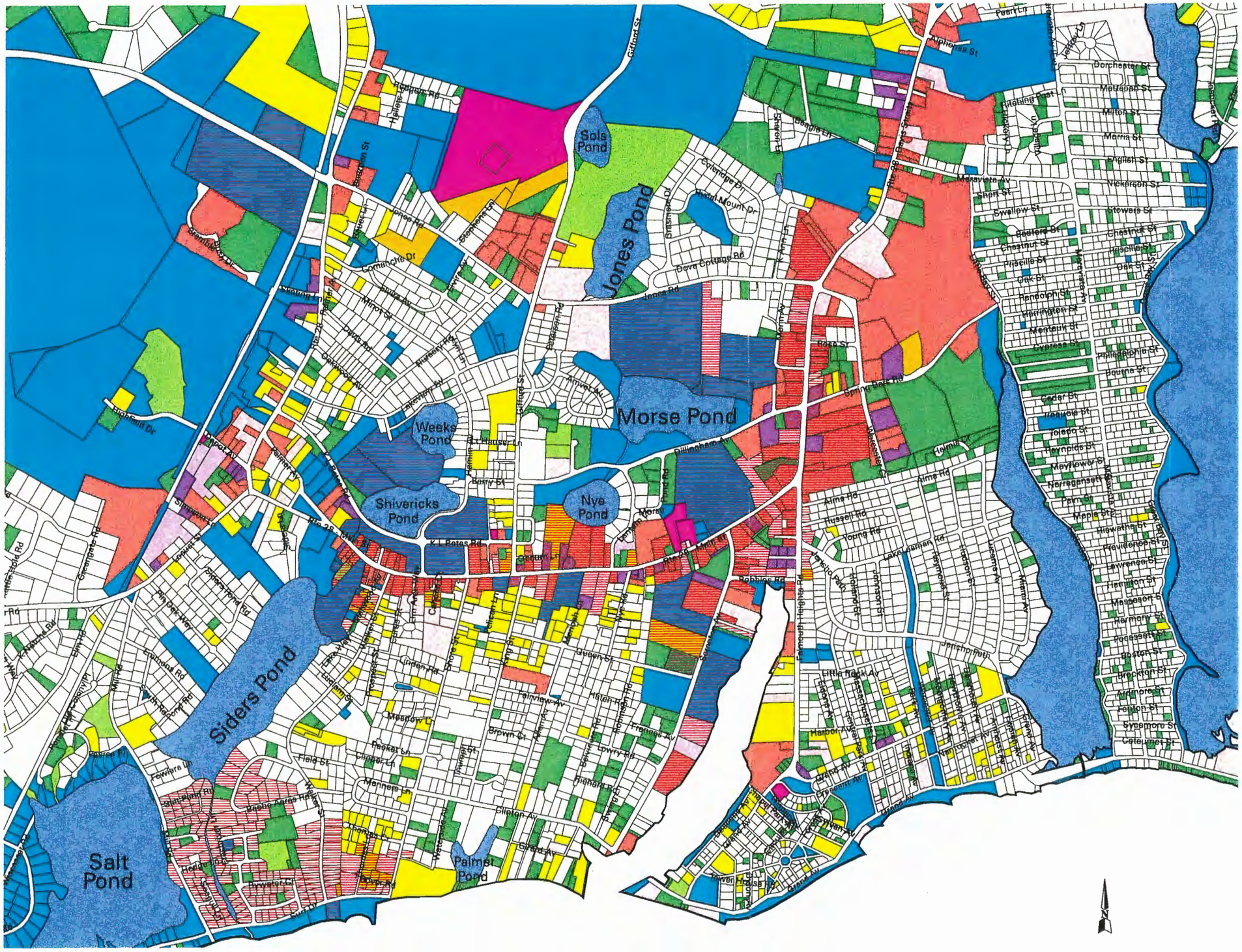
March 30, 1999

FIGURE 6-10
EXISTING CONDITIONS

Wastewater Facilities Planning Study
Town of Falmouth, MA

Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS & SCIENTISTS

Map prepared by Harvard Design and Mapping Company, Inc.



Massachusetts State Plane Feet
North American Datum - 1927

March 30, 1999

Town of Falmouth
Falmouth Center Area

This map was developed by Stearns & Wheler, LLC, Environmental Engineers &Scientists for the purpose of studying Falmouth's wastewater management needs. Sewered parcels were digitized in 1990 for the Cape Cod Commission's Regional Policy Plan. Other base map features such as coastlines, water bodies, roads and road names were automated by the Cape Cod Commission GIS department. Special technical assistance and data was provided by MassGIS of Boston, MA; and the Town of Falmouth.

