Town of Orleans
Comprehensive Wastewater Management Plan

DRAFT

April 2009

Prepared for the
Wastewater Management Steering Committee
by

Wright-Pierce
Engineering a Better Environment

DRAFT
April 2009

TOWN OF ORLEANS
COMPREHENSIVE WASTEWATER MANAGEMENT PLAN

TABLE OF CONTENTS

SECTION	DESCRIPTION	PAGE
ES	Executive Summary	ES-1
1	INTRODUCTION	1-1
2	EXISTING CONDITIONS	2-1
	2.1 Land Use and Demographics	2-1
	2.2 Environmentally Sensitive Areas	2-5
	2.2.1 Watersheds	2-6
	2.2.2 Freshwater Ponds	2-6
	2.2.3 Coastal Embayments	2-10
	2.2.4 Protected Areas	2-11
	2.3 Soils	2-15
	2.4 Groundwater	2-17
	2.5 Water Use and Wastewater Flows	2-19
3	WASTEWATER MANAGEMENT NEEDS	3-1
	3.1 Approach	3-1
	3.2 Sanitary Needs	3-2
	3.2.1 Title 5 Variances	3-2
	3.2.2 Intensive Water Use	3-8
	3.2.3 Receiving Water Impacts	3-10
	3.2.4 Combined Indicators of Sanitary Needs	3-12
	3.3 Water Supply Protection	3-14
	3.3.1 Private Wells	3-14
	3.3.2 Public Wells	3-14
	3.3.3 Overview of Water Supply Protection Needs	3-18
	3.4 Surface Water Protection	3-18
	3.4.1 Freshwater Ponds	3-18
	3.4.2 Estuaries	3-21
	3.5 Convenience and Aesthetics	3-28
	3.6 Economic Growth	3-32
	3.7 Summary of Current Needs	3-33
4	FUTURE CONDITIONS	4-1
	4.1 Future Wastewater Quantities	4-1
	4.1.1 Definition of Terms	4-1
	4.1.2 Theoretical Build-Out	4-2
	4.1.3 Practical Build-Out	4-3

TABLE OF CONTENTS (Cont.)

SECTION	DESCRIPTION	PAGE
	4.1.4 Planning Horizon	4-4
	4.2 Population Projections	4-7
	4.3 Future Wastewater Needs	4-9
	4.4 "No Action" Alternative	4-9
5	IDENTIFICATION AND EVALUATION OF WASTEWATER PLAN COMPONENTS	5-1
	5.1 Wastewater Flows and Loads	5-1
	5.1.1 Summary of Wastewater Management Needs	5-1
	5.1.2 Strategies for Reductions of Flows and Loads	5-3
	5.2 Wastewater Collection	5-6
	5.2.1 Collection System Options	5-6
	5.2.2 Criteria for Identifying Properties to be Served	5-7
	5.3 Wastewater Treatment	5-8
	5.3.1 Effluent Limitations and Expected Performance	5-9
	5.3.2 Management of Residuals	5-17
	5.4 Wastewater Reuse and Disposal	5-19
	5.4.1 Wastewater Disposal Technology	5-19
	5.4.2 Wastewater Reuse Opportunities	5-20
	5.5 Siting of Wastewater Treatment and Disposal Facilities	5-22
	5.5.1 Initial Site Identification and First-Level Screening	5-22
	5.5.2 Target Effluent Disposal Capacity	5-22
	5.5.3 Second-Level Site Screening	5-23
	5.5.4 Site-Specific Exploration Needs	5-27
	5.5.5 Next Steps	5-28
	5.6 Non-Traditional Nitrogen Control Measures	5-28
6	FORMULATION OF COMPOSITE WASTEWATER PLANS	6-1
	6.1 Initial Plan Formulation	6-1
	6.2 Evaluative Criteria	6-2
	6.3 Overview of Wastewater Plans Recommended for Detailed Evaluation	6-5
	6.4 Plan Descriptions	6-8
	6.5 No Action Plan	6-10
	6.6 Importance of Nitrogen Balance	6-10
	6.7 Extent of Sewer System	6-11
7	EVALUATION OF ALTERNATIVE PLANS	7-1
	7.1 Introduction	7-1
	7.2 Transfer of Water Among Watersheds	7-2
	7.3 Transfer of Nitrogen Among Watersheds	7-7

TABLE OF CONTENTS (Cont.)

SECTION	DESCRIPTION	PAGE
	7.4 Extent of Sewer System	7-8
	7.5 Need for Land Purchases and Easements	7-9
	7.6 Capital Costs	7-9
	7.7 Operation and Maintenance Costs	7-13
	7.8 Net Present Worth Costs	7-14
	7.9 Impacts of User Charges and Tax Rate	7-15
	7.10 Environmental Impacts	7-15
	7.11 Energy Consumption	7-15
	7.12 Suitability of Treatment Facility Sites	7-18
	7.13 Truck Traffic at Tri-Town Site	7-20
	7.14 Expandability	7-21
	7.15 Flexibility for Phasing	7-22
	7.16 Potential for Water Reuse	7-24
	7.17 Regulatory Acceptability	7-25
	7.18 Ease in Implementation	7-26
	7.19 Potential for Impacting Town Growth Rate	7-27
	7.20 Potential for Siting a Public Works Facility at the Tri-Town State	7-28
	7.21 Overall Public Acceptability	7-30
	7.22 Summary of Evaluation	7-30
8	EVALUATION OF ENVIRONMENTAL IMPACTS	8-1
	8.1 Introduction	8-1
	8.2 Project Description	8-1
	8.3 Alternatives to the Project	8-1
	8.4 Existing Environment	8-2
	8.5 Assessment of Impacts	8-2
	8.5.1 Surface Water Quality	8-2
	8.5.2 Groundwater Quality	8-3
	8.5.3 Wetlands	8-4
	8.5.4 Floodplains	8-4
	8.5.5 Coastal Resources	8-5
	8.5.6 Open Space And Recreation	8-5
	8.5.7 Rare and Endangered Species	8-6
	8.5.8 Archaeological and Historic Resources	8-7
	8.5.9 Traffic	8-7
	8.5.10 Air Quality	8-8
	8.5.11 Noise	8-8
	8.5.12 Energy	8-9
	8.5.13 Generation of Solid Waste	8-9
	8.5.14 Public Health	8-9
	8.5.15 Community Growth and Land Use	8-9

TABLE OF CONTENTS (Cont.)

SECTION	DESCRIPTION	PAGE
	8.6 Regulatory Standards and Requirements	8-10
	8.7 Mitigation Measures	8-11
	8.8 The "No Action" Alternative	8-12
9	POTENTIAL FOR REGIONALIZATION	9-1
	9.1 Introduction	9-1
	9.2 Regionalization Options	9-1
	9.3 Evaluation of Options	9-3
10	POTENTIAL FOR WATER REUSE	10-1
	10.1 Introduction	10-1
	10.2 Reuse Options	10-1
	10.3 Level of Treatment	10-5
	10.4 Cost Estimates	10-6
	10.5 Regulatory Issues	10-6
	10.6 Other Non-Cost Factors	10-7
11	RECOMMENDED PLAN	11-1
	11.1 Introduction	11-1
	11.2 Development of Recommended Plan	11-1
	11.2.1 Activities of the WMSC	11-1
	11.2.2 Public Consultation Process	11-2
	11.2.3 Plan Selection	11-3
	11.3 Overview of Recommended Plan	11-4
	11.4 Structural Elements of Recommended Plan	11-5
	11.4.1 Wastewater Collection System	11-5
	11.4.2 Wastewater Treatment System	11-6
	11.4.3 System for Effluent Disposal and Reuse	11-8
	11.4.4 Facilities for Septage Handling	11-11
	11.4.5 Facilities of Sludge Handling	11-11
	11.4.6 Local Wastewater Management Systems	11-12
	11.4.7 Alternate Layouts for Tri-Town Site	11-13
	11.5 Non-Structural Elements of Recommended Plan	11-13
	11.5.1 Fertilizer Control Program	11-15
	11.5.2 Stormwater Management	11-16
	11.5.3 Water Conservation Program	11-16
	11.5.4 Flow and Load Reduction Initiative	11-16
	11.5.5 Enhancement of Embayment Flushing Rates	11-17
	11.5.6 Land Use Controls	11-18
	11.6 TMDL Compliance Plan	11-19
	11.7 Phasing of Facilities Construction	11-22
	11.8 Regionalization	11-28
	11.9 Soil and Groundwater Studies at Tri-Town Site	11-29

TABLE OF CONTENTS (Cont.)

SECTION	DESCRIPTION	PAGE
	11.9.1 Studies Conducted to Date	11-29
	11.9.2 Future Testing Program	11-30
	11.9.3 Long-Term Monitoring Plan	11-31
	11.10 Implementation Steps	11-31
	11.10.1 Establishment of a Managing Entity	11-31
	11.10.2 Land Acquisition	11-32
	11.10.3 Regulations, Bylaws and Policies	11-32
	11.10.4 Permitting	11-34
	11.10.5 Coordination with OBEGWPD on Septage Management and Land Requirements	11-35
	11.10.6 Coordination with Brewster and Eastham on Wastewater Regionalization	11-37
	11.10.7 Pond and Estuary Monitoring	11-37
	11.10.8 Energy Conservation/Generation and Green Design	11-38
	11.10.9 Water Service to Properties Near Wastewater Disposal Locations	11-38
	11.10.10 Independent Review of MEP Studies	11-39
	11.10.11 Implementation Schedule	11-39
	11.11 Financial Plan	11-41
	11.11.1 Current Estimates of Cost	11-41
	11.11.2 Capital Costs	11-41
	11.11.3 Operation and Maintenance Costs	11-42
	11.11.4 Application for SRF Loans	11-43
	11.11.5 Potential for Grants	11-44
	11.11.6 Financing Policy with Respect to Betterments and Taxes	11-45
	11.11.7 Costs to Typical Users and Non-Users	11-45
	11.12 Environmental Mitigations	11-47

TABLE OF CONTENTS (Cont.)

LIST OF TABLES

TABLE	DESCRIPTION	PAGE
1-1	LIST OF COMMONLY USED ACRONYMS AND ABBREVIATIONS	1-4
2-1	SUMMARY OF LAND USE AND DEMOGRAPHIC DATA	2-2
2-2	CURRENT WASTEWATER FLOWS PER LOT	2-22
2-3	ANNUAL AVERAGE WASTEWATER QUANTITIES BY WATERSHED CURRENT CONDITIONS	2-25
3-1	ENVIRONMENTAL SIGNIFICANCE RATING SYSTEM FOR TITLE 5 VARIANCES	3-3
3-2	SUMMARY OF TITLE 5 VARIANCE ANALYSIS	3-6
3-3	SUMMARY OF SANITARY NEEDS	3-12
3-4	POND TROPHIC STATUS, IMPAIRED USES AND WASTEWATER MANAGEMENT PRIORITIES	3-20
3-5	WASTEWATER FLOWS UPGRADIENT OF EVALUATED PONDS	3-23
3-6	REQUIRED NITROGEN LOAD REDUCTIONS BY SUB-EMBAYMENTS OF PLEASANT BAY	3-26
3-7	SUMMARY OF NEEDS ASSOCIATED WITH CONVENIENCE AND AESTHETIC FACTORS	3-30
3-8	SUMMARY OF CURRENT NEEDS IN ALL CATEGORIES	3-34
4-1	SUMMARY OF ASSUMPTIONS USED IN BUILD-OUT ANALYSIS	4-5
4-2	SUMMARY OF FUTURE NEEDS IN ALL CATEGORIES	4-10
4-3	ANNUAL AVERAGE WASTEWATER QUANTITIES BY WATERSHED AT PLANNING HORIZON	4-11
5-1	SUMMARY OF ALTERNATIVES FOR WASTEWATER MANAGEMENT COMPONENTS	5-5
5-2	EXPECTED EFFLUENT LIMITATIONS	5-10
5-3	EXPECTED EFFLUENT QUALITY	5-12
5-4	GENERAL CATEGORIES OF WASTEWATER SYSTEMS	5-14
5-5	INITIAL CAPACITY ESTIMATES FOR IDENTIFIED DISPOSAL SITES	5-25
6-1	INITIAL PLAN IDENTIFICATION	6-3
6-2	EVALUATIVE CRITERIA USED IN RATING WASTEWATER PLANS	6-4
6-3	SUMMARY OF WASTEWATER PLAN #1	6-13
6-4	SUMMARY OF WASTEWATER PLAN #2	6-16
6-5	SUMMARY OF WASTEWATER PLAN #3	6-19
6-6	COMPARISON OF WASTEWATER PLANS	6-22

TABLE OF CONTENTS (Cont.)

LIST OF TABLES (CONT.)

TABLE	DESCRIPTION	PAGE
7-1	DISPOSITION OF EFFLUENT	7-4
7-2	DISPOSITION OF WASTEWATER NITROGEN	7-8
7-3	SUMMARY OF CAPITAL COST ESTIMATES	7-11
7-4	EVALUATION OF ENERGY USAGE	7-16
7-5	COMPARISON OF WASTEWATER TREATMENT SITES	7-19
7-6	SUMMARY OF EVALUATIVE CRITERIA	7-31
11-1	WASTEWATER SYSTEM DESIGN DATA FOR CORE PROGRAM	11-10
11-2	PRELIMINARY PHASING PLAN FOR CORE PROGRAM	11-24
11-3	NUTRIENT LOAD REDUCTION BY PHASE	11-27
11-4	SCHEDULE FOR IMPLEMENTATION TASKS	11-40
11-5	PRELIMINARY ESTIMATE OF CAPITAL COSTS FOR CORE PROGRAM	11-42
11-6	PRELIMINARY ESTIMATE OF OPERATION AND MAINTENANCE COSTS FOR CORE PROGRAM	11-43
11-7	EQUIVALENT ANNUAL COSTS FOR TYPICAL RESIDENTS	11-46

LIST OF FIGURES

FIGURE	DESCRIPTION	PAGE
1-1	MAJOR WATERSHEDS	1-3
2-1	ZONING DISTRICTS	2-3
2-2	LAND USE	2-4
2-3	MONTHLY VARIATION IN RESIDENT POPULATION	2-5
2-4	MAJOR GROUNDWATER BASINS	2-7
2-5	FRESHWATER PONDS	2-8
2-6	ACEC'S WETLANDS, AND OPEN SPACES	2-12
2-7	OUTSTANDING RESOURCE WATERS AND SHELLFISH GROWING AREAS	2-13
2-8	FLOOD PLAINS	2-16
2-9	SOIL CONDITIONS	2-18
2-10	PERCHED WATER TABLE	2-20

TABLE OF CONTENTS (Cont.)

LIST OF FIGURES (CONT.)

FIGURE	DESCRIPTION	PAGE
2-11	CURRENT WASTEWATER FLOW PER LOT	2-23
2-12	CURRENT WASTEWATER FLOWS BY MAJOR WATERSHED	2-24
2-13	SEASONAL VARIABILITY IN WATER USE AND WASTEWATER FLOW	2-27
3-1	TITLE 5 VARIANCES 1995-2005	3-7
3-2	WATER USE INTENSITY	3-9
3-3	RECEIVING WATER QUALITY	3-11
3-4	LOTS WITH SANITARY NEEDS	3-13
3-5	EXTENT OF PUBLIC WATER SUPPLY LINES	3-15
3-6	DEVELOPED LOTS IN PUBLIC WATER SUPPLY ZONE IIS	3-16
3-7	POND PROTECTION NEEDS	3-22
3-8	CONVENIENCE AND AESTHETIC FACTORS	3-31
3-9	AGGREGATED NEEDS	3-35
4-1	WASTEWATER FLOW PROJECTIONS AT BUILD-OUT	4-6
4-2	DETERMINATION OF WASTEWATER FLOW AT END OF PLANNING HORIZON	4-8
5-1	GENERIC WASTEWATER MANAGEMENT SYSTEM	5-2
5-2	TRI-TOWN SEPTAGE TREATMENT FACILITY	5-18
6-1	WASTEWATER PLAN LEGEND	6-6
6-2	WASTEWATER PLAN #1	6-14
6-3	WASTEWATER PLAN #1	6-15
6-4	WASTEWATER PLAN #2	6-17
6-5	WASTEWATER PLAN #2	6-18
6-6	WASTEWATER PLAN #3	6-20
6-7	WASTEWATER PLAN #3	6-21
7-1	SCHEMATIC REPRESENTATION OF WASTEWATER MANAGEMENT PLANS	7-3
10-1	POSSIBLE RECLAIMED WATER PIPELINE	10-4
11-1	LOCATION OF COLLECTION SYSTEM INFRASTRUCTURE AND TREATMENT FACILITY	11-7
11-2	LAYOUT OF PROPOSED WASTEWATER TREATMENT AND DISPOSAL FACILITIES AT TRI-TOWN SITE	11-9
11-3	PROPOSED WASTEWATER TREATMENT AND DISPOSAL FACILITIES ALTERNATE LAYOUTS	11-14
11-4	POSSIBLE SEWER PHASING PLAN	11-26

TABLE OF CONTENTS (Cont.)

LIST OF APPENDICES

(Included in Separate Volume)

APPENDIX	DESCRIPTION
A	Evaluation of Freshwater Ponds - Bakers Pond, Boland Pond, Cedar Pond, Crystal Lake, Ice House Pond, Pilgrim Lake, Sarah's Pond, and Shoal Pond
B	Information on Wastewater Management Components
C	Public Consultation
D	Preliminary Sizing Data for Wastewater Treatment and Disposal Elements of Recommended Plan
E	Hydrogeologic Investigations at Site 241
F	Hydrogeologic Modeling at Site 241
G	Executive Summaries of Relevant Technical Reports by the Massachusetts Estuaries Project
H	Habitat Assessment Letter Report LEC Environmental Consultants, Inc.
I	Cluster Systems (*not included in April 2009 Draft CWMP*)

Town of Orleans
Comprehensive Wastewater Management Plan

EXECUTIVE SUMMARY

OVERVIEW

The Town of Orleans has developed a Comprehensive Wastewater Management Plan to guide the improvement of coastal estuaries and freshwater ponds to meet state and federal mandates. The plan is highly adaptable to accommodate measured progress in water quality improvement, future regional opportunities, effectiveness of lower-cost alternatives, and availability of favorable financing. To meet current mandates, a municipal sewer system is needed to serve one-half of Orleans' developed properties at an estimated capital cost of $150 million to be spent over 15 to 20 years. The plan also accommodates the option of later providing town-wide sewers, if needed or desired in the future, at an added cost of $95 million. Appropriation requests will be brought before future Town Meetings for each phase of the plan.

INTRODUCTION

In 2000, the Town of Orleans embarked on a multi-year, multi-phase process to determine the best ways to improve wastewater management practices. This process has been called Comprehensive Wastewater Management Planning, and the result is a Comprehensive Wastewater Management Plan or CWMP. The CWMP has three principal segments that are summarized in this report:

- **Needs Assessment**
- **Identification and Evaluation of Alternatives**
- **Development of Recommended Plan**

NEEDS ASSESSMENT

Private on-lot disposal, in conformance with the State Sanitary Code (Title 5), adequately protects Orleans citizens from the potential public health problems associated with improperly designed or located wastewater disposal systems. Orleans' principal wastewater-related problems lie in the control of nutrients that are only poorly removed from typical septic systems. A systematic appraisal of town-wide wastewater practices demonstrated the need to eliminate 2,800 private septic systems for the purposes of:

- Protection of coastal waters from excessive nitrogen loading, and
- Protection of freshwater ponds from high phosphorus loading.

Elimination of 52% of the individual septic systems in Orleans, and construction of a municipal wastewater system, is needed to control these nutrients to meet state and federal requirements and to help protect 8 priority ponds. The Needs Assessment is presented in Sections 2, 3 and 4 of this report.

IDENTIFICATION AND EVALUATION OF WASTEWATER MANAGEMENT ALTERNATIVES

The Town's Wastewater Management Steering Committee (WMSC) embarked on a thorough evaluation of many technologies and techniques for reducing nutrient loading to fresh and marine waters. First, all available solutions were analyzed to identify those most applicable to Orleans. Next, nine wastewater plans were formulated from these applicable technologies, including centralized and decentralized systems, a range of effluent disposal techniques, and sites all across Orleans. Each plan was evaluated against 16 factors and the resultant ratings were used to reduce the candidate plans to these three:

Plan 1 Decentralized Treatment and Disposal in All Major Watersheds
Plan 2 Centralized Treatment and Disposal at the Tri-Town Site (Namskaket Watershed)
Plan 3 Centralized Treatment in South Orleans with Disposal on Golf Courses in the Pleasant Bay Watershed.

The WMSC conducted a very thorough analysis of these three plans using 20 criteria, including such factors as cost, energy use, environmental impact, treatment plant site suitability, regulatory acceptability, amenability to regionalization, and overall public acceptability. The formulation of the plans and the WMSC evaluation are described in Sections 5 through 10 of this report.

DESCRIPTION OF THE RECOMMENDED WASTEWATER MANAGEMENT PLAN

Based on the WMSC's detailed review of the three plans, and supplemented with a comprehensive public consultation process, Plan 2 emerged as the overall best one. To make Plan 2 even more suitable, it will be supplemented by provisions for small-scale treatment and disposal systems in some of the most impacted "headwaters" sub-watersheds, an active regionalization initiative, and provisions for future effluent reuse. This Recommended Plan includes both structural and non-structural components, and will be constructed in phases to reduce initial project costs, allow time for neighboring towns to proceed with their wastewater planning, and account for the effectiveness of the non-structural elements to be demonstrated. This multi-component, phased approach, with opportunities for "mid-course corrections", is termed "adaptive management." Section 11 of this report describes the Recommended Plan in detail.

Structural Elements of Plan

The principal features of the structural plan are as follows:

- **Wastewater Collection**: a municipal sewer system to serve about 2,800 Orleans properties in nitrogen-sensitive watersheds and near key ponds;
- **Wastewater Treatment**: an advanced treatment system located at the site of the Tri-Town Septage Treatment Facility to remove a high percentage of the collected nitrogen;
- **Effluent Recharge**: a series of open rapid infiltration basins at the Tri-Town site designed to disperse effluent without excessive mounding of the groundwater;
- **Septage Handling**: new septage tanks and equipment to receive and treat septage from Orleans, and neighboring towns, to replace the aging Tri-Town facilities;
- **Sludge Handling**: Dewatering equipment to produce a truckable residual that will be transported off-Cape for reuse or disposal; and
- **Cluster Systems**: Five small, local treatment and disposal facilities to provide early protection of certain threatened receiving waters.

These structural facilities are expected to cost approximately $150 million to build, and $1.4 million to operate annually, both expressed in mid 2008 dollars.