Parcels were digitized by the Cap Cod Commission GIS Department for use by the Town of Falmouth from Falmouth 1994 Assessors Maps at the original scale of 1:1200 and 1:2400.

The map has been developed as a planning tool to investigate problems related to wastewater treatment and disposal. Much Town-wide and regional information has been intergrated to produce this map. The source information comes from a variety of dates, as noted above, and therefore, may not reveal more recent changes. Also, the source information was digitized with a regional prespective, and this may show inherent inaccuracies pertaining to individual properties. This map does not intend to provide design information or regulatory enforcement for individual properties.

Legend

- Parcels
- Coastline
- Town Boundaries
- ▤ Sewered Parcels
- Single Family Residential (101, 106)
- 🟨 Multi Family Residential (102, 104, 105, 109, 111, 112, 121, 140)
- 🟥 Office and Retail Trade (13, 31, 315, 321-325, 340-342, 355, 356, 358, 359, 361, 364, 384)
- Motel and Restaurant (300, 301, 302, 304, 326)
- 🟥 Industrial (384, 400, 401, 402)
- 🟪 Auto Related Business (314, 330-334, 337, 338)
- Storage Warehouse and Distribution (310, 311, 313, 316, 318)
- 🟧 Public Utility (423, 424, 430, 431, 433)
- 🟩 Vacant Land (130, 131, 132, 220, 221, 390, 391, 392, 440, 441, 442)
- 🟩 Agricultural Land (210, 317, 393, 710, 712-714, 717-720, 722)
- 🟩 Recreation and Open Space (201, 202, 370, 374, 375, 380-383, 385, 386, 388, 805, 814)
- 🟦 Institutional (350, 352-354, 800-808)
- 🟦 Ponds

FIGURE 6-12
LANDUSE

Wastewater Facilities Planning Study
Town of Falmouth, MA

Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS & SCIENTISTS

Map prepared by Harvard Design and Mapping Company, Inc.

Town of Falmouth
West Falmouth Harbor & Falmouth High School Areas

Legend

- Parcels
- Coastline
- Town Boundaries
- Surface Water Bodies
- Septic Tank Pumped 2 Times
- Septic Tank Pumped 3 to 5 Times
- Septic Tank Pumped 6 to 10 Times
- Septic Tank Pumped Greater Than 10 Times
- ▲ Falmouth Wastewater Treatment Plant
- ● Falmouth Sanitary Landfill