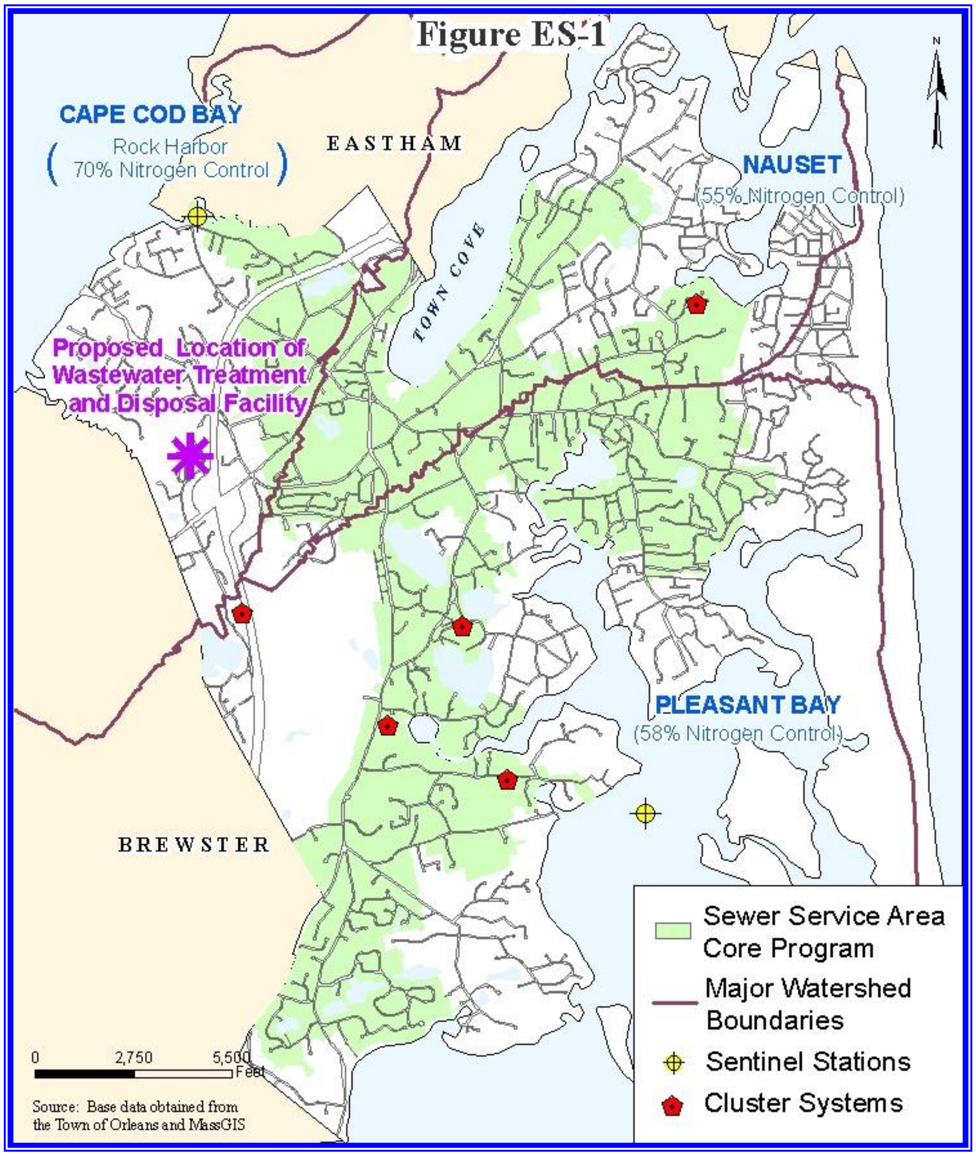
Non-Structural Elements of Plan

Cost savings may result if non-structural aspects of the Recommended Plan can be successfully implemented. These non-structural elements may allow less extensive sewering and smaller treatment and disposal facilities:

- A **fertilizer control** program to reduce nitrogen leaching from lawns and parks;
- A **stormwater management** program to reduce nutrient loads from runoff;
- Expansion of the **water conservation programs** of the Water Department;
- A **wastewater flow and load reduction** initiative, including testing of alternative toilets;
- **Enhancement of embayment flushing** rates to increase assimilative capacity; and
- **Land use controls** including the Board of Health's nutrient control regulation and measures to make this a "growth neutral" plan.

Phasing Plan

A formal phasing plan is recommended to serve as a blueprint for the Town's adaptive management approach. First, all of Orleans' documented wastewater needs would be satisfied in the "Core Program". Upon completion of the Core Program, if the Town deems it necessary or desirable, an "Extended Program" could be implemented to provide public wastewater service to the entire town at an added cost currently estimated to be about $95 million (mid 2008 dollars). The Core Program could have 6 phases completed over 15 to 20 years. At the end of each phase, the Town should document the reduction in watershed nitrogen loads and its progress on the various non-structural elements, and then adjust its expenditures in the next phase accordingly. Supporting the decisions will be a continuing program of water quality and marine habitat monitoring.



Since the achievement of water quality goals will take many years and perhaps several midcourse corrections, DEP's approval of the phased plan and associated checkpoints is intended to provide the Town with assurance that it is on the right track. It is proposed that compliance with the approved CWMP will free the Town from enforcement actions under current state and federal laws.

Capacity at Proposed Site for Wastewater Treatment and Disposal

Technical studies at the site of the Tri-Town Septage Treatment Facility have shown its capabilities for both wastewater treatment and effluent disposal. While some confirming studies are needed, the best available information indicates that this site has sufficient room for wastewater treatment facilities for both the Core and Extended Programs. There is also room for rapid infiltration of the wastewater flows expected at the end of the 20-year planning period for Orleans' Core Program. The Tri-Town site does not have adequate room for Orleans' Extended Program flows; a supplemental disposal site would be needed if that program were implemented. At that time, effluent reuse on ballfields at the nearby schools could be used to help meet the added disposal need. Effluent disposal at the Tri-Town site can be accomplished within the assimilative capacities of the Namskaket and Little Namskaket systems, without impacting Town Cove or Rock Harbor.

Opportunities for Regionalization

The Orleans Recommended Plan provides two significant opportunities for regionalization:

- Treatment of wastewater from Eastham at the Tri-Town site to enable Eastham to meet its share of the expected nitrogen control requirements for Rock Harbor and the Nauset system.
- A possible joint treatment facility with Brewster located near the Orleans' southerly boundary, with effluent reuse on golf courses in Brewster and Harwich.

The Recommended Plan would allow regionalization some time after the first three phases of the Orleans Core Program, leaving time for Eastham and Brewster to complete their wastewater planning studies.

Implementation Schedule

The Recommended Plan should be implemented in accordance with the following schedule:

Complete CWMP	late 2009
Preliminary and final design	mid 2009 to fall 2011
Bidding of Phase 1 facilities	late 2012
Town Meeting appropriation for Phase 1 construction	May 2013
Phase 1 construction	mid 2013 to mid 2015
Start-up of Phase 1 facilities	mid 2015

Costs to Typical Users and Non-Users

In 2008, the Orleans Board of Selectmen adopted an interim financing policy that calls for 20% of the debt service for the wastewater facilities to be recovered from betterment assessments levied against properties connected to the proposed sewer system and 80% recovered through increased property taxes. The goal of this policy is to equalize the costs to those connected to the sewer and those that will continue to rely on private on-site septic systems. For the typical $700,000 home, the equivalent annual cost for either category of property owner would be approximately $2,600 per year, including betterment assessments, property tax increases, user fees, connections costs, septic system replacement costs and periodic septage pumping. The Town is pursuing several grant and loan opportunities to help reduce costs.

Coordination with the Orleans Brewster Eastham Groundwater Protection District (OBEGWPD)

The Tri-Town Septage Treatment Facility, owned by the OBEGWPD, now serves the three District towns and others in the region. Many of its facilities are nearing the end of their useful life, and more stringent effluent limitations may be imposed in the future. New wastewater facilities at the Tri-Town site can easily accommodate updated septage handling capability. The Town of Orleans should work closely with Eastham and Brewster to obtain permission to build the wastewater facilities and to effect an orderly transition from existing to new septage handling functions. These discussions should be part of broader negotiations on regional solutions for wastewater needs.

CONCLUSION

The CWMP is a highly adaptable phased approach to wastewater management that allows Orleans to address recent nutrient control mandates with relatively low risk and controllable costs.

SECTION 1

INTRODUCTION

The Town of Orleans has embarked on a multi-year, multi-phase process to determine if improved methods of wastewater management are needed, and if so, what those improved methods would entail and what they would cost. The process has been called Comprehensive Wastewater Management Planning, and the result will be a Comprehensive Wastewater Management Plan or CWMP. The CWMP process is being conducted in five phases, as follows:

Phase 1: Project Administration and Support
Phase 2: Data Review and Scoping
Phase 3: Needs Assessment
Phase 4: Development and Screening of Alternatives
Phase 5: Detailed Evaluation of Alternatives, Regulatory Filings and Development of Recommended Plan

Phase 1 includes activities that span all other phases. Phase 2 was completed in late 2005, allowing the start of technical work on later phases. The Needs Assessment Report (Phase 3) was issued in draft form in February 2007 and was the subject of a public meeting on February 26, 2007. In December 2007, the Alternatives Screening Report (Phase 4) was issued, and it was reviewed with the public at two meetings held on January 17, 2008. The alternative wastewater management plans identified in the Phase 4 Report have been the subject of more detailed investigation in Phase 5. The Detailed Evaluation of Alternatives summarized that investigation and was released in May 2008. It was the subject of two public meetings held on May 22, 2008. Public input on that evaluation continued over the summer of 2008, culminating in the selection of a single wastewater plan (the Recommended Plan) in August 2008. The Recommended Plan was endorsed at a Special Town Meeting in October 2008. This current report is a compilation of the three prior reports with a single new chapter describing the Recommended Plan.

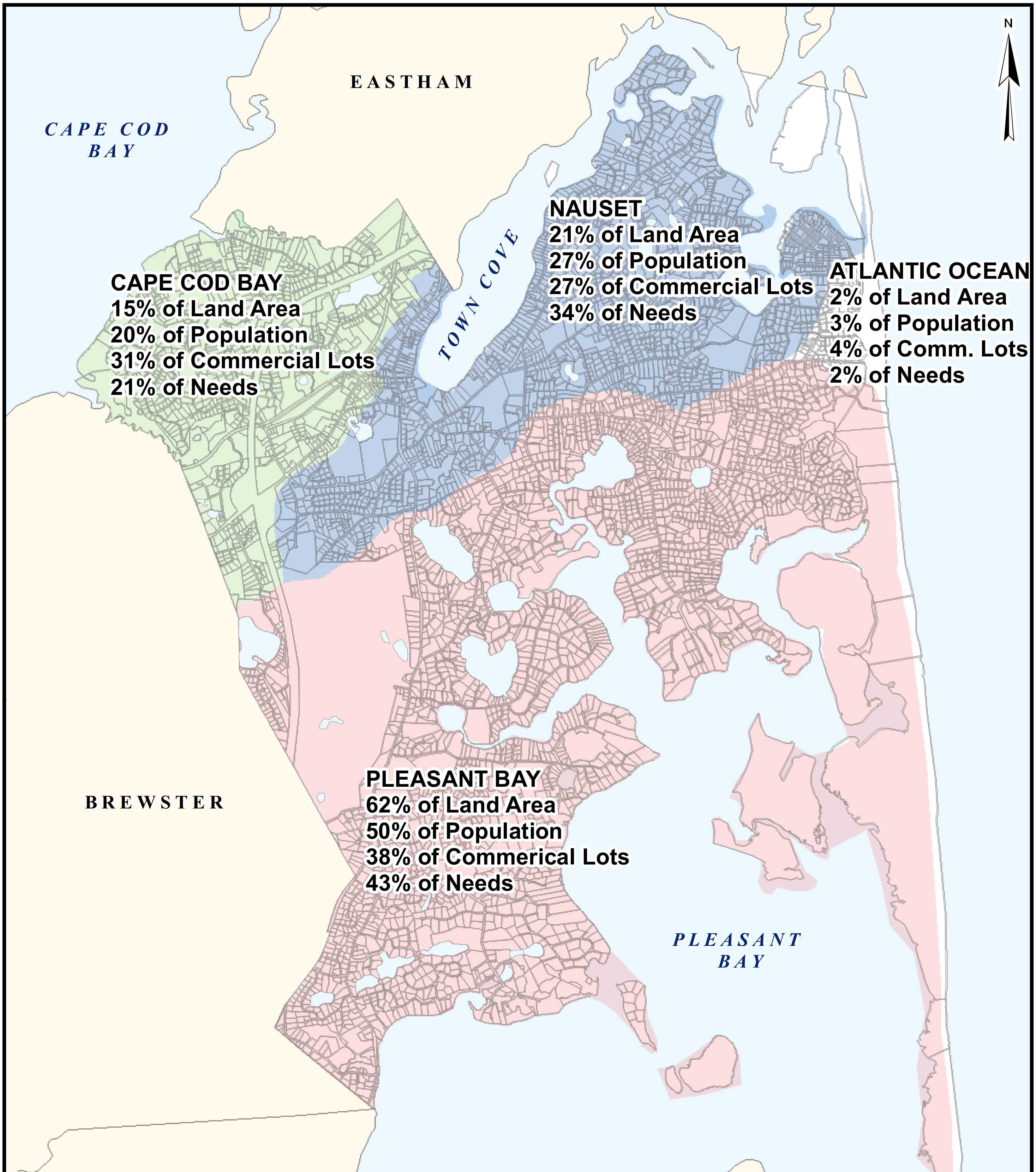
The Town has elected to call this process Comprehensive Wastewater Management Planning. Other related terms in use in the industry include Comprehensive Water Resources Planning and Integrated Water Resource Planning. The Town has chosen the CWMP title for consistency with Town Meeting appropriations, requests for proposals and engineering agreements. The Town's intention is to incorporate many of the broader aspects implicit in the alternative titles.

Orleans is blessed with significant access to marine resources, with frontage on Pleasant Bay, the Atlantic Ocean, Nauset Inlet and Cape Cod Bay. Whenever possible, this and prior reports present both town-wide data and information specific to the areas in town tributary to those water bodies. These major watersheds are the fundamental building blocks of this analysis; their geographic extent is shown in Figure 1-1.

This report consists of 11 sections and a number of supporting appendices. Following this introduction are the following sections:

Section 2:	A summary of existing conditions
Section 3:	Documentation of wastewater management needs
Section 4:	A description of expected future conditions
Section 5:	Identification and review of components of a wastewater plan
Section 6:	Description of three wastewater plans for more detailed review
Section 7:	The detailed evaluation of the three candidate wastewater plans
Section 8:	A comparison of the environmental aspects of the three plans
Section 9:	A review of the potential for regional wastewater facilities
Section 10:	A review of the potential for water reuse
Section 11:	The details of the Recommended Plan

Many technical terms, abbreviations and acronyms are used throughout this report. Table 1-1 defines those that are most commonly used.



Source: Base data obtained from the Town of Orleans and MassGIS

0 4,000 8,000 Feet

Orleans CWMP

Major Watersheds

PROJ NO:	DATE:	FIGURE:
10645G	Apr 2009	1-1

WRIGHT-PIERCE
Engineering a Better Environment

Thursday, September 11, 2008 8:04:52 AM W:\GIS_Development\Projects\10645B-Orleans\RecommendationPlan\Fig1-1.mxd

TABLE 1-1

LIST OF COMMONLY USED ACRONYMS AND ABBREVIATIONS

ACEC	Area of Critical Environmental Concern
BOH	Board of Health
BOS	Board of Selectmen
CAC	Citizens Advisory Committee
CCC	Cape Cod Commission
"Current"	Covering the dates 2002 to 2005, applied to population, wastewater flow or nitrogen load conditions
CWMP	Comprehensive Wastewater Management Plan
DEIR	Draft Environmental Impact Report
DEP	Department of Environmental Protection (Massachusetts)
DRI	Developments of Regional Impact
EIR	Environmental Impact Report
ENF	Environmental Notification Form
EOEEA	Executive Office of Energy and Environmental Affairs
ESA	Environmentally Sensitive Area
FEIR	Final Environmental Impact Report
"Future"	Referring to population, wastewater flows or nitrogen loads, expected at Planning Horizon (2030)
GIS	Geographic Information System
gpd	Gallons Per Day
gpd/sf	Gallons Per Day Per Square Foot
I/A	Innovative and Alternative
I/I	Infiltration and Inflow
kg/day	Kilograms Per Day
lb/yr	Pounds Per Year
MEP	Massachusetts Estuaries Project
MEPA	Massachusetts Environmental Policy Act
mgd	Million Gallons Per Day
mg/l	Milligrams Per Liter
NRCS	Natural Resources Conservation Service
OBEGWPD	Orleans Brewster Eastham Groundwater Protection District
ORW	Outstanding Resource Water
PALS	Pond and Lake Stewards
ppm	Parts Per Million
SMAST	School of Marine Science and Technology, University of Massachusetts at Dartmouth
SRF	State Revolving Fund
TMDL	Total Maximum Daily Load
USEPA	U.S. Environmental Protection Agency
USGS	United States Geologic Survey
WMSC	Wastewater Management Steering Committee

SECTION 2

EXISTING CONDITIONS

2.1 LAND USE AND DEMOGRAPHICS

Orleans is a predominantly residential community with a concentrated business district. Key land use and demographic data are summarized in Table 2-1 based on 2003 data supplied by the Orleans Planning Department. Figure 2-1 shows the eight zoning districts, and Figure 2-2 illustrates current land uses. The vast area of Orleans' property falls within the residential zoning districts. Commercial activity is focused in the areas along Route 6A between the Brewster and Eastham town lines. There are small areas in East Orleans, South Orleans and at Rock Harbor zoned for rural and marine businesses.

Of the 4,733 developed lots, 85% are developed residentially. Between residential neighborhoods and the apartment and condominiums in the commercial districts, there are 5,069 dwelling units including 12,622 bedrooms. The town is substantially developed; only 11% of the residential lots and 22% of the commercial parcels are vacant. A significant number of vacant lots have been set aside for conservation and other purposes and are not developable.

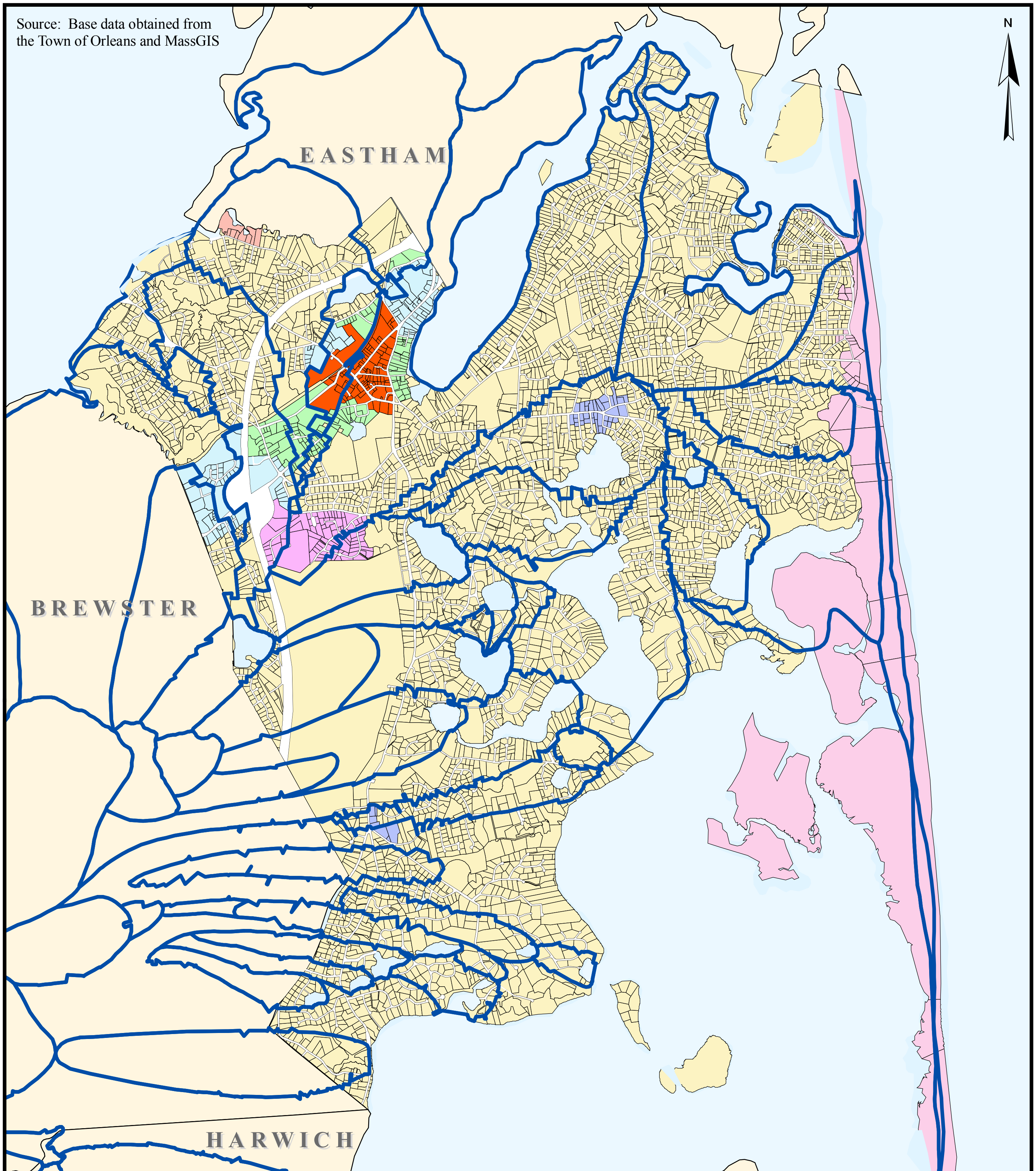
The official state and federal censuses document a permanent year-round population of approximately 7,000 people. Analysis of water use and demographic data by Town staff indicates that Orleans' current population is approximately 10,700 on an annual average basis. This figure represents the average of all months of the year, including about 6,000 in January and about 22,000 in July and August; see Figure 2-3. Town-wide, approximately 40% of the homes are occupied seasonally based on personal property tax data. About 80% of the developed residential properties are located in the Pleasant Bay and Nauset watersheds.

As is typical on Cape Cod, there are many private roads that have not been accepted as public ways. Data from the Planning Department indicates that 45% of the town's year-round parcels and 50% of the seasonal parcels are located on private roads.

TABLE 2-1
SUMMARY OF LAND USE AND DEMOGRAPHIC DATA

	MAJOR WATERSHED				
	PLEASANT BAY	NAUSET SYSTEM	ATLANTIC OCEAN	CAPE COD BAY SYSTEMS	TOWN-WIDE
Residential					
Number of Developed Parcels	2,015	1,256	115	659	4,045
Number of Vacant Parcels	308	124	14	54	500
Total Number of Parcels	2,323	1,380	129	713	4,545
Developed Lot Area, acres	2,143	1,074	79	620	3,916
Vacant Lot Area, acres	364	148	9	62	583
Total Lot Area, acres	2,507	1,222	88	682	4,499
Number of Dwelling Units	2,215	1,430	126	1,187	4,958
Number of Bedrooms	6,398	3,765	386	1,928	12,477
Avg Size of Devel. Lot, acres	1.06	0.86	0.69	0.94	0.97
Commercial, Industrial and Institutional					
Number of Developed Parcels	264	186	25	213	688
Number of Vacant Parcels	91	47	1	50	189
Total Number of Parcels	355	233	26	263	877
Developed Lot Area, acres	343	369	145	434	1,291
Vacant Lot Area, acres	146	44	<1	98	288
Total Lot Area, acres	489	413	145	532	1,579
Number of Dwelling Units	12	95	1	3	111
Number of Bedrooms	59	32	16	38	145
Total					
Number of Developed Parcels	2,279	1,442	140	872	4,733
Total Number of Parcels	2,678	1,613	155	976	5,422
Developed Lot Area, acres	2,486	1,443	224	1,054	5,207
Total Lot Area, acres	2,996	1,635	233	1,214	6,078
Total Number of Dwell. Units	2,235	1,525	127	1,190	5,069
Total Number of Bedrooms	6,457	3,797	402	1,966	12,622

Source: Orleans Planning Department, 2003 data



Zoning Districts

- General Business
- Industrial
- Marine Business
- Residence
- Rural Business
- Seashore
- Village Center
- Limited Business

Watershed Boundaries

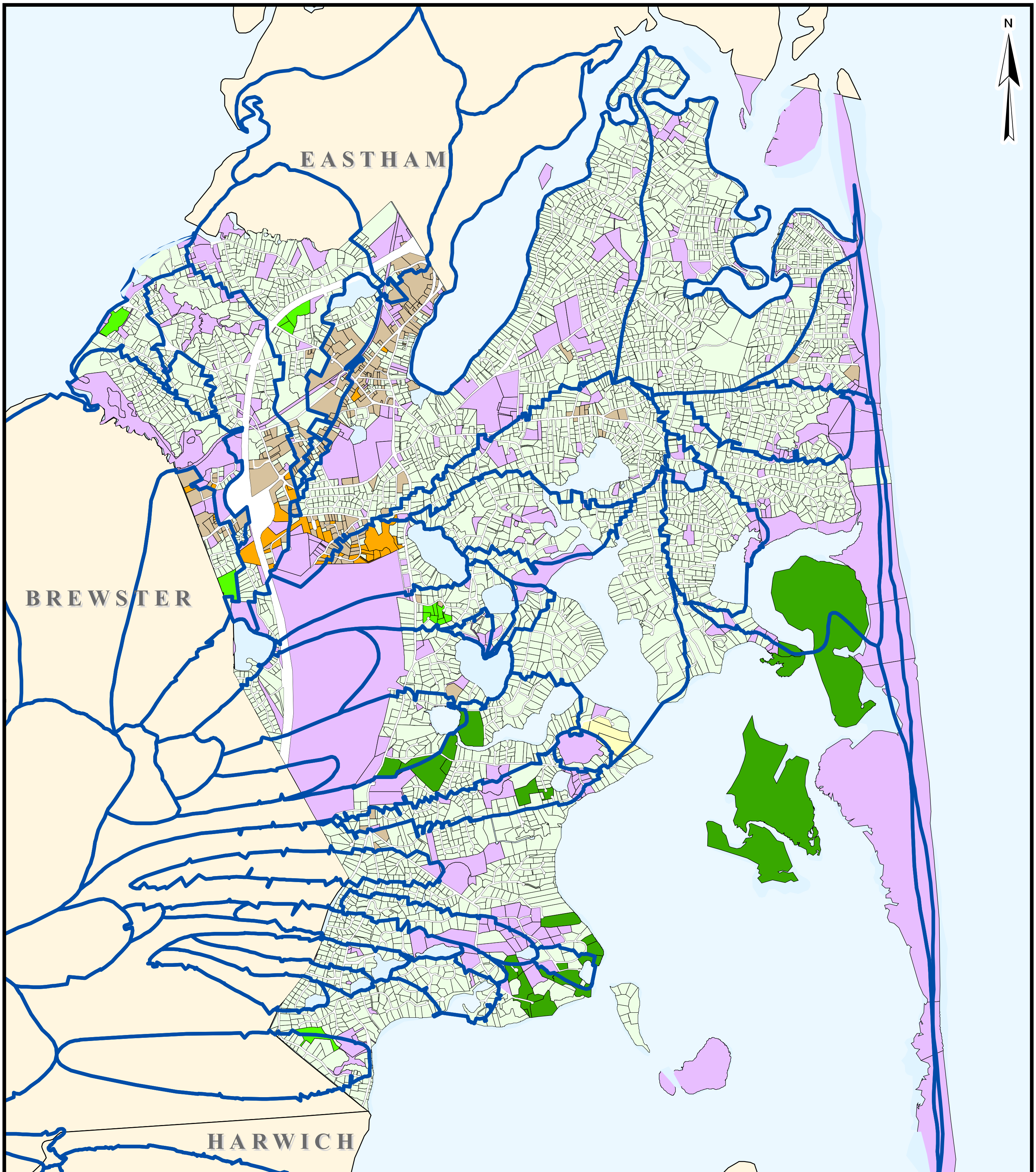
0 4,000 8,000 Feet

Orleans CWMP

Zoning Districts

PROJ NO:	DATE:	FIGURE:
10645G	Apr 2009	2-1

WRIGHT-PIERCE
Engineering a Better Environment



Land Use

- Watershed Boundaries
- Residential
- Commercial
- Industrial
- Agricultural
- Recreational
- Chapter 61
- Public Service

0 4,000 8,000 Feet

Source: Parcel data obtained from the Orleans Planning Dept. Watershed boundaries from MEP.

Orleans CWMP

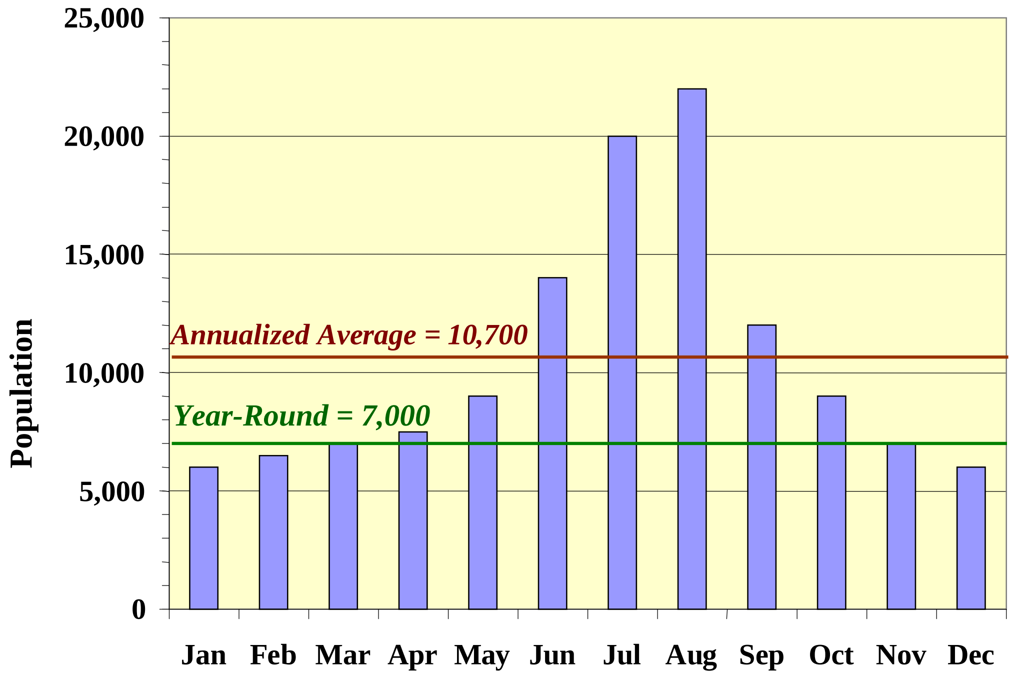
Land Use

PROJ NO: 10645G DATE: Apr 2009 FIGURE: 2-2

WRIGHT-PIERCE
Engineering a Better Environment

Thursday, September 11, 2008 8:06:49 AM W:\GIS_Development\Projects\10645B-Orleans\RecommendationPlan\Fig2-2.mxd

FIGURE 2-3
MONTHLY VARIATION IN RESIDENT POPULATION



Source: Orleans Planning Dept.

2.2 ENVIRONMENTALLY SENSITIVE AREAS

Identification of environmentally sensitive areas (ESAs) is an integral part of the CWMP. Based on review of available Massachusetts Geographic Information System (MassGIS) and Town files, maps, and relevant documents, this summary of ESAs identifies those issues that should be considered when developing the CWMP. These ESAs constitute significant natural resources that may warrant additional investigation and/or protection when considering the effects of nitrogen loading and/or potential wastewater management options across the Orleans landscape. Information is provided below for:

- Watersheds
- Freshwater Ponds
- Coastal Embayments
- Protected Areas

2.2.1 Watersheds

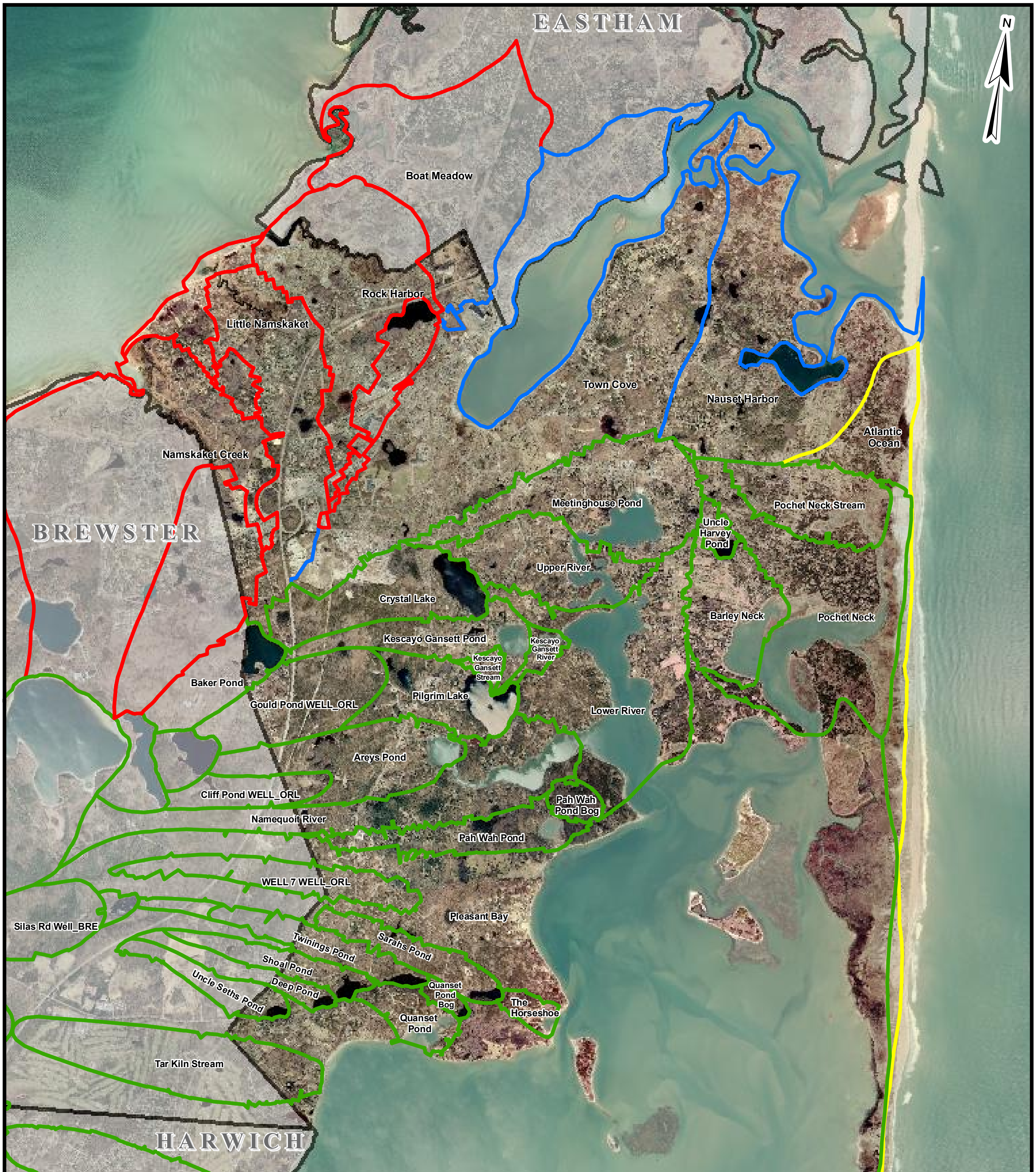
Watersheds refer to the areas of recharge and groundwater which flow toward a surface water body, be it a freshwater (lake, pond, wetland) or marine feature (tidal wetland, coastal embayment, open ocean). Due to the sandy soil in most of Orleans, the areas of the natural watersheds correspond strongly to the groundwater contours and flow.

In terms of watersheds, the Town is divided into four areas that drain into Cape Cod Bay, Nauset Harbor, Pleasant Bay, and the Atlantic Ocean. The first three represent the major watersheds. Work by the United States Geological Survey (USGS) has led to further sub-division of the three major watersheds into sub-watersheds for the Town's prominent tidal ponds, inlets and embayments. Figure 2-4 depicts the four major watersheds as well as the sub-watersheds leading to Pleasant Bay and Cape Cod Bay. Further sub-division of the Nauset watershed will be possible when the Massachusetts Estuary Project (MEP) report and underlying databases are made available for this area. The direct watershed of the Atlantic Ocean is not included in the MEP studies. The groundwater in Orleans (and Cape-wide) has been designated as a Sole Source Aquifer by the USEPA.

2.2.2 Freshwater Ponds

Orleans is well-endowed with freshwater features, including 63 ponds which cover approximately 220 acres. Most of these ponds are relatively small in size, with only 12 being greater than 5 acres. These include: Bakers Pond, Bolands Pond, Cedar Pond, Crystal Lake, Gould Pond, Ice House Pond, Pilgrim Lake, Sarah's Pond, Shoal Pond, Twinings Pond, Uncle Harveys Pond, and Uncle Seths Pond (see Figure 2-5). Four of these are listed as Great Ponds by the Commonwealth of Massachusetts: Bakers Pond, Cedar Pond, Crystal Lake, and Pilgrim Lake. Eight of these ponds will be further analyzed as part of the needs assessment: Bakers Pond, Bolands Pond, Cedar Pond, Crystal Lake, Ice House Pond, Pilgrim Lake, Shoal Pond and Sarah's Pond.

Historical water quality information prior to the 1970s is sparse for most Orleans ponds, and consists mainly of state assessments of depth profiles of temperature and dissolved oxygen levels for acceptable trout habitat. Publicly-available information on water quality for the 12 ponds listed above and 5 additional smaller ponds is summarized in the Cape Cod Commission's *Cape*



Major Basin

- Atlantic Ocean
- Cape Cod Bay
- Nauset System
- Pleasant Bay

Source: Aerial imagery provided by MassGIS.
Watershed boundaries from MEP.

0 4,000 8,000 Feet

Orleans CWMP

Major Groundwater Basins

PROJ NO: 10645G DATE: Apr 2009 FIGURE: 2-4

WRIGHT-PIERCE
Engineering a Better Environment

Tuesday, September 23, 2008 7:34:22 AM W:\GIS_Development\Projects\10645B-Orleans\RecommendationPlan\Fig2-4.mxd

Principal Fresh Water Ponds

Source: Aerial imagery provided by MassGIS.

0 4,000 8,000 Feet

Orleans CWMP

Freshwater Ponds

PROJ NO: 10645G	DATE: Apr 2009	FIGURE: 2-5

WRIGHT-PIERCE
Engineering a Better Environment

Thursday, September 11, 2008 8:08:26 AM W:\GIS_Development\Projects\10645B-Orleans\RecommendationPlan\Fig2-5.mxd

Cod Lake and Pond Atlas. The water quality data, based on the 2001 Pond and Lake Stewards (PALS) summer survey, include key trophic indicator parameters: total phosphorus (TP), total nitrogen (TN), chlorophyll *a* (chl *a*), and Secchi disk transparency (SDT) depth readings. Some additional water chemistry for relevant Cape Cod ponds is also available.

The Commission used an USEPA method and the sampling results from the 2001 PALS snapshot to estimate Cape-Cod-specific nutrient reference criteria. Comparison of the 2001 PALS data to these reference threshold data indicated that, of the 17 Orleans ponds sampled, all were classified as "impacted" for at least one of the following parameters: chlorophyll a, total nitrogen, or total phosphorus. It is important to note that USEPA's use of the term "impacted" is not equivalent to impairments as defined under the state water quality standards, although available data does show some correlation. The USEPA method picks the lower 25^{th} percentile from all available data as the threshold. This method has some notable limitations (e.g., accounting for macrophyte influence), but its results on Cape Cod generally match other data developed in the northeast and USEPA analysis of data within the eastern US coastal ecoregion. Individual assessments of each pond is a preferred approach, but this type of analysis can be useful for ponds with limited water quality data. Further evaluation of water quality, trophic status, and the potential susceptibility to current and future land uses is provided in Section 3.4.1 and Appendix A.

More detailed evaluation of the morphological features and conditions of the three larger ponds (Bakers, Crystal and Pilgrim) is provided in the *Cape Cod Lake and Pond Atlas* with bathymetric maps. All three of the water bodies were considered impacted. Varying amounts of information is available for other Orleans ponds regarding bathymetry, average depth and pond volume. The most complete study of an Orleans pond is the *Baseline Water Quality Study for Crystal Lake*, which synthesizes chemical, physical and biological conditions of the lake, as well as describing the nature and character of the watershed.

In addition to the PALS water quality "snapshot" data for Orleans ponds, water quality data and field observations were collected over the summer of 2002 to 2005. These water quality samples and observations were made by Orleans volunteers with the oversight, laboratory services, and cooperation of the Cape Cod Commission, the Cape Cod National Seashore, and UMass Dartmouth's School of Marine Science and Technology (SMAST). To date, this effort includes over 600 water quality samples collected from over 17 ponds in Orleans along with over 1,800 complementary field data points (dissolved oxygen, temperature) during the past four summers. These data have been analyzed and interpreted by Commission staff with regard to selected ponds' hydrologic and nutrient budgets, trophic status, and recommended changes in current management practices and monitoring activities. A document presenting the data summary and preliminary results (*Review and Interpretation of Orleans Ponds Volunteer Monitoring Data*) was issued in draft form in September 2006.

2.2.3 Coastal Embayments

Coastal embayments, tidal creeks and inlets are important features of the Town of Orleans, which has an abundance of coastal shoreline. The more significant coastal embayments, inlets and major water bodies include: Areys Pond, the Atlantic Ocean, Cape Cod Bay, Little Namskaket Creek, Little Pleasant Bay, Lonnies (or Kescayogansset) Pond, Meetinghouse Pond, Mill Pond, Namskaket Creek, Nauset Harbor, Namequoit River, Paw Wah Pond, Pleasant Bay, Pochet Inlet, Quanset Pond, Rock Harbor, The River, and Town Cove (see Figure 2-4).

These marine features and their biological resources have been the focus of much attention in Orleans and neighboring towns due to their status as nitrogen-sensitive waters and their functional role as important environmental indicators of potential eutrophication due to land use influences. Extensive information and databases on these water bodies, their current water quality and biological conditions, trophic status, current and projected nutrient loads from their watersheds, and potential management implications, are being developed as part of the MEP modeling and TMDL (Total Maximum Daily Load) process.

All of the coastal embayments impacted by Orleans are included in the Massachusetts Estuaries Project. A series of reports containing watershed-specific information, nutrient loads, modeling analyses, and underlying databases is being developed by SMAST; one each for Pleasant Bay, and the Nauset system and three for individual Cape Cod Bay systems. The Pleasant Bay technical report was issued for public comment in 2006 and the Cape Cod Bay reports in 2008.

The Nauset report is expected to be issued by late 2008. These reports, which provide an evaluation of water quality and the potential susceptibility to current and future nitrogen loadings, have been or will be reviewed and the relevant findings incorporated into the Orleans CWMP. Following completion of the MEP technical reports, DEP and EPA propose and then adopt nitrogen-based TMDLs that establish the nitrogen loads below which water quality impairment will not occur. These TMDLs form the regulatory basis for potential enforcement actions against towns that do not provide for appropriate control of nitrogen loads.

2.2.4 Protected Areas

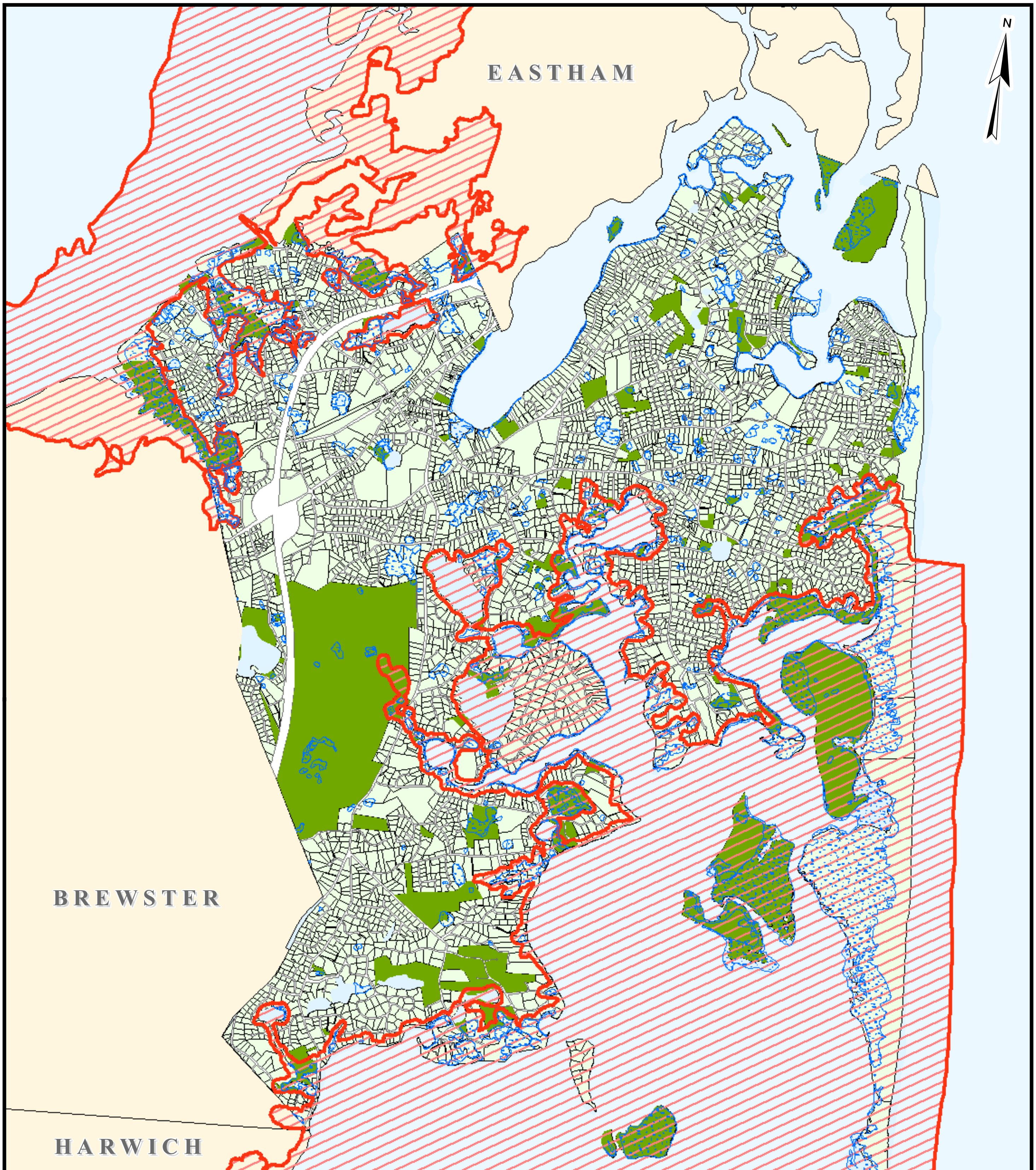
Environmentally sensitive areas include protected areas such as Areas of Critical Environmental Concern (ACECs), wetlands, cranberry bogs, shellfishing areas, outstanding resource waters (ORWs), and protected lands. These areas were identified through analysis of Town GIS mapping provided by the Planning Department, and through mapping available from the MassGIS. These protected areas are shown on Figures 2-6, 2-7 and 2-8 and described below.