0 500 1000 2000 feet

Massachusetts State Plane Feet
North American Datum - 1927
Scale - 1:18,500

March 30, 1999

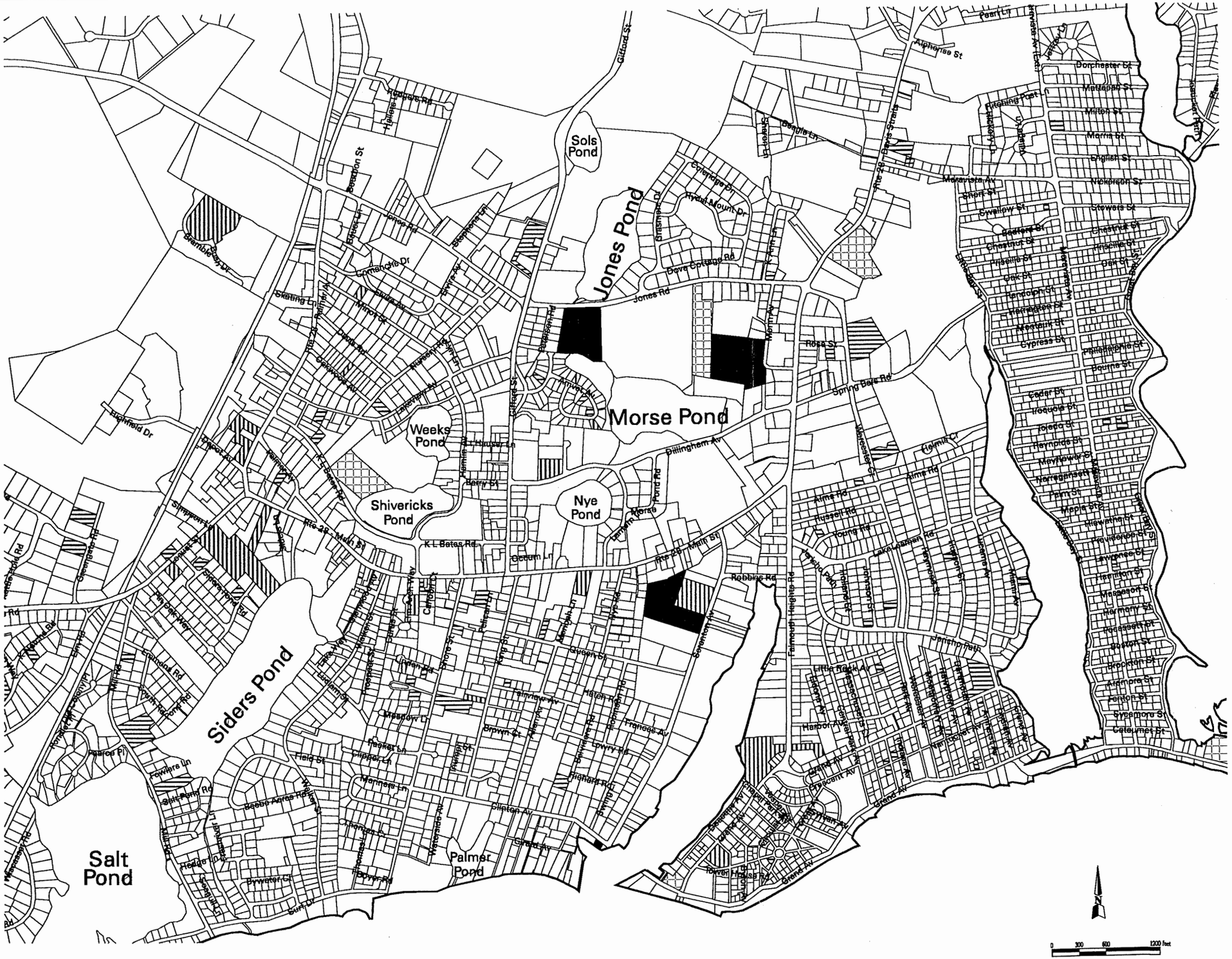
SEPTIC TANK PUMPING

Wastewater Facilities Planning Study
Town of Falmouth, MA

Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS & SCIENTISTS

Map prepared by Harvard Design and Mapping Company, Inc.
Base map prepared by the Cape Cod Commission, GIS Department

Town of Falmouth
Falmouth Center Area



Legend

- Parcels
- Coastline
- Town Boundaries
- Surface Water Bodies
- ▤ Septic Tank Pumped 2 Times
- ▥ Septic Tank Pumped 3 to 5 Times
- ▦ Septic Tank Pumped 6 to 10 Times
- ■ Septic Tank Pumped Greater Than 10 Times