Areas of Critical Environmental Concern

ACECs are natural communities that have been nominated and designated for recognition due to the presence of critical resources, wildlife habitat and scenic landscapes, among other features. The Town of Orleans includes portions of two ACECs: Pleasant Bay and Inner Cape Cod Bay (Figure 2-6). The Pleasant Bay ACEC was designated in 1987 and encompasses 9,240 acres in Brewster, Chatham, Harwich, and Orleans. The Pleasant Bay ACEC comprises approximately 6,600 acres in Orleans (72 percent of its total acreage) and includes the Namequoit River, The River, Crystal Lake, and Pilgrim Lake, as well as numerous wetlands, creeks, salt marshes, tidal flats and barrier beaches that discharge into, or border upon Pleasant Bay. The Inner Cape Cod Bay ACEC was designated in 1985 and encompasses 2,600 acres in Brewster, Eastham, and Orleans. Approximately 750 acres of this ACEC are located within Orleans and include Cedar Pond, as well as several tidal creeks, salt marshes and barrier beaches that discharge into, or border upon Cape Cod Bay.

Wetlands

According to the Massachusetts DEP wetlands mapping, approximately 340 acres of freshwater wetlands are located in the Town of Orleans (Figure 2-6). Freshwater wetlands include marshes,



DEP Designated Wetland

Area of Critical Environmental Concern

Open Space

Source: Parcels and Wetland data were obtained from Orleans Planning Dept.
Aerial imagery, open space, and ACEC provided by MassGIS.

0 4,000 8,000 Feet

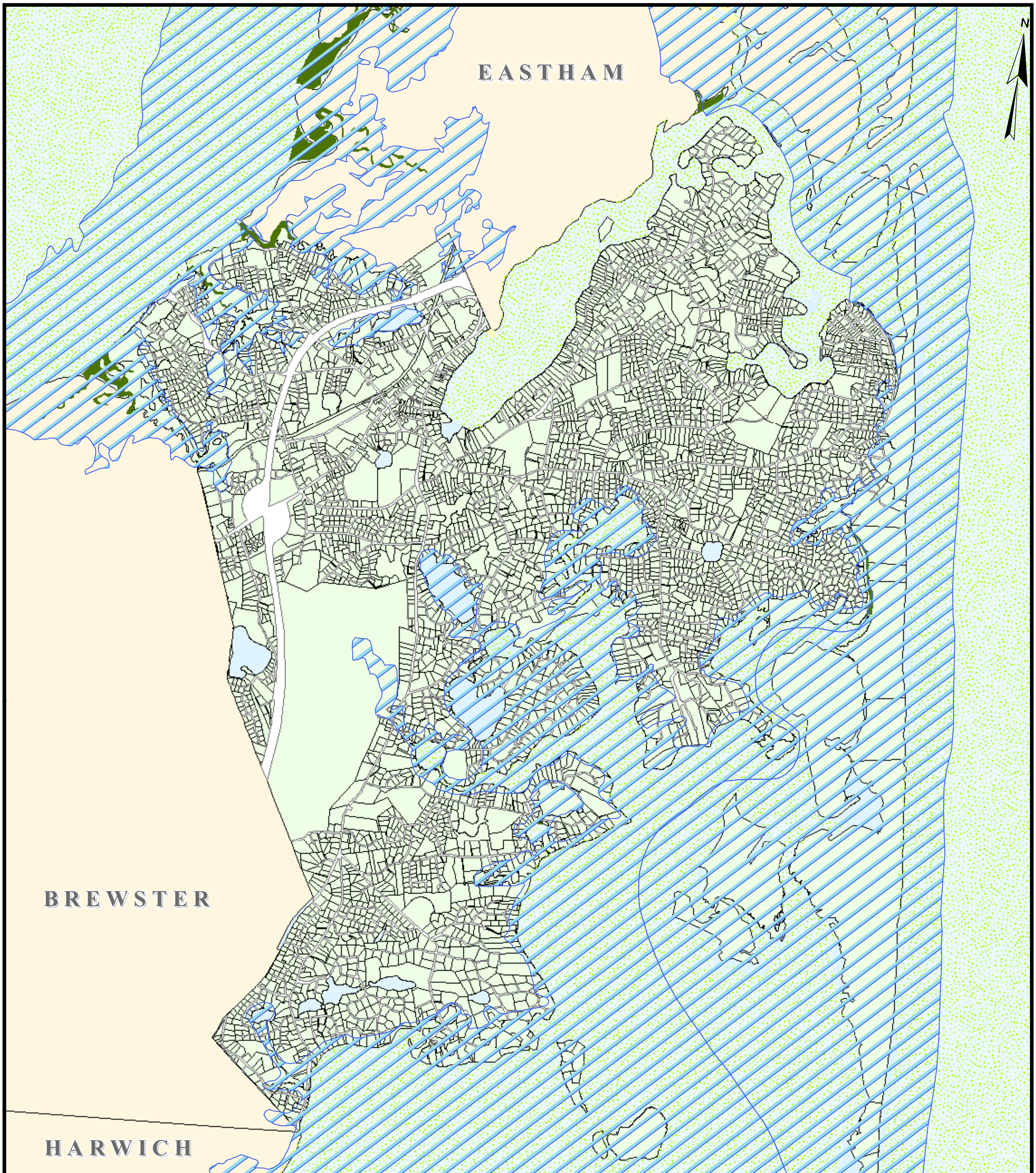
Orleans CWMP

ACECs, Wetlands, and Open Space

PROJ NO: 10645G DATE: Apr 2009 FIGURE: 2-6

WRIGHT-PIERCE
Engineering a Better Environment

Tuesday, September 23, 2008 7:36:55 AM W:\GIS_Development\Projects\10645B-Orleans\RecommendationPlan\Fig2-6.mxd



Approved Shellfish Growing Area

Prohibited Shellfish Growing Area

Outstanding Resource Waters

Source: Parcel data obtained from Orleans Planning Dept. Aerial imagery and growing areas provided by MassGIS.

0 4,000 8,000 Feet

Orleans CWMP

Outstanding Resource Waters and Shellfish Growing Areas

PROJ NO: 10645G DATE: Apr 2009 FIGURE: 2-7

WRIGHT-PIERCE
Engineering a Better Environment

shrub or wooded swamps, wet meadows and bogs. Wetland resource areas in Orleans also include approximately 220 acres of freshwater ponds including two Great Ponds of more than 10 acres (Crystal Lake and Pilgrim Lake), 940 acres of salt marsh, and 20 acres of cranberry bogs.

Parks, Open Space and Conservation Lands

Currently, almost 30 percent (2,600 acres) of land in Orleans is designated open space or protected lands (Figure 2-6). Of these 2,600 acres, approximately 1,000 acres are privately-owned open space land, including private land trusts and the Orleans Conservation Trust which manages land owned in fee and held in conservation restrictions. Approximately 1,600 acres of open space is publicly owned, including approximately 75 acres of federal and state-owned lands (land owned or protected by conservation constructions) and the remainder of town-owned lands (land owned in fee or protected by conservation restrictions). Federal and state-owned lands of significance include the Cape Cod National Seashore, Sampson Island and Hog Island, which are managed by the National Park Service; and Nickerson State Park and Campground in Brewster, which is managed by the Massachusetts Department of Conservation and Recreation and which covers a portion of the watersheds of Orleans' water supply wells.

Shellfishing

Electronic mapping of shellfish areas is not yet available from the Town of Orleans. MassGIS has an available data layer of designated shellfish growing areas. This data layer depicts areas of potential shellfish habitat and their respective harvest classification. According to this information, the tidal waters in Orleans are classified as “Approved,” which is indicative of general compliance with applicable water quality standards (Figure 2-7). However, the Town does have a posted list of shellfish closures (effective November 2005) which includes 6 shellfish areas that were closed to harvesting. As of early 2007, 80 acres of shellfish areas were closed. The Town has issued 24 licenses to private aquaculture operators who harvest shellfish in Orleans waters, predominantly in Pleasant Bay near the mouth of Pochet Creek.

Outstanding Resource Waters

ORWs constitute water bodies that are designated for protection under Massachusetts surface water quality standards due to high ecological, recreational, or aesthetic values. ORWs include drainage sub-basins, water supply watersheds, and ACECs. All tidal waters in the town are mapped as ORWs, with the exception of Town Cove, Rachel's Cove, Woods Cove, Little Cove, Mill Pond, Roberts Cove, and portions of Nauset Harbor (Figure 2-7).

Floodplains

Figure 2-8 shows the extent of lands that may be flooded on average once every 100 or 500 years. Along the Pleasant Bay and Cape Cod Bay shorelines, the floodplains closely follow the ACEC limits.

Habitat of Rare and Endangered Species

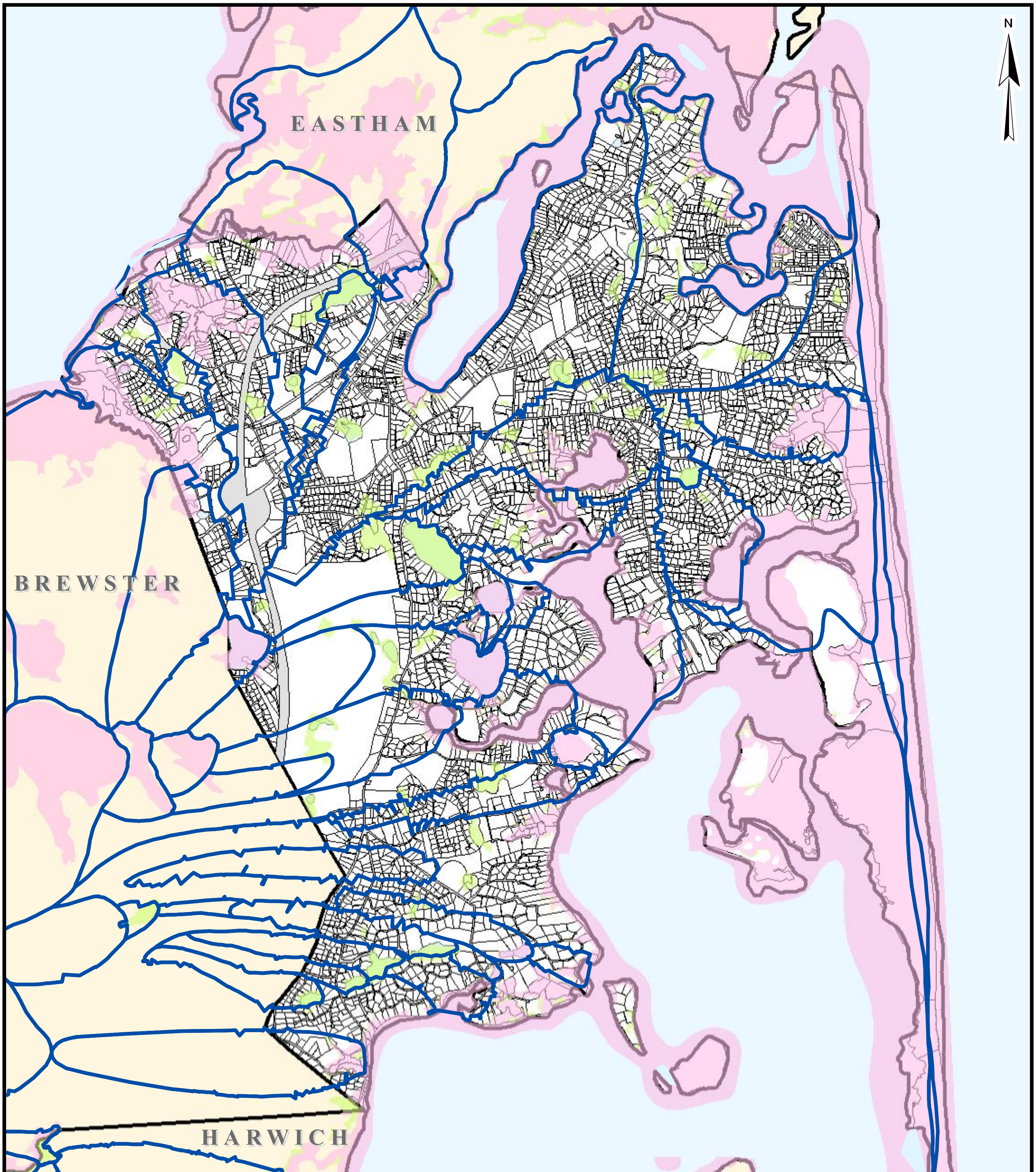
Some areas of Orleans have been determined to be within Priority Habitat of Rare Species and Estimated Habitat of Rare Wildlife, as documented in the 13th edition of the *Massachusetts Natural Heritage Atlas (October 1, 2008).* Some undeveloped and sparsely developed areas west of Route 6 and in South Orleans are mapped as both Priority and Estimated Habitat. Portions of Pleasant Bay, and scattered kettle ponds, are also mapped. Currently there are 12 state-listed rare animal species and 8 state-listed rare plant species in Orleans.

2.3 SOILS

Soil conditions are important in selecting sites for effluent disposal and in screening for sanitary needs related to Title 5 compliance. The rate at which effluent can percolate through soil directly impacts the size and design of effluent disposal systems and the viability and longevity of an on-site septic system.

From the standpoint of wastewater collection, treatment and disposal, most of the Cape benefits from sandy soils. Problems associated with bedrock do not exist and boulders tend to be the only similar construction impediment. Problems associated with peat and muck are in limited areas, largely associated with wetlands.

Soils identification begins with the classifications used by the Natural Resources Conservation Service (NRCS). Overall, poorly-drained soils are not suited for large-scale effluent disposal and may be acceptable for siting individual systems only with special design considerations and



Extent of 100-year flood plain

Extent of 500-year flood plain

Watershed Boundaries

0 4,000 8,000 Feet

Source: Parcel data obtained from Orleans Planning Dept. Watershed boundaries from MEP. Flood data obtained from MassGIS.

Orleans CWMP

Floodplains

PROJ NO:	DATE:	FIGURE:
10645G	Apr 2009	2-8

WRIGHT-PIERCE
Engineering a Better Environment

Thursday, September 11, 2008 8:10:28 AM W:\GIS_Development\Projects\10645B-Orleans\RecommendationPlan\Fig2-8.mxd

Title 5 variances. It is common for soils rich in peat or loam to support natural wetlands where groundwater remains at or near the surface for part or all of the year. Most commonly, well-drained soils are a considerable distance above the groundwater table. Well-drained soils are most desirable for siting wastewater facilities. When selecting sites for effluent disposal, sites with well-drained soil should take priority over sites that have moderately drained material.

The majority of soils in Orleans are well drained and consist of sands and silty sands. Moderately well drained soils are typically loamy sands; poorly drained soils are classified as peat- or muck-based which are predominately associated with wetlands. Figure 2-9 highlights the location of soil type by these three major categories. The approximate area covered by these types of soil town-wide is listed below.

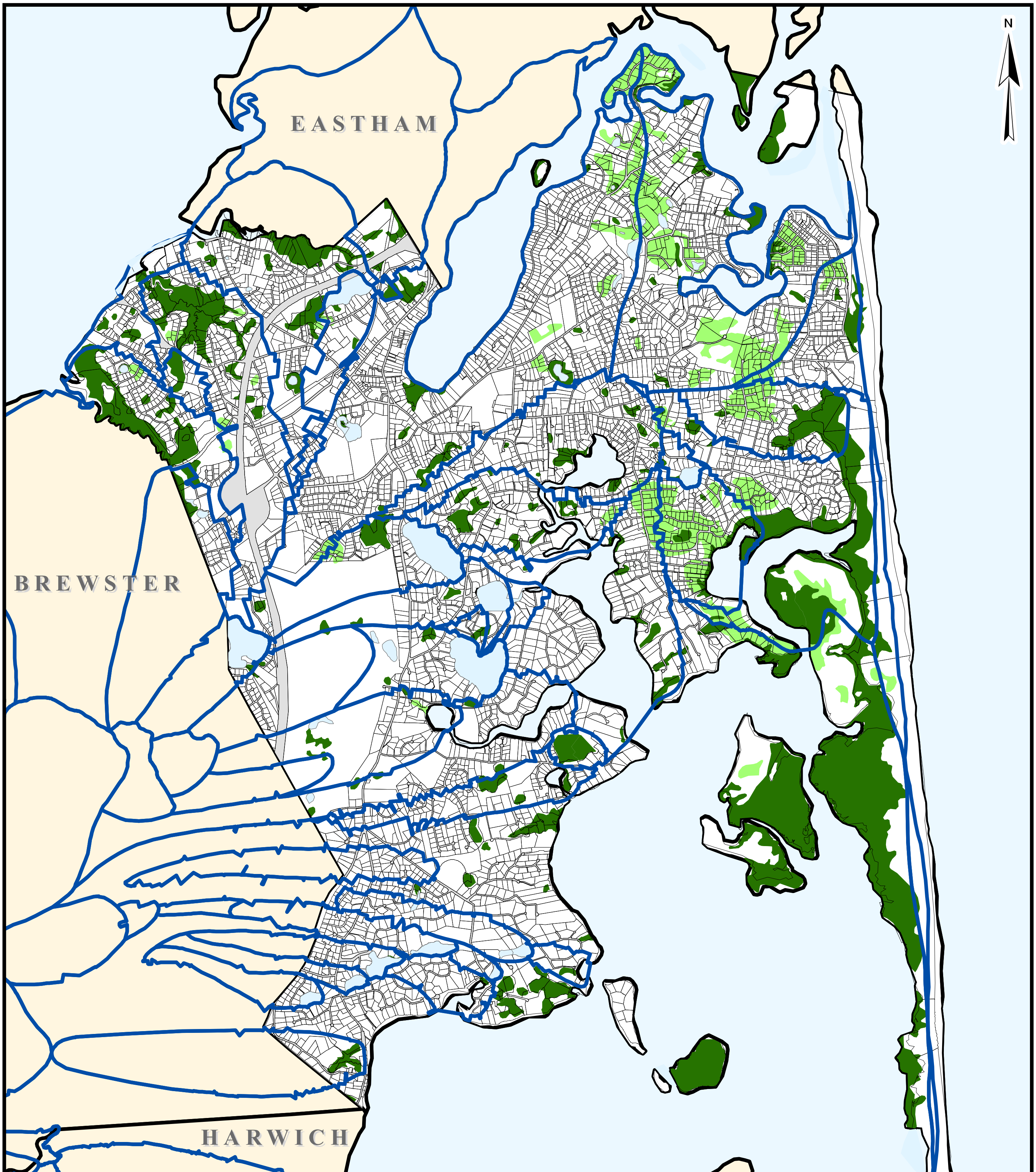
Well drained soils	80 %
Moderately well drained soils	14 %
Poorly drained soils	6 %

The NRCS data serve as a starting point for determining soil suitability. NRCS usually only classifies the top-most soil strata. Subsurface explorations including test pits and borings are mandatory during later phases of the CWMP process once a number of sites have passed initial screening. Further investigations will also yield valuable information such as: accurate readings of seasonal groundwater, specific classification of deeper soil strata, and permeability rates from small scale testing.

Compared to many towns in New England, Orleans has significant amounts of well-drained soil. Without considering the availability of land, it is clear that good soils exist in each sub-watershed. The Pochet Inlet and Cape Cod Bay sub-watersheds have the greatest area of poorly-drained soils. Figure 2-9 is a valuable overlay for the evaluation of site suitability in all phases of the CWMP.

2.4 GROUNDWATER

Groundwater quality is generally good in Orleans. Documented contaminant plumes exist at the



Well Drained Soils

Moderately Drained Soils

Poorly Drained Soils

Watershed Boundaries

Source: Parcel data obtained from Orleans Planning Dept. Watershed boundaries from MEP. Soils data obtained from MassGIS.

0 4,000 8,000 Feet

Orleans CWMP

Soil Conditions

PROJ NO:	DATE:	FIGURE:
10645G	Apr 2009	2-9

WRIGHT-PIERCE
Engineering a Better Environment

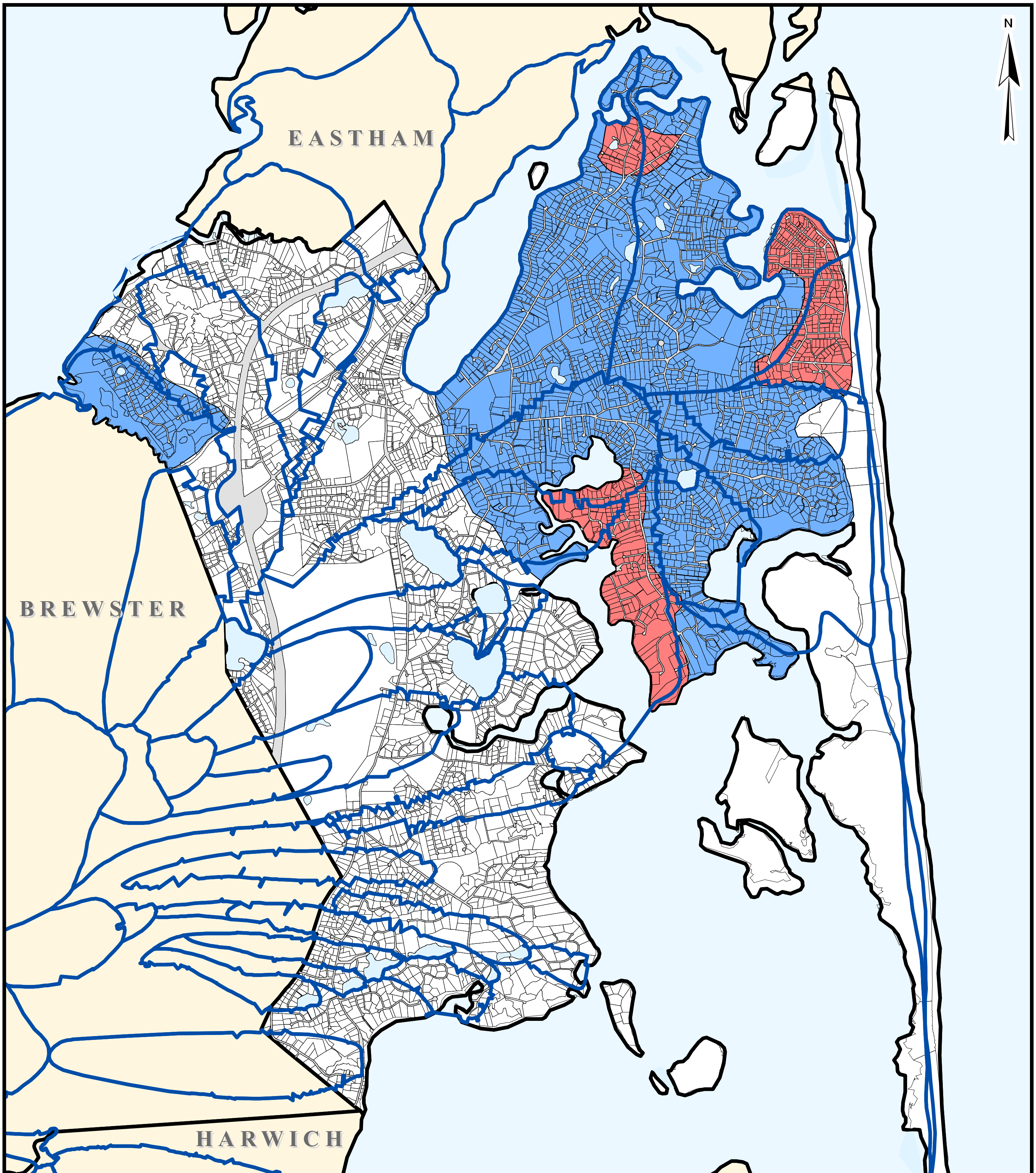
Thursday, April 23, 2009 10:40:12 AMW:\GIS_Development\Projects\10645B-Orleans\10645G\April 2009 Draft Report\Fig2-9.mxd town landfill (Town Cove sub-watershed), at the Tri-Town Septage Treatment Facility (Namskaket Creek), Hopkins Cleaners (Rock Harbor) and the Getty gas station (Town Cove). Concerns exist over possible dumping at a gravel pit in Brewster that is located within the Zone II of municipal supply Well 7, but the exact nature of any possible contamination has not been determined.