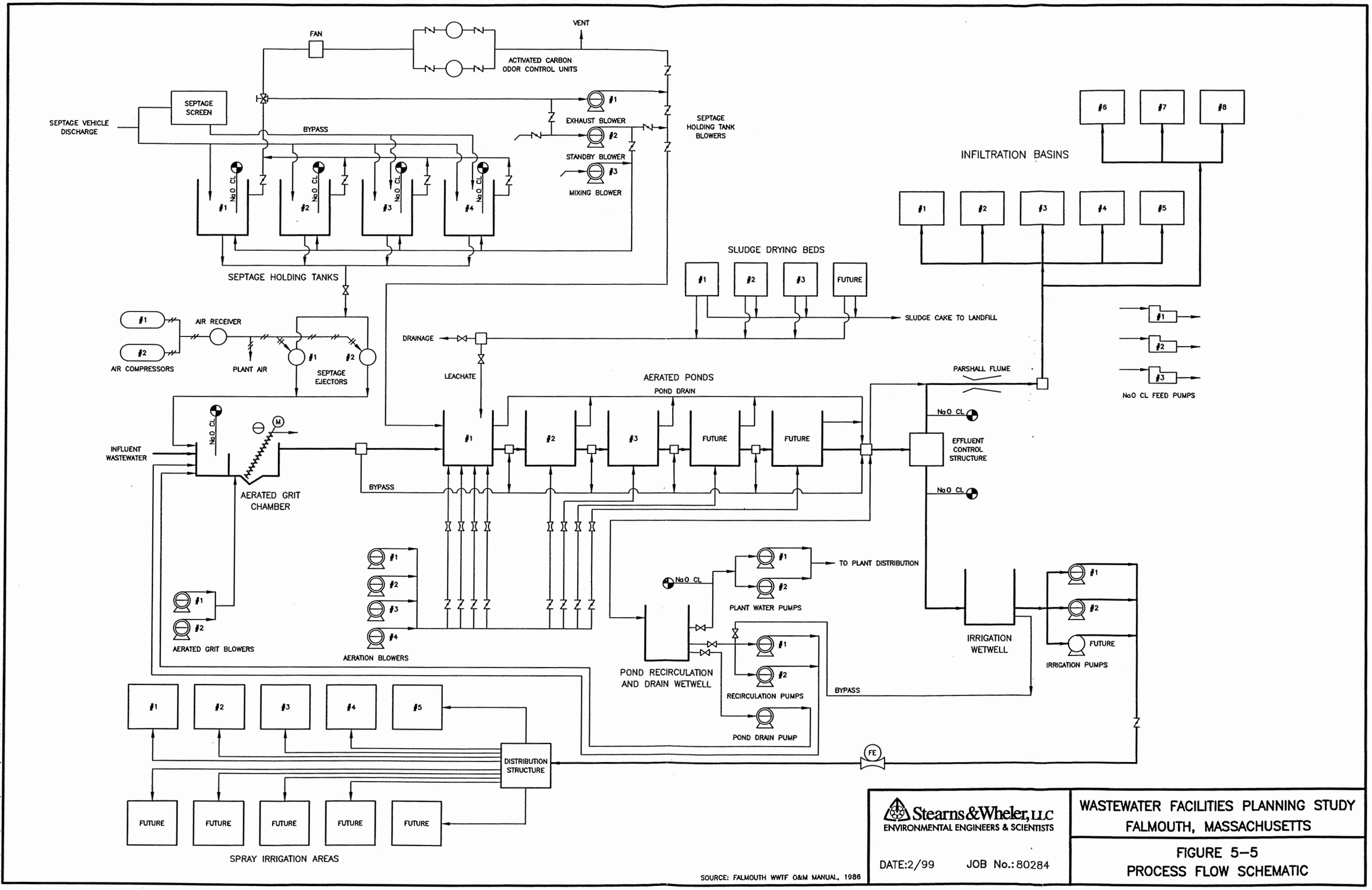
SEPTIC TANK PUMPING

Wastewater Facilities Planning Study
Town of Falmouth, MA

Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS & SCIENTISTS

Map prepared by Harvard Design and Mapping Company, Inc.
Base map prepared by the Cape Cod Commission, GIS Department

March 30, 1999


FAN
VENT
ACTIVATED CARBON ODOR CONTROL UNITS
SEPTAGE VEHICLE DISCHARGE
SEPTAGE SCREEN
BYPASS
EXHAUST BLOWER
STANDBY BLOWER
MIXING BLOWER
SEPTAGE HOLDING TANK BLOWERS
NaO CL
SEPTAGE HOLDING TANKS
AIR RECEIVER
AIR COMPRESSORS
PLANT AIR
SEPTAGE EJECTORS
DRAINAGE
LEACHATE
SLUDGE DRYING BEDS
FUTURE
SLUDGE CAKE TO LANDFILL
INFILTRATION BASINS
NaO CL FEED PUMPS
PARSHALL FLUME
AERATED PONDS
POND DRAIN
INFLUENT WASTEWATER
AERATED GRIT CHAMBER
EFFLUENT CONTROL STRUCTURE
AERATED GRIT BLOWERS
AERATION BLOWERS
TO PLANT DISTRIBUTION
PLANT WATER PUMPS
POND RECIRCULATION AND DRAIN WETWELL
RECIRCULATION PUMPS
POND DRAIN PUMP
IRRIGATION WETWELL
IRRIGATION PUMPS
DISTRIBUTION STRUCTURE
FE
SPRAY IRRIGATION AREAS
SOURCE: FALMOUTH WWTF O&M MANUAL, 1986
Stearns&Wheler, LLC
ENVIRONMENTAL ENGINEERS & SCIENTISTS
DATE:2/99
JOB No.:80284
WASTEWATER FACILITIES PLANNING STUDY
FALMOUTH, MASSACHUSETTS
FIGURE 5-5
PROCESS FLOW SCHEMATIC
99/2 CAZ JDB
\\FS2\DATA2\CADUSE2\8028413\FIG5-5.DWG