Figure 2-10 shows those areas of town where silt and clay soils create a perched groundwater condition that impacts septic system siting and design. This figure is derived from non-site-specific anecdotal information and is intended to depict general areas only. Areas of perched water are regularly encountered on the west side of Barley Neck and the Nauset Heights neighborhood. The potential for perched water exists throughout East Orleans and in the Namskaket Creek watershed. The general locations of perched water shown in Figure 2-10 are supported by data generated by the Cape Cod Commission (*Orleans Water Table Mapping Project*, 1995).

2.5 WATER USE AND WASTEWATER FLOWS

The Orleans Planning Department has compiled a database that includes parcel-by-parcel information on lot area, building coverage, zoning designations, build-out data, and water use. The information on water use spans four years, from mid 2002 to mid 2005, and the average daily consumption of 880,00 gallons per day (gpd) over that period has been used as the basis for estimating town-wide wastewater flows.

Billed water use during the period of 2002 to 2005 varied considerably. Most of the variability is believed to be associated with weather conditions that impact the quantities of water used in irrigation. An analysis of the data indicates that the water used for lawn watering, car washing, and other uses that do not contribute to the wastewater flow (collectively called "consumptive use") makes up approximately 13% of the total water use in the residential sector. Therefore residential wastewater flow has been computed as 87% of the average water use for the period. Based on literature sources, it has been assumed that 95% of commercial water use becomes wastewater. This analysis leads to estimates of current town-wide wastewater flows, expressed



Perched Water Often Encountered

Perched Water Potential

Watershed Boundaries

Source: Parcel data obtained from Orleans Planning Dept. Watershed boundaries from MEP. Perched water areas from Orleans Health Dept.

Note: Perched Water data is very approximate and is intended for general planning uses only.

0 4,000 8,000 Feet

Orleans CWMP

Perched Water Table

PROJ NO:	DATE:	FIGURE:
10645G	Apr 2009	2-10

WRIGHT-PIERCE
Engineering a Better Environment

Thursday, April 23, 2009 10:37:12 AMW:\GIS_Development\Projects\10645B-Orleans\10645G\April 2009 Draft Report\Fig2-10.mxd as annual averages in gallons per day, as follows:

Residential	608,000 gpd
Commercial, etc.	171,000 gpd
Total	779,000 gpd

In this report, the term "commercial" is used as "short-hand" for commercial, light industrial and institutional land uses; in essence all land uses except residential.

The town-wide total of 779,000 gpd represents the best estimate of all the wastewater currently generated in Orleans. The vast majority of that flow is treated and disposed of in individual on-site systems (generally septic tanks and leaching facilities). Some of the wastewater is treated to a higher level in individual treatment systems (often called "I/A" or innovative/alternative systems) or in modular satellite treatment plants, such as the one that serves the Community of Jesus near Rock Harbor. Town-wide, 97% of the wastewater is disposed of through conventional Title 5 systems; just over 2% in I/A or satellite systems and less than 1% through tight tanks.

It is important to recognize how the residential wastewater generation rates in Orleans vary by size of home and seasonal use. Table 2-2 shows how wastewater flow from residential properties increases based on the size of home, measured by the number of bedrooms. Seasonal homes on average produce about 75% of the wastewater generated at year-round homes, reflecting contrasting factors of reduced periods of occupancy and more intensive use when occupied. In creating the lot-by-lot database of wastewater flows, the figures in Table 2-2 were used to estimate the wastewater flows at homes served by private wells, where public water use data are not available. Figure 2-11 illustrates the distribution of Orleans properties by wastewater flow. 79% of the developed lots produce less than 200 gallons per day per lot. Interestingly, 32% of the town-wide wastewater flow is generated on 5% of the properties, those that produce greater than 400 gallons per day per lot.

Based on estimates of current population, the Town's water use data indicates an average per-capita water use of 65.3 gpd. Using the estimates of consumptive use noted above, this figure

TABLE 2-2

CURRENT WASTEWATER FLOWS PER LOT

	Flow By Type of Occupancy, gpd		
Type of Use	**Year-Round**	**Seasonal**	**Town-wide**
Residential			
Single-Family Homes			
1 and 2 Bedrooms	110	78	95
3 Bedrooms	142	101	125
4 Bedrooms	163	132	150
5 Bedrooms	197	179	190
6 or more Bedrooms	329	143	201
Overall	143	107	128
Multi-Family Homes	313	259	287
Commercial			563

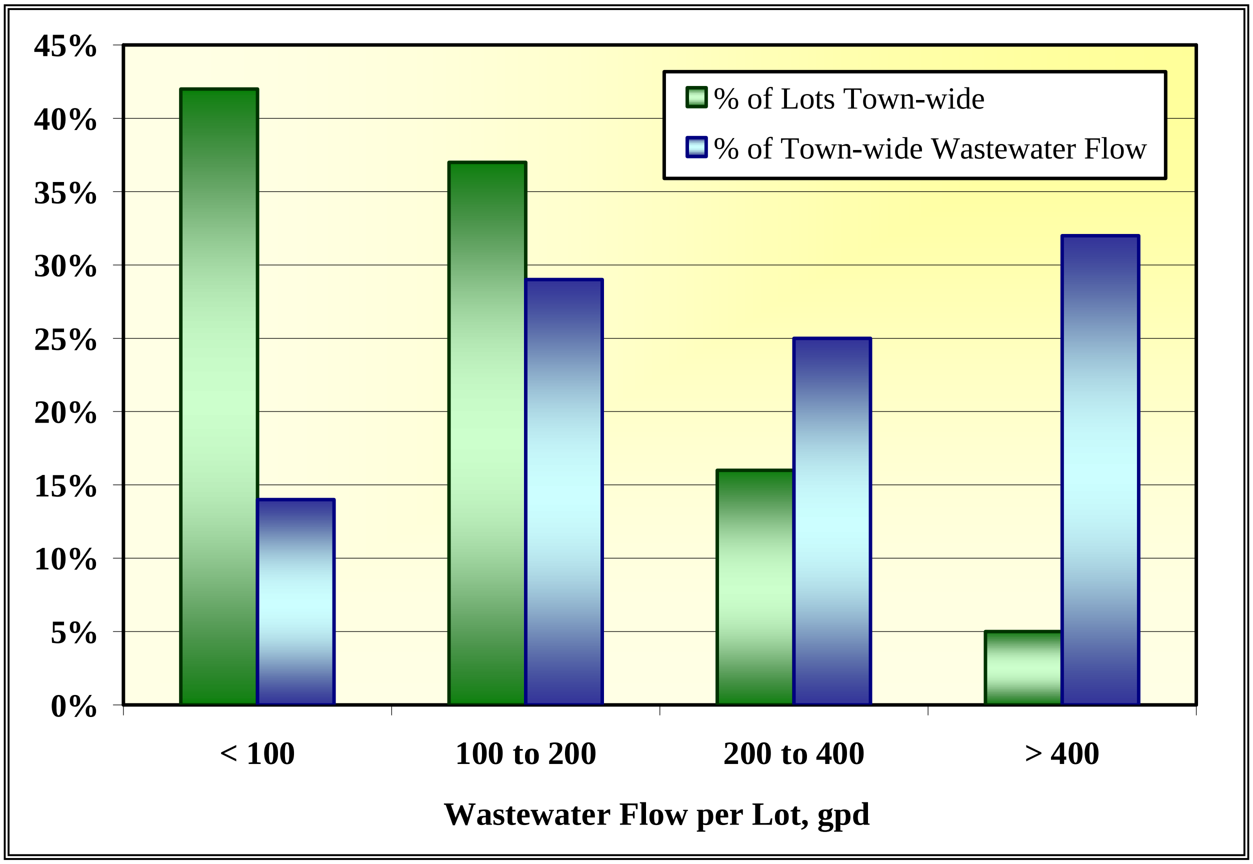
Note: Based on 3,950 residential parcels and 35 commercial parcels with public water service.
Source: Orleans Water Department, 2002 to 2005 data.

translates to an average per-capita wastewater flow of 56.8 gpd. These per-capita figures, and the per-property data summarized in Table 2-2, are consistent with reported water use and wastewater generation rates from other Cape Cod towns.

The database can be queried to determine the distribution of wastewater flows by major watershed, with the following results:

Pleasant Bay	39% of wastewater (307,000 gpd) 62% of land area 1.06-acre average residential lot size
Nauset System and Atlantic Ocean	34% of wastewater (266,000 gpd) 23% of land area 0.84-acre average residential lot size
Cape Cod Bay Systems	27% of wastewater (206,000 gpd) 15% of land area 0.94-acre average residential lot size

FIGURE 2-11
CURRENT WASTEWATER FLOW PER LOT



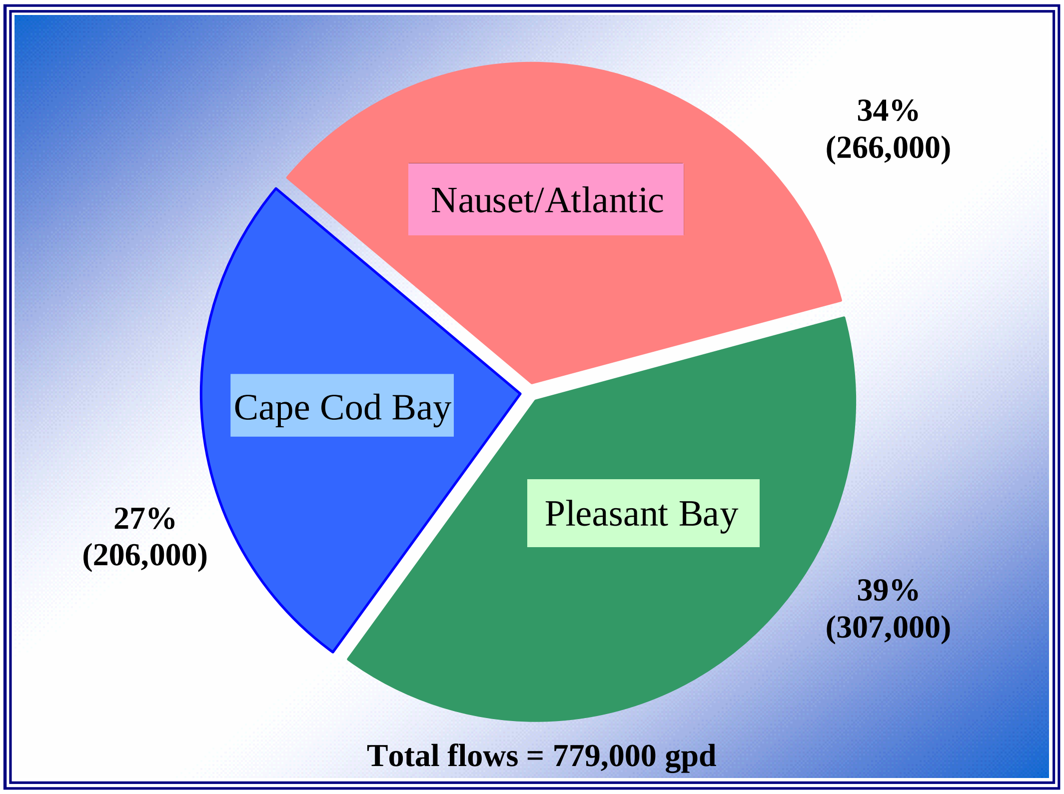
Notes: Based on metered water use and estimates of private water use.
Includes separate estimates of consumptive use for residential and commercial lots.
Source: Orleans Water Department, 2002 to 2005 data.

The wastewater flow distribution is shown graphically in Figure 2-12. These figures reflect the relative lot sizes and intensity of development across town. The Pleasant Bay watershed covers more than 60% of Orleans' land area, but currently produces only 39% of the wastewater flow. The more heavily developed areas in town, including the commercial districts, are located in the Nauset and Cape Cod Bay watersheds. Nearly 90% of the town's commercial wastewater is generated in these two watersheds.

Table 2-3 lists the estimated wastewater flows for all of the sub-embayments that are impacted by land in Orleans.

FIGURE 2-12

CURRENT WASTEWATER FLOWS BY MAJOR WATERSHED



Source: See text.

Wastewater treatment and disposal systems must be sized adequately to handle short-term peak flows. During the summer, water use peaks are attributed to both higher population and higher consumptive use. From the water pumping records available for 1996 to 2005, the following peaking factors have been estimated for wastewater flows:

Maximum month:	2.0 times annual average
Maximum week:	2.2 times annual average
Maximum 2-day:	2.4 times annual average

Figure 2-13 illustrates typical monthly variations in both water use and estimated wastewater flow.

TABLE 2-3

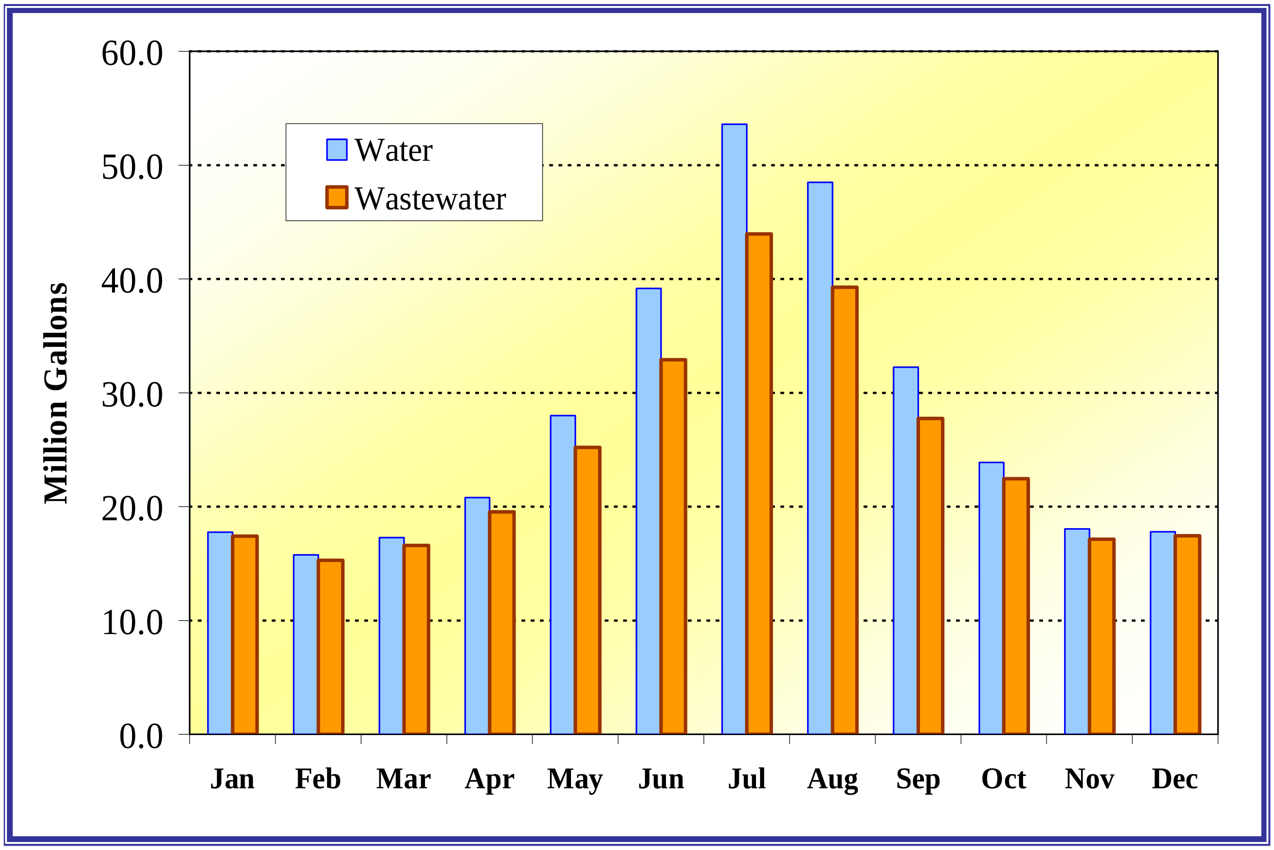
ANNUAL AVERAGE WASTEWATER QUANTITIES BY WATERSHED
CURRENT CONDITIONS

		Wastewater Flow, gpd		
Watershed	**# Parcels**	**Residential**	**Commercial**	**Total**
Areys Pond	65	7,000	400	7,400
Atlantic Ocean	155	18,000	5,000	23,000
Baker's Pond	11	1,000	-	1,000
Barley Neck	170	18,000	-	18,000
Boat Meadow	13	100	12,000	12,100
Crystal Lake	67	5,000	1,000	6,000
Deep Pond	21	2,000	-	2,000
Gould Pond Well_ORL	46	5,000	-	5,000
Kescayogansett Pond	77	7,000	1,000	8,000
Kescayogansett River	13	1,000	-	1,000
Kescayogansett Stream	18	500	100	600
Little Namskaket	346	51,000	11,000	62,000
Lower River	220	53,000	-	23,000
Meetinghouse Pond	333	42,000	8,000	50,000
Multiple watersheds	13	-	-	-
Namequoit River	147	17,000	-	17,000
Namskaket Creek	289	30,000	23,000	53,000
Nauset Harbor	638	70,000	400	70,400
Paw Wah Pond	112	11,000	1,000	12,000
Paw Wah Pond Bog	12	1,000	-	1,000
Pilgrim Lake	61	6,000	2,000	8,000
Pleasant Bay	429	47,000	1,000	48,000
Pochet Neck	209	23,000	-	23,000
Pochet Neck Stream	153	18,000	-	18,000
Quanset Pond	44	8,000	-	8,000
Quanset Pond Bog	6	400	-	400
Rock Harbor	328	47,000	32,000	79,000
Sarah's Pond	63	7,000	-	7,000
Shoal Pond	34	4,000	-	4,000
Tar Kiln Stream	35	3,000	500	5,000
The Horseshoe	11	1,000	-	1,000
Town Cove	975	98,000	73,000	171,000
Twinings Pond	50	5,000	-	3,500
Uncle Harvey's Pond	16	2,000	-	2,000
Uncle Seth's Pond	23	4,000	-	4,000
Upper River	150	17,000	100	17,100
Well 7 Well_ORL	57	8,000	-	8,000
Total	**5,410**	**608,000**	**171,500**	**779,500**

Throughout this report, wastewater flow estimates are presented that are based on water use records from the period of 2002 to 2005. These flows are characterized as "current", even though they represent a time period 3 to 6 years earlier than the publication of the draft CWMP. Due to normal year-to-year variations in water use and consumptive use, it is difficult to discern any trends that would indicate that the 2002-to-2005 data are either higher or lower than comparable data for 2008. Nonetheless, it will be important to reevaluate these figures in the design stage of the project, recognizing that the first year of operation of municipal wastewater facilities may be ten years later than the period of this analysis.

It is also important to note that these wastewater flow estimates represent actual wastewater flow leaving homes and businesses. Only the wastewater flows are conveyed to the wastewater treatment facility via the collection and transport system, including gravity sewers, pump stations, force mains. Gravity collection systems are typically installed five to twenty feet below the ground surface and, due to this depth, typically also receive some amount of groundwater infiltration. Manhole covers also allow for some amount of inflow into the collection system during rain events, as do illicit cellar drain connections. In combination, these extraneous flows are referred to as "infiltration/inflow". The sizing of the collection, transport, treatment and disposal systems is based on the combined wastewater and infiltration/inflow.

FIGURE 2-13
SEASONAL VARIABILITY IN WATER USE AND WASTEWATER FLOW



Source: Water use data from Orleans Water Department (1996 to 2005)

SECTION 3

WASTEWATER MANAGEMENT NEEDS

3.1 APPROACH

Many communities rely exclusively on private on-site systems for wastewater treatment and disposal. The state sanitary code, Title 5, provides a thorough regulatory framework (with a few important exceptions) for such systems. Under ideal circumstances, on-site systems can provide cost-effective and environmentally-sound wastewater management. Those circumstances include favorable soils, adequate depth to groundwater, reliable and protected water supplies, absence of sensitive downgradient receiving waters, and absence of high-intensity water users.

In assessing Orleans' needs for improved wastewater management, the fundamental question is:

> **On which properties is an on-site wastewater system an adequate means of providing for sanitation and environmental protection, and on which properties is an off-site solution needed?**

One way to answer this question is to identify areas where the above-noted ideal circumstances do not exist. For the purposes of this report, wastewater management needs have been evaluated in the following 5 categories:

- **Ensuring Sanitary Conditions**--correction or avoidance of unsanitary conditions (that is, public health problems) such as effluent surfacing over a leaching field, inadequate set-back from a private well, or direct discharge of sanitary wastewater to a watercourse.

- **Water Supply Protection**--preventing contaminants (such as bacteria, viruses or nitrates) from reaching private or public drinking water sources.

- **Protecting Surface Waters from Nutrient Enrichment**--reducing nutrients that can cause accelerated degradation of freshwater ponds (typically phosphorus) or estuarine waters (typically nitrogen).

- **Addressing Convenience and Aesthetic Issues**--avoiding unsightly mounded septic systems or individual treatment systems that may be the only way to achieve compliance with Title 5 if off-site options do not exist, or avoiding frequent septage pumping that creates odor and disruption (particularly in the downtown area).

- **Enabling Sustainable Economic Development**--providing off-site wastewater treatment and disposal so that on-site conditions (such as impermeable soils or shallow groundwater) are not the limiting factors to community growth and development.

The overall approach for needs assessment is the categorization of all lots in Orleans according to these five general categories. The specific approach is different for each category, and is presented in the paragraphs that follow. Each category has been evaluated separately, and then the results compiled town-wide to address the fact that some lots fall into more than one category of need.

Where off-site disposal is necessary, the reasons must be well documented and defensible. For cost reasons alone, it is critical to accurately determine the sewer needs. However, it is also important to fairly assess the reasons for public sewers so costs can be equitably allocated. For some property owners, the requirement to connect to a public sewer is a significant financial burden; for other property owners, unlimited access to public sewer may be viewed as an economic windfall. Wastewater solutions based on documented needs, and with appropriate growth controls, can be tailored to optimize the costs, benefits and impacts.

3.2 SANITARY NEEDS

Correction or avoidance of public health problems (sanitary needs) was addressed by considering three factors:

- Properties that have required variances from Title 5 to install or repair an on-site system;
- Properties that use a large amount of water per acre of land; and
- Properties near receiving waters where high bacterial counts have been recorded with no other apparent cause.

3.2.1 Title 5 Variances

Methodology

Title 5 is a thorough sanitary code with respect to sanitary issues. If significant variances from Title 5 have been required to allow an on-site system to be constructed or repaired, then there may be benefits to providing that property with an off-site wastewater solution.

The Health Department provided its records spanning 11 years: 1995 through 2005. An evaluation was conducted of records of Board of Health meetings during 100 months in that period, the equivalent of eight and one-third years. For each variance that was granted, key information was tabulated, such as the name and address of the applicant, and the nature of the variance that was granted. Points were then assigned to each variance based on the environmental significance of that type of variance.

It is important to distinguish between procedural variances and those of environmental significance when evaluating the need to provide off-site wastewater disposal. Table 3-1

TABLE 3-1

ENVIRONMENTAL SIGNIFICANCE RATING SYSTEM FOR TITLE 5 VARIANCES

	Nature of Variance	Points
1	**Setback From Wetlands (100-ft local requirement)**	
	Setback greater than 50 feet	**2**
	Setback less than 50 feet	**4**
2	**Setback From Well (100 feet required)**	
	Potable Well Setback greater than 75 feet	**5**
	Setback of 50 to 75 feet	**7**
	Setback less than 50 feet	**10**
	Non-Potable Well	
	Setback less than 100 feet	**1**
3	**Setback From Property Lines**	**1**
4	**Setback From Structures**	**1**
5	**Depth to Groundwater (4 feet required)**	
	Depth of 3 to 4 feet	**3**
	Depth less than 3 feet	**5**
6	**Thickness of Underlying Pervious Soil**	
	Thickness of 3 to 4 feet	**3**
	Thickness less than 3 feet	**5**
7	**Depth of Cover Over Disposal System**	
	Depth greater than 3 feet	**1**
8	**Inadequate Reserve Area**	
	Reserve area less than 50%	**1**
	No reserve area	**2**

summarizes an additive points system for assigning a score to each lot based on the type and severity of the variance granted. Variances that are minor or procedural in nature received a single-point score. Variances that could significantly impair public or environmental health, such as a variance for setback to a private water supply, would add 3 to 10 points to a lot's rating. In the case where multiple minor variances have been granted on a single lot, the cumulative impact can be considered, even if each individual variance would be insignificant on its own.

Using this additive system, scores could range from 0 to 10 points depending on the type and severity of the variance granted. To convert this scoring process into a rating system for needs assessment, properties were grouped into one of three categories: little or no environmental significance (1 or 2 points), moderate environmental significance (3 or 4 points), and major environmental significance (5 points or more). This additive system provides a consistent and graduated method for identifying individual needs, and is central to this assessment of sanitary needs town-wide.

Findings

There are approximately 4,500 Title 5 systems in Orleans according to the Health Department. Table 3-2 (pg 3-6) is a summary of the analysis of approximately 2,100 permits granted between 1995 and 2005. Key findings are as follows:

1. On an annual basis, 220 to 260 requests for new systems or system modifications come before the Health Department, with an average of 250 per year. Of the total 2,075 permits granted, 210 (about 10% or roughly 25 applications per year) have required one or more variances.

2. During the period of analysis, 323 variances were granted, an average of about 1.5 variances per applicant.

3. Of the 25 applicants that needed variances in the typical year, only about 10 of them required variances of environmental significance.

4. The types of variances are as follows, in order of frequency

❖ Setback to wetlands	34%
❖ Setback to property lines	17%
❖ Setback to structures	16%
❖ No reserve area	9%
❖ Depth of cover over system	9%

- ❖ Depth to groundwater 5%
- ❖ Thickness of underlying permeable soil 5%
- ❖ Setback from non-potable well 5%

No variances were granted for inadequate setback to potable wells. The February 2007 Draft Needs Assessment Report contains a listing of the specific variances for all 210 properties for which variances were granted in the 1995-to-2005 period.

5. On average, 90% of the applications to the Health Department did not require variances, and only 4% required variances of environmental significance. Therefore 96% of the properties can be viewed as having no significant sanitary need.
6. The properties with variances are fairly uniformly spread across town; no one watershed seems to have a disproportionate number of variances. See Figure 3-1.
7. Over the period of record, 210 variances were granted, of which 85 (40%) have enough environmental significance to indicate a potential sanitary need for off-site wastewater disposal. Said another way, if public sewers (leading to a cluster, satellite or centralized system) were available at the time the application was filed with the Health Department, there may have been justification for the Board of Health to require a sewer connection.
8. The average wastewater flow associated with the 210 variance applications is 240 gallons per day (gpd). This figure compares with the town-wide average residential flow of 143 gpd, and the average commercial flow town-wide of 563 gpd. Therefore the properties that have required significant variances are not just the very-high water users, and are not disproportionately commercial.
9. A total of 73 properties were granted the 85 environmentally significant variances. Those properties generate about 15,000 gpd of wastewater on an annual average basis.

Table 3-2 describes a rating system for individual lots using categories A through E, where Category A and B lots are quite acceptable for on-lot wastewater disposal, through Category E lots that are unsuitable. Table 3-2 shows how the point system for Title 5 variances is related to these categories. Based on 11 years of records, 90% of the permit requests to the Health Department fall in Categories A and B; 6% fall in Category C, and 4% fall in Categories D and E. The category C, D and E lots are shown in Figure 3-1. The Category D and E parcels are considered to have a sanitary need.

Conclusions

During the period of analysis, about 40% of the septic systems in Orleans required permits for repair, increase in flow, or new construction. If these 11-year findings are extrapolated to a 20-year period, or to all of the 4,500 systems in town, it can be estimated that about 150 to 200 properties, generating 35,000 to 45,000 gpd of wastewater, might benefit from off-site disposal. These extrapolated flows represent only 5 to 6% of the current town-wide wastewater generation rate. This low percentage indicates that on-site wastewater disposal under Title 5 (and supplemental local regulations) is quite effective from a strictly sanitary perspective. Favorable soils and generally large lots are important factors in this conclusion. The thorough approach of the Health Department and Board of Health has resulted in very good compliance with applicable requirements.

TABLE 3-2
SUMMARY OF TITLE 5 VARIANCE ANALYSIS

1. **Over 8.3 years, 2,075 Title 5 permits were issued.**
   210 of those applications required a variance.

2. **Determination of Site Suitability--Rating in 5 Categories**
   A. Suitable for current and future use without variances
   B. Suitable for current use without variances
   C. Suitable for current use with variances
   D. Suitable for current use with significant variances
   E. Not suited for onsite disposal

3. **What is environmental significance of variances that were granted?**

Score	Rating	# of Permits	% of Permits
N/A	A	1,865	90
N/A	B		
1 to 2	C	124	6
3 to 4	D	51	2
5 or more	E	35	2
	Total	2,075	100

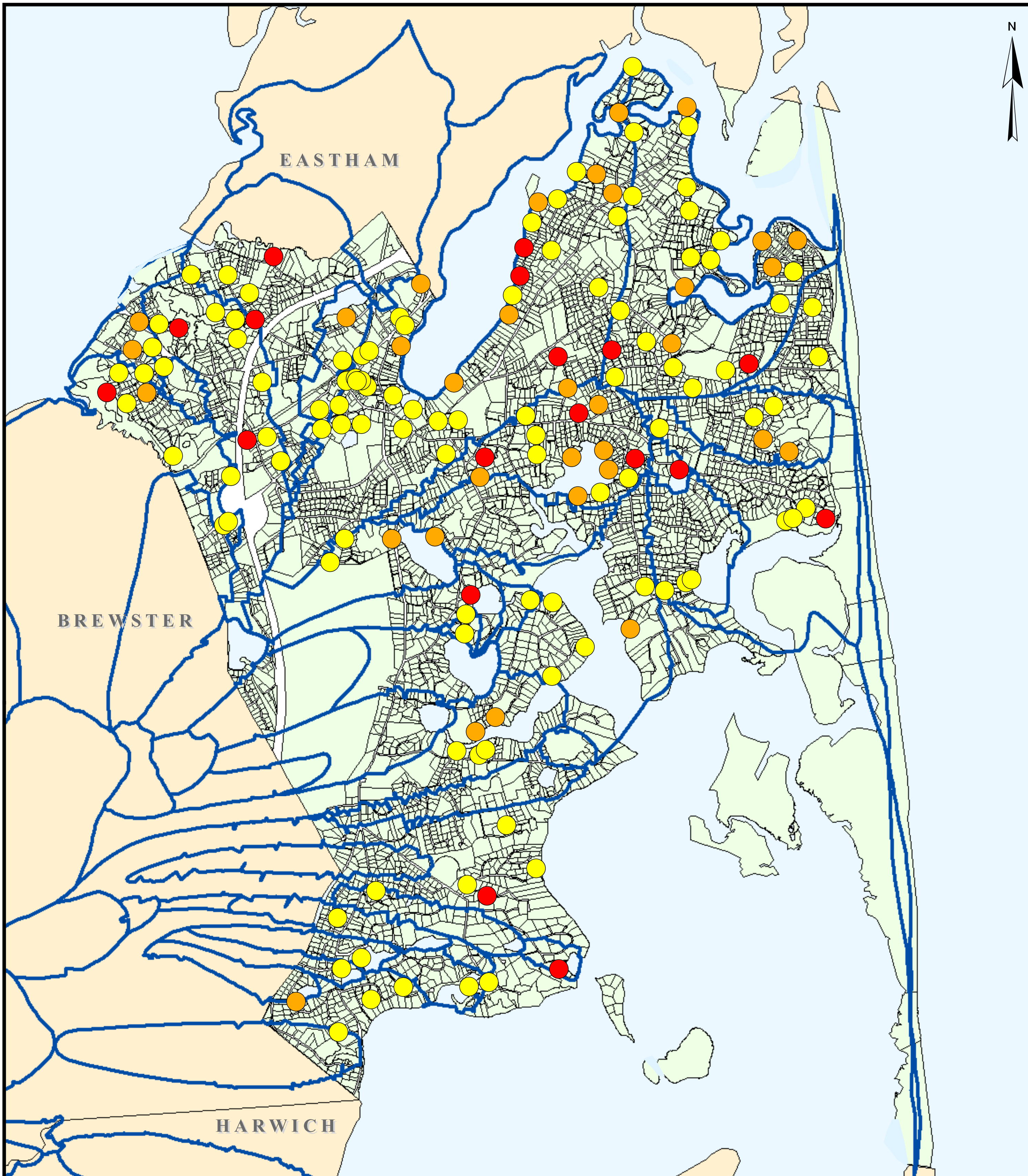
4. **Where are properties with variances located?**

Cape Cod Bay	25%
Nauset/Atlantic Ocean	40%
Pleasant Bay	35%

5. **What was the basis for the variance request?**

Repair	65%
New Construction	25%
Flow Increase	5%
Miscellaneous	5%

Note: Variance data from 1995 to 2005
Source: Orleans Health Department



Title 5 Variances
Lot Suitability Rating

C

D

E

Watershed Boundaries

Source: Parcel data obtained from Orleans Planning Dept. Watershed boundaries from MEP.

0 4,000 8,000 Feet

Orleans CWMP

Title 5 Variances 1995-2005

PROJ NO: 10645G	DATE: Apr 2009	FIGURE: 3-1

WRIGHT-PIERCE
Engineering a Better Environment

Thursday, September 11, 2008 8:53:34 AM W:\GIS_Development\Projects\10645B-Orleans\RecommendationPlan\Fig3-1.mxd

3.2.2 Intensive Water Use

The greater the water use per unit lot area, the greater the potential difficulties with on-lot wastewater disposal. The Planning Department's GIS database, including water use records and assessors records, was used to identify lots with potential sanitary needs based on the intensity of water use.

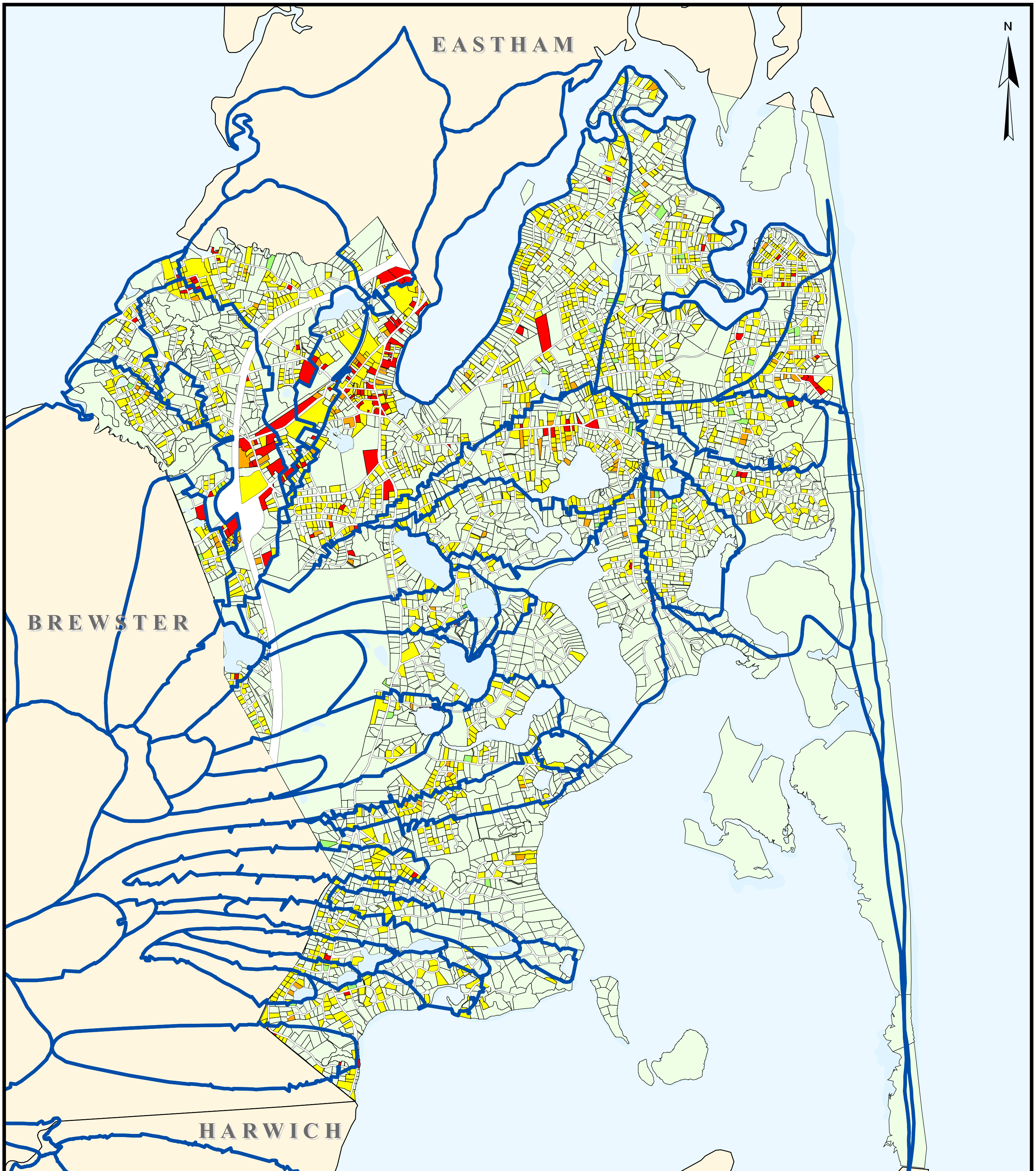
The Orleans GIS includes water use records for the period of 2002 to 2005. Annual average water use was calculated as the average of eight consecutive 6-month periods divided by 182. Parcel size was calculated based on overall property boundaries, without deduction for wetlands. For example, a parcel that has an annual daily water use of 200 gpd and a total lot area of 50,000 sq. ft. has a water use intensity of 40 gpd per 10,000 sq. ft.

This evaluation revealed the following breakdown of water use intensity:

Greater than **200** gpd per 10,000 sq. ft:	131 lots
100 to **199** gpd per 10,000 sq. ft:	412 lots
50 to **99** gpd per 10,000 sq. ft:	1,058 lots
25 to **49** gpd per 10,000 sq. ft:	1,191 lots
Less than **25** gpd per 10,000 sq. ft:	1,212 lots

(Title 5 uses a similar approach to determine if a project warrants nitrogen control in the recharge areas of public water supply wells. In Title 5, the nitrogen control threshold is 110 gpd per 10,000 sq.ft. (This threshold is based on the Title 5 wastewater flow, which is typically much greater than the annual average water use.) The Orleans water use data shown above have been compiled to look at water use intensity as an indicator of potential sanitary needs, not as an indicator of water supply protection with respect to nitrogen loading.)

Figure 3-2 shows the water use intensity for all developed parcels in Orleans. Shown in red are the parcels with water use greater than 200 gpd/10,000 sq.ft. Note that most of these properties are in the commercial areas of town. Some of these parcels have received one or more Title 5 variance; others may not have come before the Board of Health during the period of analysis, but would be expected to require variances based on the intensity of water use.



Water Use Intensity

gpd/10,000 SF

- 0 - 49
- 50 - 99
- 100 - 149
- 150 - 199
- 200 +

Watershed Boundaries

Source: Parcel data obtained from Orleans Planning Dept. Water use data from Orleans Water Dept. Watershed boundaries from MEP.

0 4,000 8,000 Feet

Orleans CWMP

Water Use Intensity

PROJ NO:	DATE:	FIGURE:
10645G	Apr 2009	3-2

WRIGHT-PIERCE
Engineering a Better Environment

Tuesday, September 23, 2008 7:44:29 AM W:\GIS_Development\Projects\10645B-Orleans\RecommendationPlan\Fig3-2.mxd

3.2.3 Receiving Water Impacts

In areas of failing septic systems, it is not unusual to find high coliform concentrations in nearby receiving waters. Therefore, information was obtained from the Harbormaster/Shellfish Warden on documented water quality problems that may be associated with septic systems.

Water quality issues of concern to the Harbormaster/Shellfish Warden include the incidence of red tide and the presence of fecal coliform in Orleans' receiving waters. The Harbormaster/Shellfish Warden attributes the red tide outbreaks to an historic open-ocean "wash-in" that continues to affect Mill Pond in the Nauset system on an annual basis. He provided a map highlighting the areas of town where fecal coliform have been reported at concentrations that would cause a closure. Figure 3-3 depicts the sampling stations that have tested positive for the presence of fecal coliform.

The Harbormaster/Shellfish Warden believes that surface water runoff is responsible for the presence of bacteria at sampling stations located in Paw Wah Pond, Meetinghouse Pond, Town Cove, and Rock Harbor. Pochet Creek, with no major convergence point for runoff, is the only location where it appears that no direct link exists between stormwater events and the presence of bacteria. However, one or more other factors can contribute to bacterial contamination of surface waters. A wash-over from Nauset Beach could bring with it bacteria from activities at the beach. Waterfowl can also be a source of bacteria. Failed septic systems could be another source of contamination. Septic system leach fields located near steep slopes, especially in areas of clay and perched groundwater (not uncharacteristic for the area around Pochet Creek) could conceivably leach wastewater to the surface water. If groundwater is breaking out on the side of a slope, wastewater (recently reaching the groundwater from a leach field) could quickly reach the surface. This type of event could occur following an extended wet period. Overall, the slow flushing rate of the creek would allow bacterial contamination to persist. While the Health Department is currently not aware of any failed septic systems within the Pochet Creek watershed, it was not possible to completely rule out wastewater as a source of bacteria in Pochet Creek without an intensive review of on-site septic systems.

Over a two-day period in the fall of 2006, an environmental engineer inspected all 55 homes that are located within 300 feet of Pochet Creek. No evidence was found of any septic system malfunction that might be causing high coliform counts in the Creek.

- Sampling Stations
- Locations where Elevated Fecal Coliform have been Reported
- Watershed Boundaries

Source: Sample data obtained from the Orleans Harbormaster. Aerial imagery provided by MassGIS. Watershed boundaries from MEP.

0 4,000 8,000 Feet

Orleans CWMP

Receiving Water Quality

PROJ NO: 10645G DATE: Apr 2009

WRIGHT-PIERCE
Engineering a Better Environment

FIGURE: 3-3

Thursday, September 11, 2008 9:15:54 AM W:\GIS_Development\Projects\10645B-Orleans\RecommendationPlan\Fig3-3.mxd

On the basis of these inspections, it has been concluded that the high coliform counts are not related to existing septic systems.

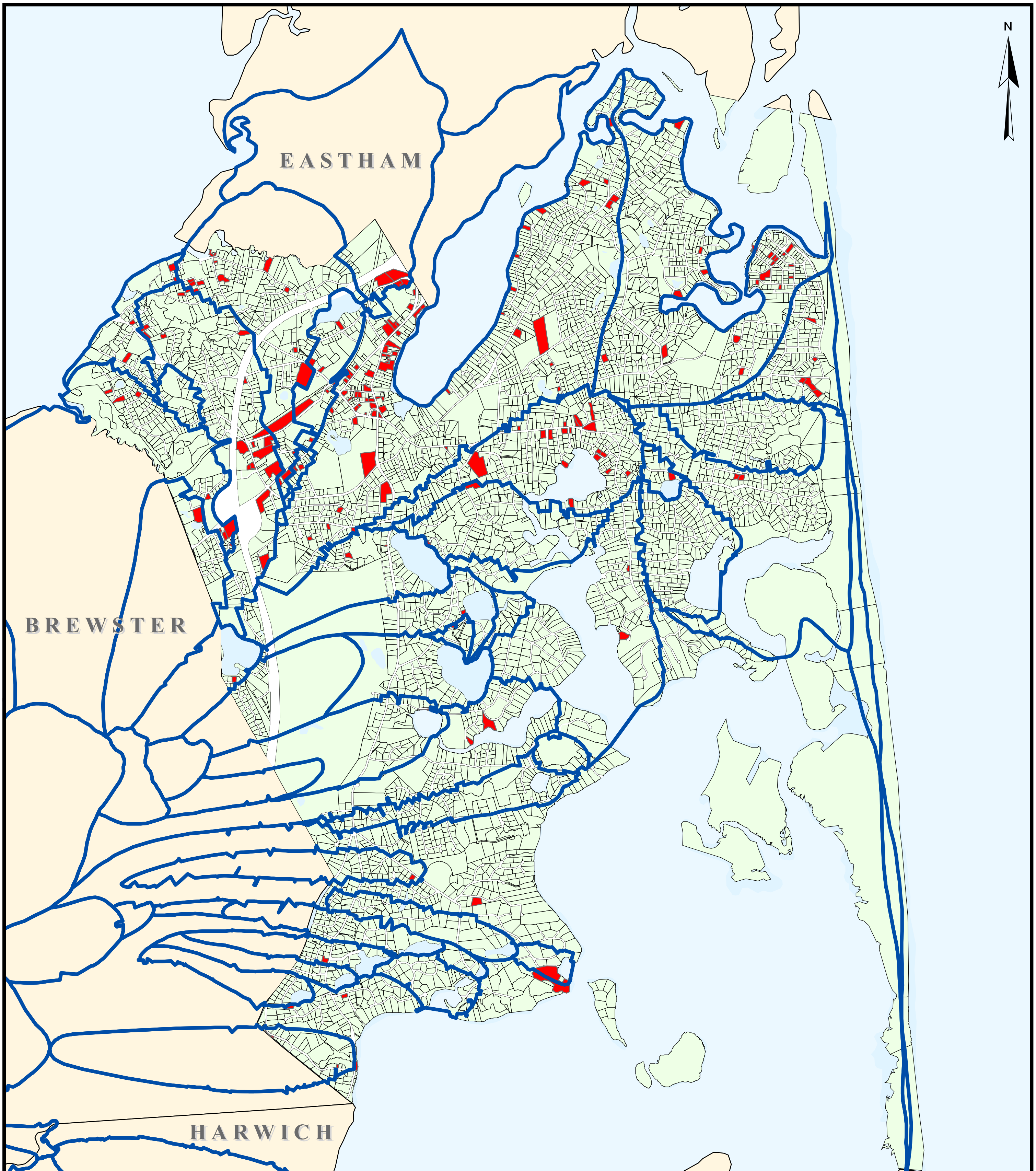
3.2.4 Combined Indicators of Sanitary Needs

Table 3-3 shows how the three indicators of sanitary needs were combined. The record of Title 5 variances is the most definitive indicator and the one that deserves the most weighting. However, it covers a period of only 11 years. To try to address the fact that some other properties may be coming to the Board of Health in the next few years, the sanitary need category also includes those properties with water use intensity greater 200 gpd per 10,000 sq.ft. that were not granted significant variances during the past 11 years. This is a conservative approach. Figure 3-4 shows all 198 properties that have a sanitary need using these criteria.