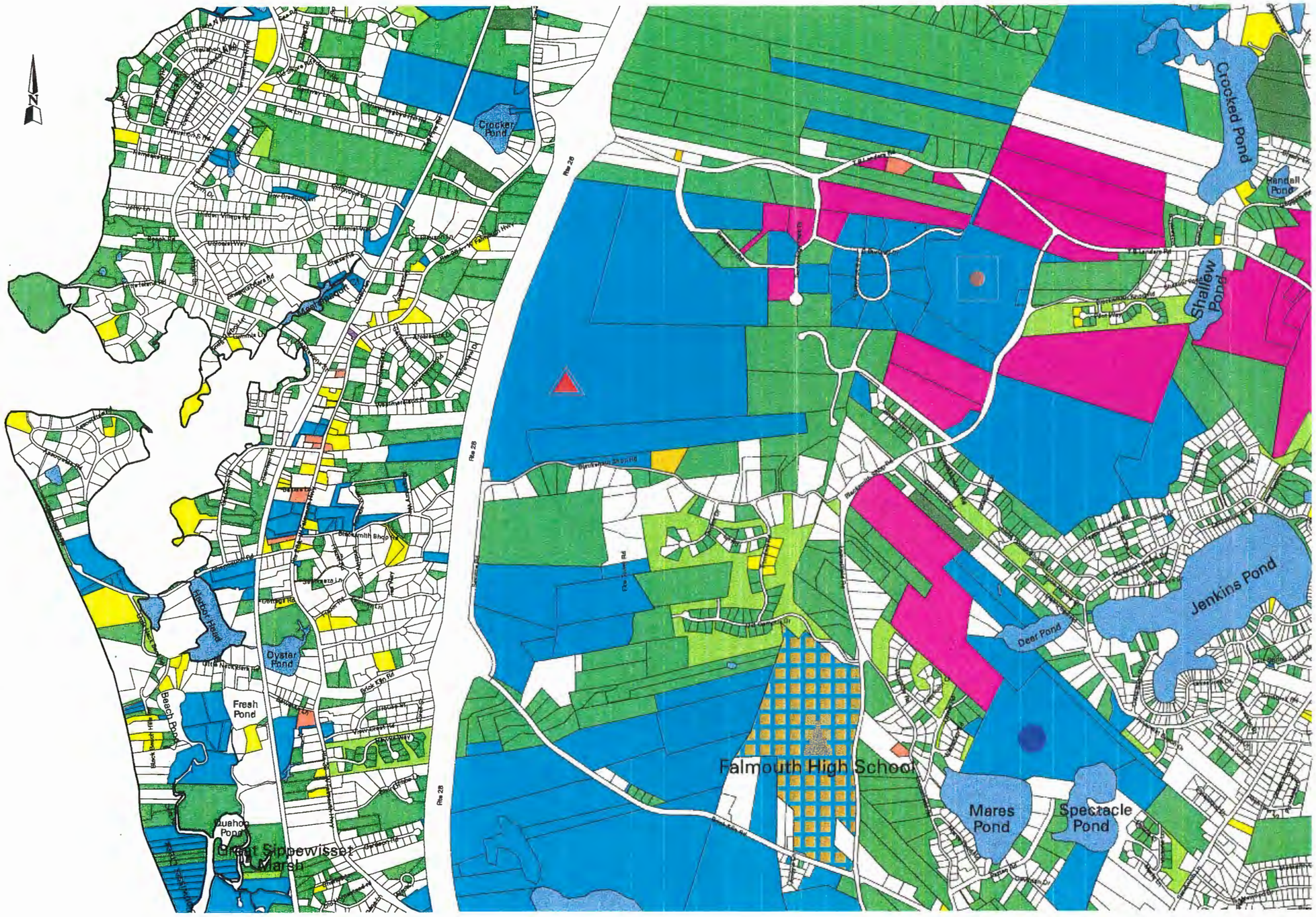
Town of Falmouth

West Falmouth Harbor & Falmouth High School Areas

This map was developed by Stearns & Wheler, LLC, Environmental Engineers &Scientists for the purpose of studying Falmouth's wastewater management needs. Sewered parcels, and the Water Pollution Control Facility were digitized in 1990 for the Cape Cod Commission's Regional Policy Plan. Other base map features such as coastlines, water bodies, roads and road names were automated by the Cape Cod Commission GIS department. Special technical assistance and data was provided by MassGIS of Boston, MA; and the Town of Falmouth.

Parcels were digitized by the Cap Cod Commission GIS Department for use by the Town of Falmouth from Falmouth 1994 Assessors Maps at the original scale of 1:1200 and 1:2400.

The map has been developed as a planning tool to investigate problems related to wastewater treatment and disposal. Much Town-wide and regional information has been intergrated to produce this map. The source information comes from a variety of dates, as noted above, and therefore, may not reveal more recent changes. Also, the source information was digitized with a regional prespective, and this may show inherent inaccuracies pertaining to individual properties. This map does not intend to provide design information or regulatory enforcement for individual properties.



Legend

- Parcels
- Coastline
- Town Boundaries
- Sewered Parcels
- Falmouth High School
- Single Family Residential (101, 106)
- Multi Family Residential (102, 104, 105, 109, 111, 112, 121, 140)
- Office and Retail Trade (13, 31, 315, 321-325, 340-342, 355, 356, 358, 359, 361, 364, 384)
- Motel and Restaurant (300, 301, 302, 304, 326)
- Industrial (384, 400, 401, 402)
- Auto Related Business (314, 330-334, 337, 338)
- Storage Warehouse and Distribution (310, 311, 313, 316, 318)
- Public Utility (423, 424, 430, 431, 433)
- Vacant Land (130, 131, 132, 220, 221, 390, 391, 392, 440, 441, 442)
- Agricultural Land (210, 317, 393, 710, 712-714, 717-720, 722)
- Recreation and Open Space (201, 202, 370, 374, 375, 380-383, 385, 386, 388, 805, 814)
- Institutional (350, 352-354, 900-908)
- Ponds
- Existing Municipal Wells
- Falmouth Wastewater Treatment Plant
- Falmouth Sanitary Landfill