TABLE 3-3
SUMMARY OF SANITARY NEEDS

	MAJOR WATERSHED				
	PLEASANT BAY	NAUSET SYSTEM	ATLANTIC OCEAN	CAPE COD BAY SYSTEMS	TOWN-WIDE
Title 5 Variances					
Number of Parcels	24	30	1	18	73
Current Flow, gpd	3,200	6,900	200	4,600	14,900
Intensive Water Use					
Number of Parcels	27	50	4	50	131
Current Flow, gpd	13,500	59,600	3,700	76,900	153,700
Receiving Water Quality					
Number of Parcels	0	0	0	0	0
Current Flow, gpd	0	0	0	0	0
Total					
Number of Parcels	48	79	5	66	198
Current Flow, gpd	16,100	63,500	3,900	78,900	162,400

Note: Town-wide totals are additive across the row. Totals by major watershed are not additive by column. The category total by watershed accounts for parcels that have more than one need.
Source: See text for data sources and analysis.



Lots with Sanitary Needs

Watershed Boundaries

Source: Parcel data obtained from Orleans Planning Dept.

0 4,000 8,000

Feet

Orleans CWMP

Lots With Sanitary Needs

PROJ NO:	DATE:	FIGURE:
10645G	Apr 2009	3-4

WRIGHT-PIERCE

Engineering a Better Environment

Thursday, September 11, 2008 9:24:37 AM W:\GIS_Development\Projects\10645B-Orleans\RecommendationPlanFig3-4.mxd

3.3 WATER SUPPLY PROTECTION

3.3.1 Private Wells

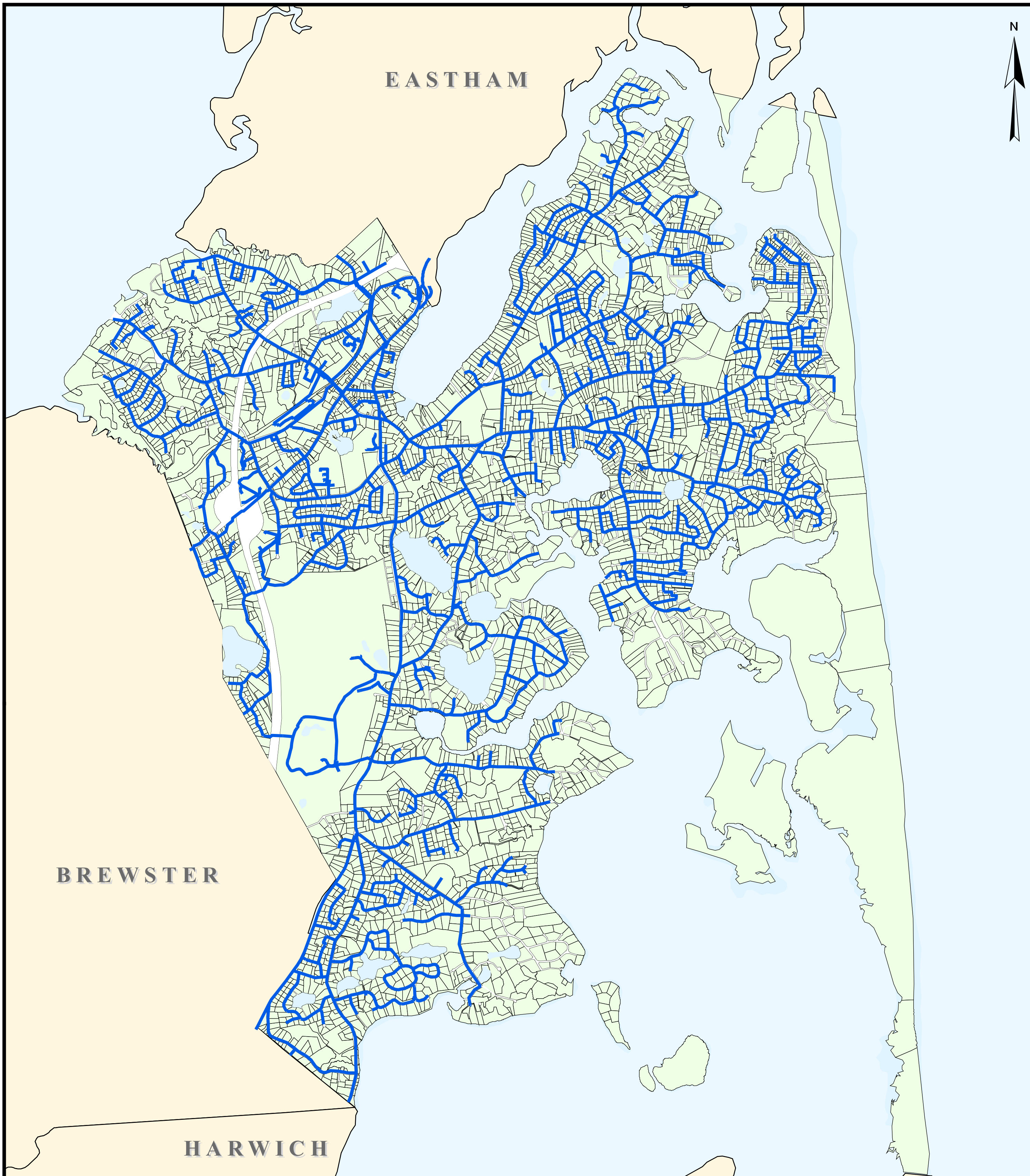
Figure 3-5 depicts the extent of the public water supply system in Orleans. According to Town records, over 90% of the developed lots in Orleans are connected to the public water system. Most of the lots that rely on private wells are located at the ends of peninsulas extending into Pleasant Bay, in the Pochet Inlet and Paw Wah Pond sub-watersheds, and east of the Quanset Pond sub-watershed.

When private wells are installed for potable purposes, the Board of Health requires that an analysis of water quality be submitted prior to occupancy. There is no requirement for homeowners to continue to document water quality after initial occupancy, nor is there information available on wells installed prior to the Board's adoption of this policy. Although there is no readily-accessible database of water quality in private potable wells, the Health Department is not aware of any widespread problems, whether related to nearby septic systems or other causes.

If there were problems with nearby septic systems impacting private potable wells, the elimination of those septic systems through public sewering might not be the best solution. Prior groundwater contamination would not be affected by the presence of a public sewer, and the private well owner would still be at risk. Therefore, the best solution, should such problems come to light in the future, would be to extend the public water supply to the affected properties. Given the fact that the Orleans water system extends to all areas of town, the cost of such an extension might be less than the cost of sewering. If a satellite wastewater treatment and disposal system were to be installed upgradient from a neighborhood served by private potable wells, it would be prudent to extend the public water supply systems to serve that neighborhood.

3.3.2 Public Wells

The Town of Orleans draws water from seven wells located in the southwesterly portion of town. Figure 3-6 shows the recharge areas of those wells under drought conditions, the DEP-approved Zone II areas. Most of the Town wells are located within an 500-acre wellfield located between



Public Water Supply Lines

Source: Parcels and Water Supply Lines
data obtained from Orleans Planning Dept.

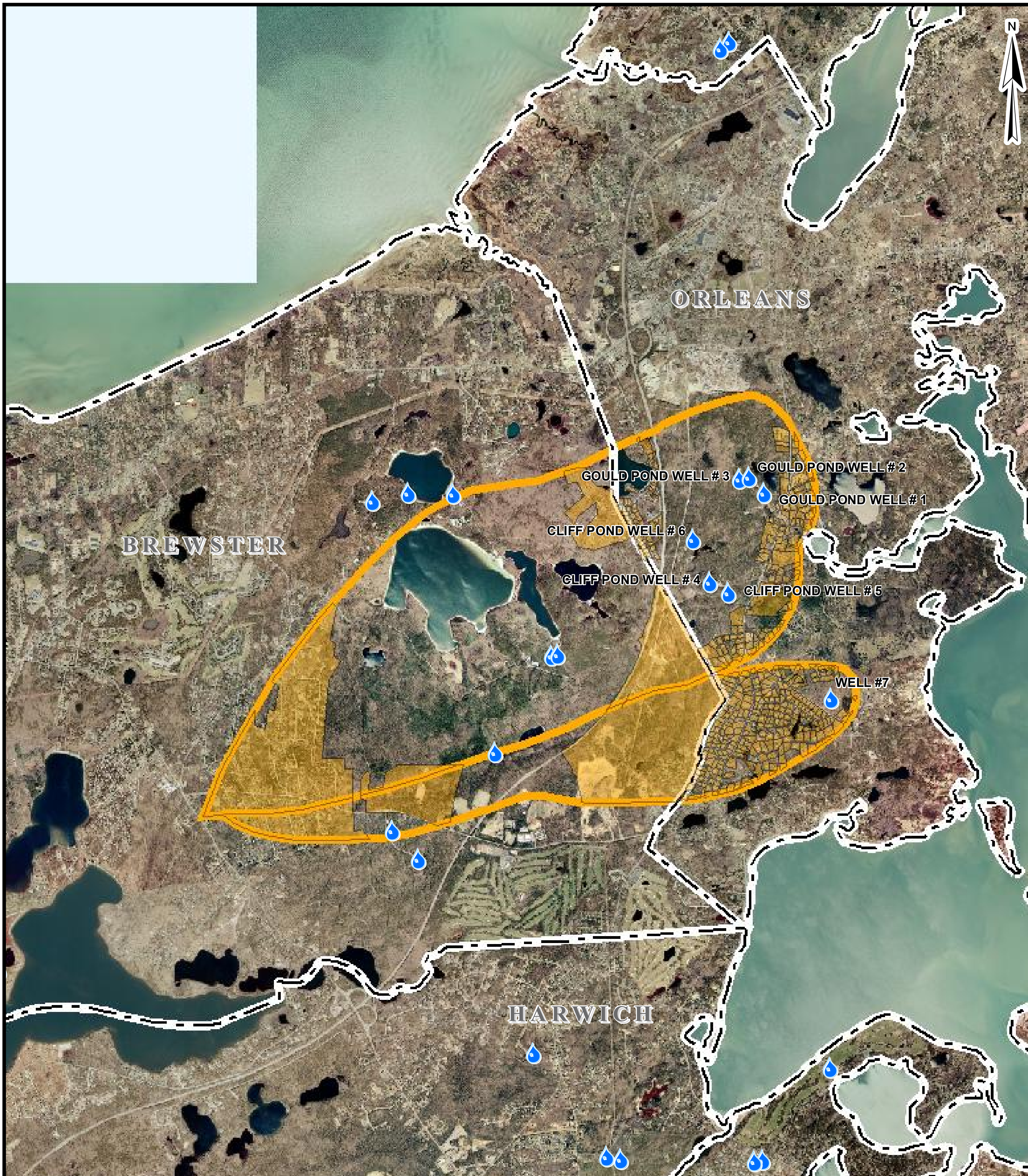
0 4,000 8,000 Feet

Orleans CWMP

Extent of Public Water Supply Lines

PROJ NO: 10645G DATE: Apr 2009 FIGURE: 3-5

WRIGHT-PIERCE
Engineering a Better Environment



Public Water Supply Wells

Developed Lots

Public Water Supply Zone II

Source: Parcel data obtained from Orleans Planning Dept. Aerial imagery Zone II and PWS provided by MassGIS.

0 4,000 8,000 Feet

Orleans CWMP

Developed Lots in Public Water Supply Zone IIs

PROJ NO:	DATE:	FIGURE:
10645G	Apr 2009	3-6

WRIGHT-PIERCE Engineering a Better Environment

Thursday, September 11, 2008 9:37:37 AM W:\GIS_Development\Projects\10645B-Orleans\RecommendationPlan\Fig3-6.mxd

Route 6 and Route 28. Well 7 is located in a largely developed area of South Orleans. The Zone II for Wells 1 through 6 extends westerly into Brewster and merges with the Zone IIs of several Brewster wells. The Zone II for Well 7 also extends well into Brewster and is somewhat distinct from the remaining Zone II area. Of the aggregate Zone II area for Brewster and Orleans wells, about 70% lies within the Town of Brewster.

The standard approach for judging development impacts on public water supply wells is a DEP-endorsed nitrogen loading model. This analytical model aggregates all of the nitrogen loads and compares them with the sum of all of the recharge sources within the Zone II. The result is an approximation of the wellhead nitrogen concentration that will eventually occur.

That model has been applied separately to the Zone II for Wells 1 through 6 and the Zone II for Well 7. The Planning Department's parcel-specific database was used to estimate nitrogen loads and recharge volumes in Orleans. For Brewster, where such parcel-specific data are not available, a nitrogen loading rate was applied that is consistent with a comparable density of development in Orleans.

The drinking water standard for nitrate, the most common form of nitrogen in groundwater, is 10 mg/l, established to protect infants from methemoglobinemia. Since wellhead concentrations should never exceed that level, a planning guideline of 5 mg/l has been established in the Cape Cod Commission's Regional Policy Plan for water supply protection. This modeling indicates that the wellhead nitrogen concentrations in the main wellfield will not exceed 1 mg/l and the comparable figure for Well 7 will be below 2 mg/l, even at build-out. (By comparison, current wellhead nitrogen concentrations are 0.1 to 0.2 mg/l in the main wellfield and 0.7 to 0.8 mg/l at Well 7). The presence of large tracts of undevelopable protected land in both Brewster and Orleans provide protection against development-related nitrogen problems. Therefore, there is no over-riding need for public sewers to protect public water supplies by eliminating septic systems in the Zone IIs.

(It is important to note that this analysis focuses on nitrate as a water supply contaminant. It has been found that nitrate also functions as a good surrogate for other contaminants that could reach the groundwater from septic systems. That is, low levels of nitrate typically reflect low levels of other parameters. Such a generalization does not apply, however, when there is a large point source of contamination within the watershed, such as a landfill and does not account for catastrophic spills. While this analysis addresses the nitrogen loading in the wellfields, it should not be considered as a full assessment of all water quality concerns.)

3.3.3 Overview of Water Supply Protection Needs

Based on the evaluations described above, the protection of water supplies, either public or private, is not a significant driving force in the provision of public sewers in Orleans. Should sewers be needed to limit nitrogen loading to Pleasant Bay, lots within the Zone II of Well 7 could be given priority to eliminate septic systems in that area as a pre-cautionary measure.

3.4 SURFACE WATER PROTECTION

3.4.1 Freshwater Ponds

There are 63 freshwater lakes and ponds in Orleans, 25 of which have surface areas greater than one acre. Eight of the larger ponds and lakes were selected for evaluation as part of this CWMP. They are:

Bakers Pond	Ice House Pond
Bolands Pond	Pilgrim Lake
Cedar Pond	Sarah's Pond
Crystal Lake	Shoal Pond

These eight freshwater bodies (all called "ponds" in this report) account for two-thirds of the total pond surface area in Orleans, and include all of the freshwater ponds with public beaches and boat ramps.

One of the principal causes of water quality changes in freshwater ponds is increased loading of phosphorus. This nutrient can cause excessive growth of algae which degrades water quality and impairs human uses of the pond, in a manner analogous to the effects of excess nitrogen in the estuarine setting. Phosphorus sources include subsurface wastewater disposal, lawn fertilization, stormwater runoff, and release from bottom sediments. Travel time in the groundwater is significantly different for phosphorus than for nitrogen, however. Nitrogen is readily converted to the nitrate form which does not bind to particles and tends to move through the soil at the same speed as the groundwater. Under typical Cape Cod conditions, nitrogen will move about 300 feet in one year. In contrast, phosphorus tends to chemically bind to the soil and moves down-gradient only after soil uptake sites are exhausted. As a rule of thumb, phosphorus will take about 100 years to travel 300 feet, or about 100 times as long as nitrogen. Given the slow groundwater travel of phosphorus, stormwater runoff (both in general and especially from near-shore fertilized lawns) is often the first priority for lake protection, while septic systems represent a longer-term threat.

This CWMP is not intended to determine the magnitude and relative importance of all phosphorus sources to the major ponds in Orleans. However, it is important to determine if elimination of on-site wastewater disposal systems upgradient of major ponds is warranted.

As a first step in this evaluation, the project limnologist assembled and interpreted all readily available data on the eight selected ponds. This pond assessment, prepared by ENSR Corporation, is provided in Appendix A and summarized in Table 3-4. The trophic status (a relative measure of the productivity) of the eight ponds ranges from "oligotrophic" (least amount of biological growth) for Bakers Pond, through "mesotrophic" for Pilgrim to "eutrophic" (most amount of biological growth) for Bolands, Cedar and Shoal Ponds. Of the designated uses included in the state water quality standards, Cedar and Shoal Ponds are considered impaired with respect to swimming, while Bolands and Sarah's are occasionally impaired. All but Bakers Pond are considered potentially impaired with respect to maintenance of aquatic life (fisheries).

The number of developed properties upgradient of and within 300 feet of each pond was determined from the Town's Geographic Information System, and wastewater flows were estimated from Town water use records. In the aggregate, there are 77 developed properties in the 300-foot upgradient areas of these eight ponds, with current wastewater flows of 8,800 gpd. These current wastewater flows represent 1.1% of the town-wide flows. (At the end of the planning period, those flows are projected to reach 14,300 gpd or 1.5% of the projected town-wide totals.)

Using current and project wastewater flows, the project limnologist then made an assessment of the likelihood that removal of septic phosphorus loads would be significant in terms of each pond's water quality and use impairment. For three ponds (Bolands, Crystal and Pilgrim), the removal of septic phosphorus loads within the 300-foot buffer is expected to provide some

TABLE 3-4
POND TROPHIC STATUS, IMPAIRED USES AND WASTEWATER MANAGEMENT PRIORITIES

WATER BODY	TROPHIC STATUS	IMPAIRED USES	WASTEWATER MANAGEMENT PRIORITY
Bakers Pond	Oligotrophic	None	Second priority
Bolands Pond	Eutrophic	Aquatic life support Contact recreation	First priority
Cedar Pond	Eutrophic	Aquatic life support Contact recreation	Defer for MEP studies
Crystal Lake	Oligo-mesotrophic	Aquatic life support	First priority
Ice House Pond	Oligo-mesotrophic	None	Second priority
Pilgrim Lake	Mesotrophic	Aquatic life support	First priority
Sarah's Pond	Mesotrophic	Aquatic life support Contact recreation	No need
Shoal Pond	Eutrophic	Aquatic life support Contact recreation	Second priority

degree of protection from excessive phosphorus loading. For Cedar Pond, which may be nitrogen-limited, any such determination should be deferred until the results of the Massachusetts Estuary Project are complete for Rock Harbor, the estuary to which Cedar Pond is connected. For three of the ponds evaluated (Bakers, Ice House, and Shoal), there is insufficient linkage between pond quality and septic loading to warrant the elimination of septic systems in their watersheds without further evaluation. For Sarah's Pond, the characteristics of the pond and its protected watershed indicate no need for control of septic phosphorus loads.

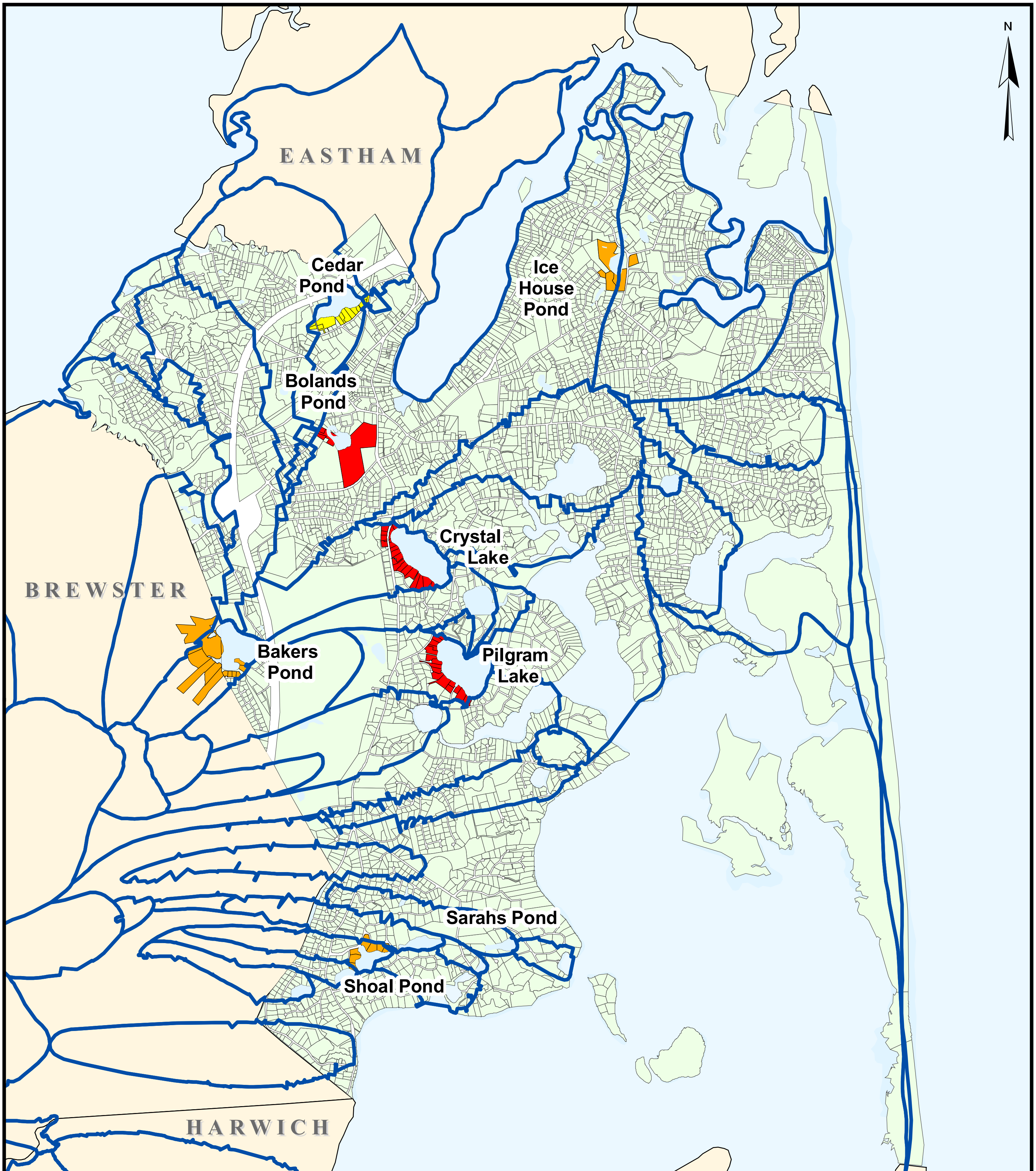
Since septic systems are but one source of phosphorus and each pond has different characteristics with respect to phosphorus loading and recycling, the Town should conduct focused studies of feasible phosphorus control strategies for each of its major ponds. The Orleans wastewater plan should include, concurrent with these feasibility studies, provisions for collection and off-site disposal of wastewater currently discharged within the 300-foot upgradient areas for Bolands Pond, Crystal Lake and Pilgrim Lake. For the other three ponds, (Baker, Ice House and Shoal) those studies should be completed before formal actions are taken to eliminate septic systems, which could be included in later phase of a wastewater management program. In general, sewering of upgradient lots is a good long-term investment, but should not be undertaken without first having considered and addressed the stormwater loads, near-shore fertilization practices and establishment of shoreline vegetated buffers.