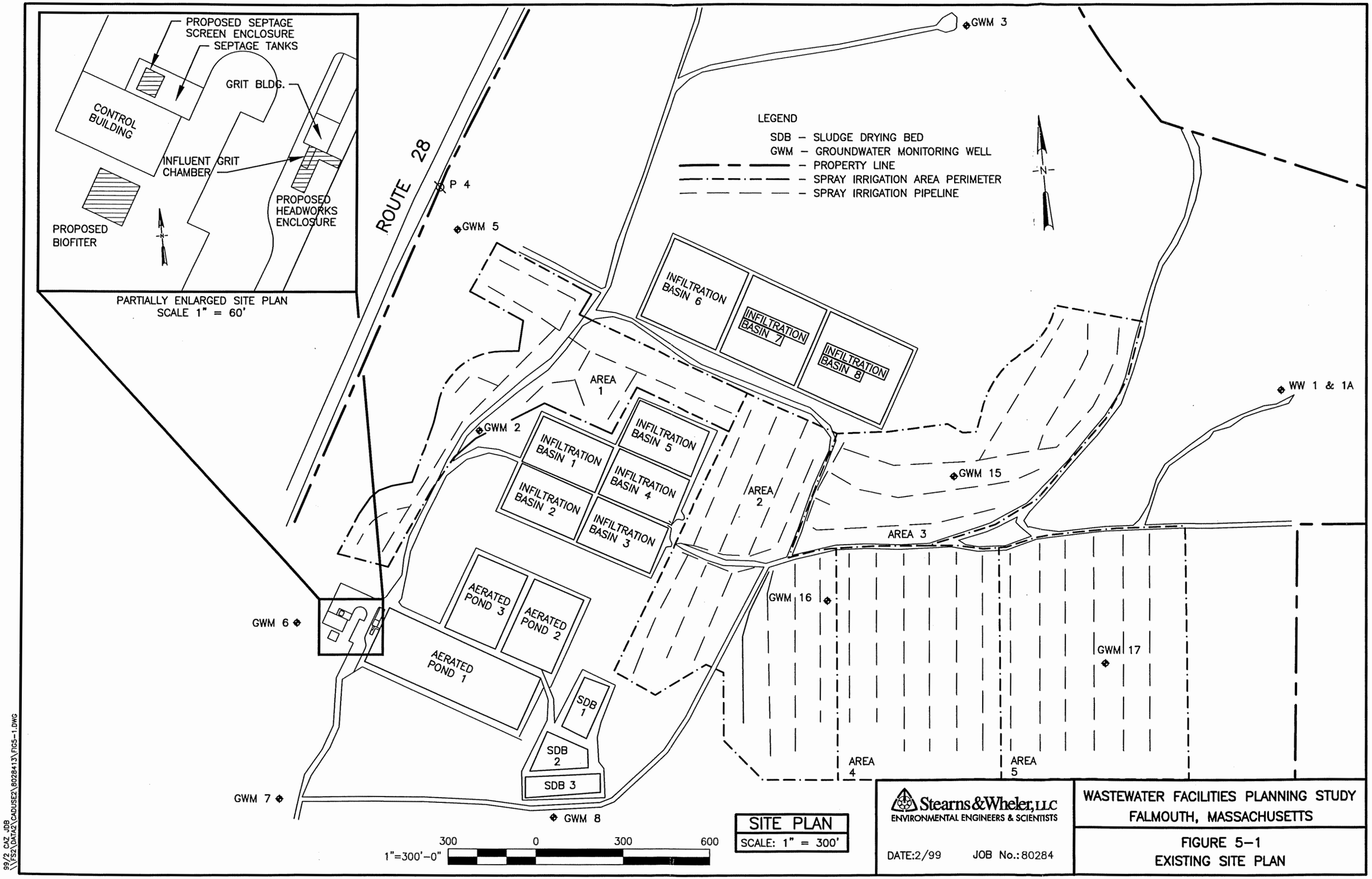
FIGURE 6-4
LANDUSE

Wastewater Facilities Planning Study
Town of Falmouth, MA

Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS & SCIENTISTS

Map prepared by Harvard Design and Mapping Company, Inc.

February 12, 1998

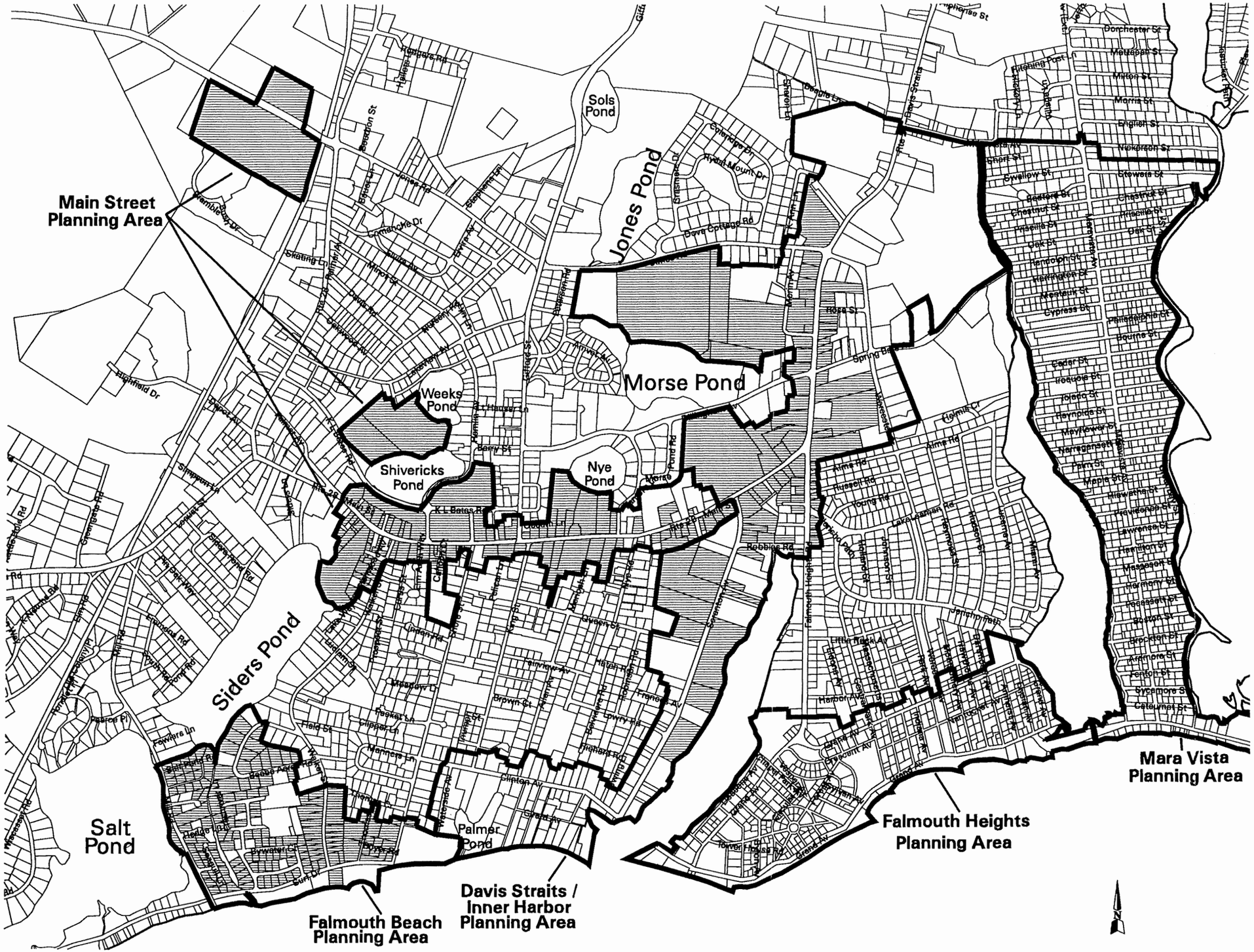

PROPOSED SEPTAGE SCREEN ENCLOSURE
SEPTAGE TANKS
GRIT BLDG.
CONTROL BUILDING
INFLUENT GRIT CHAMBER
PROPOSED HEADWORKS ENCLOSURE
PROPOSED BIOFITER
PARTIALLY ENLARGED SITE PLAN
SCALE 1" = 60'
ROUTE 28
P 4
GWM 5
GWM 3
LEGEND
SDB – SLUDGE DRYING BED
GWM – GROUNDWATER MONITORING WELL
– PROPERTY LINE
– SPRAY IRRIGATION AREA PERIMETER
– SPRAY IRRIGATION PIPELINE
N
INFILTRATION BASIN 6
INFILTRATION BASIN 7
INFILTRATION BASIN 8
AREA 1
GWM 2
INFILTRATION BASIN 1
INFILTRATION BASIN 2
INFILTRATION BASIN 3
INFILTRATION BASIN 4
INFILTRATION BASIN 5
AREA 2
GWM 15
WW 1 & 1A
AREA 3
GWM 16
GWM 17
AREA 4
AREA 5
GWM 6
AERATED POND 3
AERATED POND 2
AERATED POND 1
SDB 1
SDB 2
SDB 3
GWM 7
GWM 8
300 0 300 600
1"=300'-0"
SITE PLAN
SCALE: 1" = 300'
Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS & SCIENTISTS
DATE:2/99
JOB No.:80284
WASTEWATER FACILITIES PLANNING STUDY
FALMOUTH, MASSACHUSETTS
FIGURE 5-1
EXISTING SITE PLAN
99/2 CAZ JDB
\\FS2\DATA2\CADUSE2\8028413\FIG5-1.DWG

Town of Falmouth
Falmouth Center Area

This map was developed by Stearns & Wheler, LLC, Environmental Engineers &Scientists for the purpose of studying Falmouth's wastewater management needs. Base map features such as coastlines, water bodies, roads and road names were automated by the Cape Cod Commission GIS department. Special technical assistance and data was provided by MassGIS of Boston, MA; and the Town of Falmouth.

Parcels were digitized by the Cap Cod Commission GIS Department for use by the Town of Falmouth from Falmouth 1994 Assessors Maps at the original scale of 1:1200 and 1:2400.

The map has been developed as a planning tool to investigate problems related to wastewater treatment and disposal. Much Town-wide and regional information has been intergrated to produce this map. The source information comes from a variety of dates, as noted above, and therefore, may not reveal more recent changes. Also, the source information was digitized with a regional prespective, and this may show inherent inaccuracies pertaining to individual properties. This map does not intend to provide design information or regulatory enforcement for individual properties.



Legend

- Parcels
- Coastline
- Town Boundaries
- Planning Area Boundaries
- Sewered Parcels

0 300 600 1200 feet

Massachusetts State Plane Feet
North American Datum - 1927

March 30, 1999

FIGURE 6-9
PLANNING AREAS

Wastewater Facilities Planning Study
Town of Falmouth, MA

Stearns & Wheler, LLC
ENVIRONMENTAL ENGINEERS & SCIENTISTS

Map prepared by Harvard Design and Mapping Company, Inc.