Figure 3-7 shows the parcels located in the upgradient 300-foot impact areas for the studied ponds. Table 3-5 summarizes the numbers of lots and wastewater flows in these areas. Figure 3-7 includes the noted three ponds in the "second priority" category. Other significant Orleans pond, although not evaluated in this assessment, should also be included in this category for future feasibility studies, including Uncle Seth's Pond, Deep Pond, Twinings Pond, Uncle Israel's Pond, Ruebens Pond and Uncle Harvey's Pond.

3.4.2 Estuaries

It has become widely accepted that residential and commercial development on Cape Cod has negatively impacted estuarine water quality. The contaminant of principal concern is nitrogen. Principal nitrogen sources include on-site wastewater disposal, lawn fertilization, stormwater disposal, atmospheric deposition and recycling from bottom sediments.

The Massachusetts Department of Environmental Protection, in conjunction with the University of Massachusetts at Dartmouth (School of Marine Science and Technology, or SMAST) is undertaking comprehensive studies of 89 embayments in southeastern Massachusetts as part of the Massachusetts Estuaries Program (MEP). Those studies will determine the degree of impairment, the magnitude of the nitrogen sources, and the degree of nitrogen reduction needed



First Priority
Second Priority
Defer for MEP Results
Watershed Boundaries

Source: Parcel data obtained from Orleans Planning Dept.

0 4,000 8,000 Feet

Orleans CWMP

Pond Protection Needs

PROJ NO:	DATE:	FIGURE:
10645G	Apr 2009	3-7

WRIGHT-PIERCE
Engineering a Better Environment

TABLE 3-5
WASTEWATER FLOWS UPGRADIENT OF EVALUATED PONDS

	MAJOR WATERSHED			
WATER BODY	**PLEASANT BAY**	**NAUSET SYSTEM**	**CAPE COD SYSTEM**	**TOTAL**
	300-ft Buffer	300-ft Buffer	300-ft Buffer	300-ft Buffer
Bolands Pond				
Number of Parcels		4		4
Current Flow, gpd		2,100		2,100
Ice House Pond				
Number of Parcels		5		5
Current Flow, gpd		300		300
Cedar Pond				
Number of Parcels			13	13
Current Flow, gpd			500	500
Pilgrim Lake				
Number of Parcels	16			16
Current Flow, gpd	1,500			1,500
Bakers Pond				
Number of Parcels	7			7
Current Flow, gpd	800			800
Crystal Lake				
Number of Parcels	20			20
Current Flow, gpd	2,300			2,300
Shoal Pond				
Number of Parcels	7			7
Current Flow, gpd	1,200			1,200
Sarah's Pond				
Number of Parcels	5			5
Current Flow, gpd	100			100
Total				
Number of Parcels	55	9	13	77
Current Flow, gpd	5,900	2,400	500	8,800

Note: Six parcels in Brewster upgradient of Bakers Pond are not included.

to restore water quality. Five MEP technical reports will cover the estuarine waters impacted by Orleans:

- Pleasant Bay;
- Nauset system; and
- Three Cape Cod Bay systems.

These technical reports will form the basis for the establishment of Total Maximum Daily Loads (TMDLs) for nitrogen. The TMDLs will formally establish the degree of nitrogen reduction required to restore estuarine water quality. In that on-site wastewater disposal is by far the largest controllable source of nitrogen to these estuaries, the TMDLs will constitute a significant driving force for wastewater collection treatment and disposal.

As of April 2009, MEP technical reports have been issued for Pleasant Bay (final) and the three Cape Cod Bay systems (draft). The TMDL for Pleasant Bay was approved by EPA (based on the final MEP technical report) in October 2007. The last technical report of importance to Orleans, covering the Nauset system, is scheduled for release in mid 2009. Therefore, this needs assessment has addressed the nitrogen control needs in Pleasant Bay based on approved TMDLs, in Rock Harbor based on published MEP reports, and on preliminary estimates for the Nauset system. Summary information from MEP technical reports is presented in Appendix G.

There are a variety of nitrogen sources and many ways to reduce the overall nitrogen loads from the watersheds in question. Later in this report, a broad range of nitrogen control strategies are identified and evaluated, including wastewater collection/treatment/disposal, management of fertilizer load, stormwater management, and enhancement of natural attenuation. In the Pleasant Bay and Rock Harbor watersheds, the required degree of nitrogen control is so large that wastewater collection and treatment must be the primary basis for control; that is, even the complete removal of other controllable sources of nitrogen will be insufficient to effect the overall nitrogen reduction needed.

This CWMP also involves the identification and evaluation of sites for wastewater treatment and disposal. The most prudent approach with respect to siting is to assume that all of the nitrogen control needs will be achieved via wastewater treatment and to look for sites large enough to handle the associated wastewater volumes. If other nitrogen control strategies are identified and found to be feasible, the volumes of wastewater to be treated can then be commensurately reduced. At the end of this planning process, the Town will have identified the best combination of nitrogen control steps that, once implemented, will reduce nitrogen loads to levels at or below the TMDLs. As nitrogen control measures are implemented, monitoring of water quality and estuarine habitats will be needed to confirm TMDL compliance.

Table 3-6 is a summary of the nitrogen loads reported in the MEP technical report for Pleasant Bay. This table includes both current loads (on the left) and the reduced loads necessary to restore water quality (on the right). Using Meetinghouse Pond as an example, the important findings are as follows. The total nitrogen load to the Pond is currently 21.15 kilograms per day (kg/day). Most of that load is released from bottom sediments (the "benthic load"). The benthic and atmospheric loads are largely uncontrollable, while the "watershed load" consists of controllable loads such as from on-site wastewater disposal (the "septic load"), fertilizer use and stormwater runoff. For Meetinghouse Pond, the watershed load is now about 30% of the total load (6.20 out of 21.15 kg/day), and 83% of the watershed load is from septic systems. The modeling conducted by the MEP technical team indicates that water quality goals will be achieved if the total nitrogen load is reduced to 9.5 kg/day. By reducing the watershed load to 1.06 kg/day, the benthic load will eventually decline to 7.86 kg/day. Thus the total nitrogen load must be reduced by 55%, and to accomplish that overall reduction, the watershed load must be reduced by 83%. Since the septic load is 83% of the total watershed load, it is obvious that complete removal of the septic load is needed in this sub-watershed. Across most of Pleasant Bay, the large removal percentages that are required indicate that wastewater collection and treatment must be a large part of the solution.

Table 3-6 includes nitrogen load estimates and goals for 19 sub-embayments that comprise Pleasant Bay. Eleven of those sub-embayments are impacted by Orleans, of which three (Meetinghouse Pond, Pah Wah Pond and Pochet Neck) are impacted only by Orleans and six (The River, Lonnies Pond, Areys Pond, Namequoit River, Little Pleasant Bay, and Quanset Pond) receive a substantial nitrogen load from Orleans. The restoration of Pleasant Bay will be accomplished by nitrogen controls enacted by multiple towns, and the responsibility for the associated costs must be appropriately shared among Orleans, Brewster, Harwich and Chatham. Many of the most sensitive "headwaters" sub-embayments are most directly affected by Orleans, so the highest nitrogen removal percentages are associated with the "Orleans-only" watersheds.

As Orleans moves into later phases of the CWMP (including evaluation of nitrogen control alternatives and wastewater treatment site identification), it is prudent to assume that all of the nitrogen control needs will be accomplished by wastewater collection, treatment and disposal.

TABLE 3-6
REQUIRED NITROGEN LOAD REDUCTIONS
BY SUB-EMBAYMENTS OF PLEASANT BAY

Sub-Embayment	Other Towns In Watershed	Current Loads, kg/day			Target Loads kg/day		Required Percentage Reductions		
		Watershed	% Septic	Total	Watershed	Total	Overall	Watershed	Septic
Orleans-Only Watersheds									
Meetinghouse Pond	None	6.20	83	21.15	1.06	9.50	55	83	100
Paw Wah Pond	None	1.86	81	5.57	0.73	3.48	38	61	75
Pochet Neck	None	8.42	79	10.19	4.12	5.89	42	51	65
Subtotal		**16.48**	**79**	**36.91**	**5.91**	**18.87**	**49**	**64**	**80**
Watersheds Shared by Orleans									
Lonnies Pond	Brewster	2.44	67	4.26	1.63	3.16	26	33	50
The River-Upper	Brewster	2.77	75	9.32	1.74	6.13	34	37	50
The River-Lower	Brewster	3.88	74	16.60	2.44	13.20	20	37	50
Areys Pond	Brewster	1.31	60	7.49	0.92	6.03	19	30	50
Namequoit River	Brewster	2.74	73	17.83	1.73	14.47	19	37	50
Little Pleasant Bay	Brewster	8.14	61	69.46	5.88	65.19	6	28	45
Quanset Pond	Brewster	1.78	79	7.94	1.08	6.04	24	39	50
Pleasant Bay	Brew/Har/Chat	29.28	51	175.11	21.85	155.03	11	25	50
Subtotal		**52.34**	**56**	**308.01**	**37.27**	**269.25**	**13**	**29**	**49**
Watersheds Not Shared by Orleans									
Round Cove	Harwich/Brewster	4.22	75	12.81	2.96	9.87	23	30	40
Muddy Creek-Upper	Harwich/Chatham	9.99	72	14.71	4.61	7.47	49	54	75
Muddy Creek-Lower	Harwich/Chatham	8.48	75	8.69	2.14	2.35	73	75	100
Ryder Cove	Chatham	9.82	73	20.48	4.47	12.48	39	54	75
Frost Fish Creek	Chatham	2.90	76	3.00	0.70	0.80	73	76	100
Crows Pond	Chatham	4.22	79	6.22	4.22	6.22	0	0	0
Bassing Harbor	Chatham	1.67	84	2.74	1.67	2.74	0	0	0
Chatham Harbor	Chatham	17.10	83	31.25	17.1	31.25	0	0	0
Subtotal		**58.40**	**77**	**99.90**	**37.87**	**73.18**	**27**	**35**	**48**
Total		**127**	**70**	**445**	**81**	**361**	**19**	**36**	**52**

Note: The target nitrogen loads represent a single scenario; other combinations of nitrogen removal may also result in TMDL compliance.
Source: MEP technical report and TMDL document.

(This assumption is to facilitate those later activities and is not intended to reflect a bias toward sewering as the best solution.) From Table 3-6, it has been assumed that the maximum quantities of collected wastewater can be determined by combining 80% of the wastewater generated in the Orleans-only watersheds and 49% of the wastewater generated in the watersheds Orleans shares with other towns. That combined percentage represents about 60% of the wastewater generated in the portions of Orleans in the Pleasant Bay watershed, assuming that the collected and treated wastewater is disposed of outside the Pleasant Bay watershed. If 90% nitrogen removal is effected through tertiary treatment, and the effluent is discharged within the Pleasant Bay watershed, then about 67% of Orleans' Pleasant Bay wastewater must be collected and treated.

As presented in Section 2 of this report, the current wastewater generation rate in the Pleasant Bay watershed is approximately 309,000 gpd on an annual average basis. Given the assumptions of this analysis, the nitrogen-control needs for this watershed can be expressed as 200,000 gpd of wastewater. At average per-lot generation rates, this translates to wastewater collection from approximately 1,500 parcels. (By selecting lots with above-average water use and nitrogen load, a sewer system would serve a somewhat lower number of parcels.)

The Cape Cod Commission, a participant in the MEP program, has determined that the current nitrogen loads to Pleasant Bay are distributed by town as follows:

Orleans	32%
Brewster	11%
Harwich	20%
Chatham	37%

As the Towns complete their CWMPs, it will be necessary to determine the optimum arrangement of nitrogen control strategies among the contributing towns. DEP has suggested that the distribution of current loads be used as the initial approach for allocating responsibility for nitrogen control. If Orleans removes, say, 60% of the nitrogen generated in its portion of the Pleasant Bay watershed, and Brewster removes an equal percentage, then each town is assuming responsibility in proportion to its current loads. It is feasible for one town to provide more than its fair share of nitrogen control, if that represents the most cost-effective regional approach, and to rely on cost sharing formulas to allocate the cost of the completed facilities. Such regional scenarios are considered in Section 9 of the CWMP.

In some of the other areas of wastewater needs, it is possible to identify specific parcels; for example, those with significant Title 5 variances, high water use, or frequent septage pumping. In the category of estuary water protection, the lot identity is less important. This is because nitrogen loading is a cumulative problem, and effecting the necessary overall nitrogen reduction is more important than the specific lot location. Lots will be identified based on their proximity to the Bay (restoration will occur faster if near-shore septic systems are eliminated), the water use (which is proportional to the wastewater volume), the density of development (it is more cost-effective to build collection systems in areas of small lots), and their occupancy status (year-round homes produce more nitrogen than seasonal homes).

The draft MEP technical reports for the Cape Cod Bay systems document a broad range of nitrogen control needs. For the Namskaket and Little Namskaket systems, the current nitrogen loads are well below the estimated threshold loads. In contrast, the threshold loads are exceeded by current nitrogen inputs in the Rock Harbor system, indicating the need to remove 70% of the septic load. The MEP results for Rock Harbor translate to a wastewater flow of 52,000 gpd if all of the nitrogen removal is effected through sewering.

Given the fact that the MEP analyses for the Nauset systems has not been issued, only preliminary estimates can be made of the potential wastewater volumes that may need collection and treatment. Based on water quality testing accomplished to date and initial interpretations by MEP staff, wastewater planning has proceeded based on 55% nitrogen control in the Nauset system. This percentage translates to 134,000 gpd of wastewater flow. No nitrogen control is expected to be necessary in the Atlantic Ocean watershed.

3.5 CONVENIENCE AND AESTHETICS

On-site wastewater disposal can be inconvenient and/or aesthetically displeasing to property owners or neighbors under certain circumstances. These instances are independent of public health issues or the protection or drinking water or surface waters. Based on discussion with Town officials and with the Wastewater Management Steering Committee, four types of convenience or aesthetic factors were identified:

- The presence of an enhanced (I/A) treatment system;

- A record of frequent septage pumping;
- A tight tank; or
- A mounded septic system.

Some people do not like the appearance of above-grade private wastewater treatment systems (often called Innovative/Alternative or I/A systems). Further, these systems require regular sampling and monitoring that homeowners view as inconvenient or expensive. On-site systems that require frequent pumping of septage, or tight tanks that require frequent pumping of wastewater, can create impacts due to truck traffic, noise and odor. Mounded systems, particularly those associated with severe retaining walls and lack of landscaping, are often viewed as aesthetically displeasing by neighbors or passers-by. If lots with any of these characteristics were provided with off-site wastewater options, the property owners and/or neighbors would probably support the abandonment of the current system and participation in the off-lot option. (Conversely, property owners who have made a significant investment in an I/A system or mounded leaching field may not wish to abandon those facilities.)

Table 3-7 shows the number of properties and current wastewater flow in each of the four noted categories of convenience and aesthetic factors. The locations of these properties are shown town-wide in Figure 3-8.

The locations of enhanced treatment systems and tight tanks were determined from Health Department files, which was also the source of septage pumping volumes. The mounded systems are those identified by the Citizens Advisory Committee (CAC) during a survey conducted in March 2006. (That CAC survey was not intended to locate all mounded systems, but should have found most of the ones that are most visible from the street. Those not readily visible pose much less of a concern.) Figure 3-8 shows that these convenience and aesthetic issues are not widespread in Orleans. As predicted by the Health Agent, a large percentage of the identified lots are located in the northwesterly portion of town (in the Cape Cod Bay watersheds) and the westerly portion of the Nauset system. Note that some lots have two or three of the identifiers.

This analysis identified 120 lots with these concerns, with an aggregate flow (current annual average) of about 105,000 gallons per day. This flow represents 13% of the current town-wide

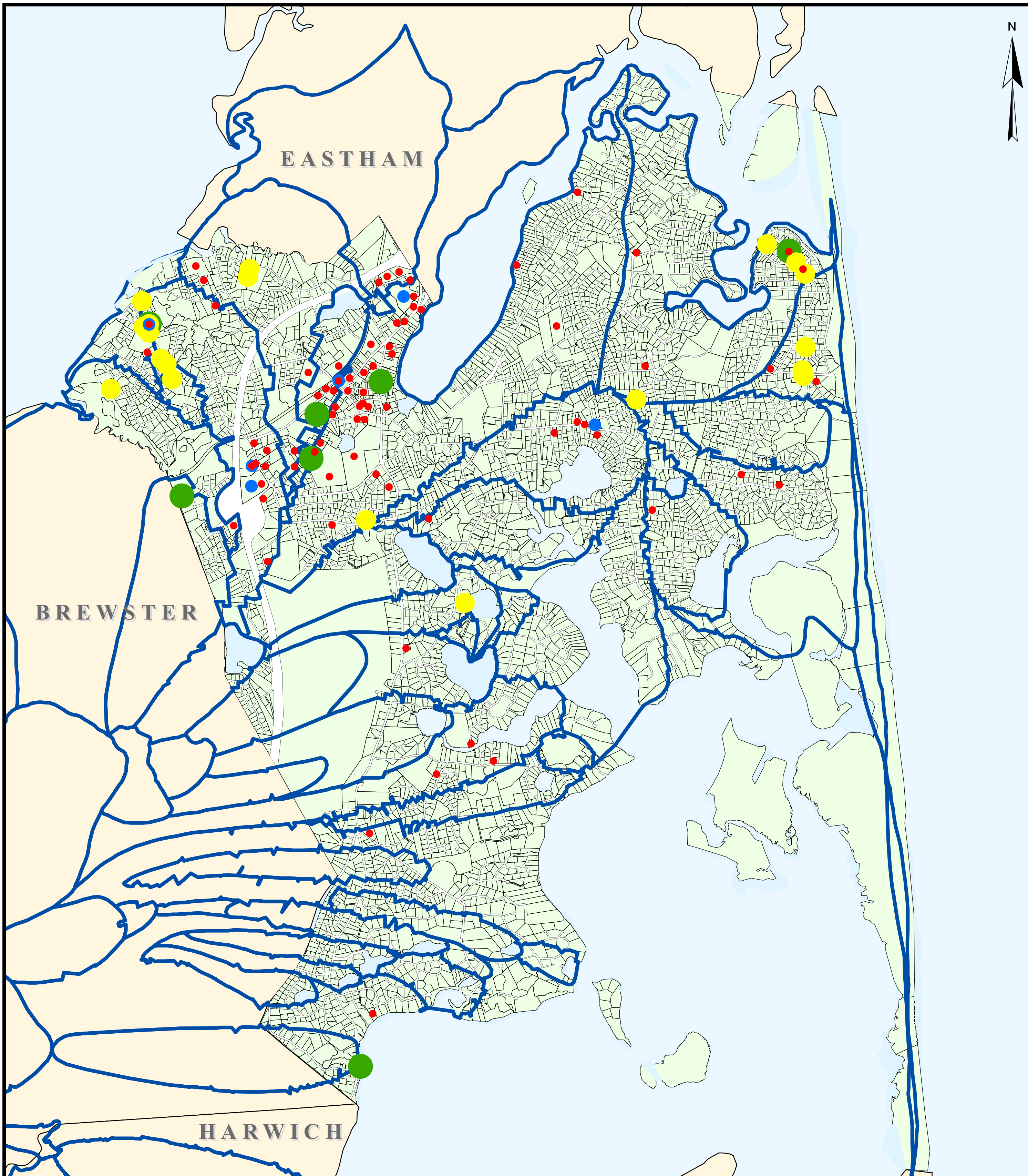
TABLE 3-7

SUMMARY OF NEEDS ASSOCIATED WITH CONVENIENCE AND AESTHETIC FACTORS

	MAJOR WATERSHED				
NEED CATEGORY	PLEASANT BAY	NAUSET SYSTEM	ATLANTIC OCEAN	CAPE COD BAY SYSTEMS	TOWN-WIDE
Innovative/Alternative Systems					
Number of Parcels	14	3	0	10	27
Current Flow, gpd	4,800	3,200	0	10,000	18,000
Tight Tanks					
Number of Parcels	1	2	0	4	7
Current Flow, gpd	500	500	0	5,000	6,000
Frequent Septage Pumping					
Number of Parcels	14	31	3	30	78
Current Flow, gpd	7,200	35,300	4,300	50,900	97,700
Mounded Systems					
Number of Parcels	1	5	3	10	19
Current Flow, gpd	100	400	400	1,000	1,900
Total					
Number of Parcels	29	39	6	46	120
Current Flow, gpd	9,600	36,500	4,700	53,900	104,700

Note: Town-wide totals are additive across the row. Totals by major watershed are not additive by column. The category total by watershed accounts for parcels that have more than one need.
Sources: Orleans Health Department and Citizen Advisory Committee.

average flow, so these properties include some of the larger water users in town. Many of these properties could be the first priority for providing public sewers.



Septage Pumping
4 or more times/yr

I/A Systems

Mounded Systems

Tight Tanks

Watershed Boundaries

Source: Parcel data obtained from Orleans Planning Dept. Wastewater systems from Orleans Health Dept. Watershed boundaries from MEP.

0 4,000 8,000 Feet

Orleans CWMP

Convenience and Aesthetic Factors

PROJ NO: 10645G DATE: Apr 2009

WRIGHT-PIERCE
Engineering a Better Environment

FIGURE: 3-8

Thursday, September 11, 2008 9:57:37 AM W:\GIS_Development\Projects\10645B-Orleans\RecommendationPlan\Fig3-8.mxd

3.6 ECONOMIC GROWTH

Some communities provide public sewerage in selected areas to promote more intense economic development than can be supported by on-site wastewater disposal. Typical examples include downtown commercial areas and industrial or office parks.

The Orleans Planning Board addressed this issue in the spring of 2006, as part of the build-out analysis (see Section 4). The Planning Board was asked to answer the following question:

> Should the Comprehensive Wastewater Management Plan include an allowance for sustainable economic growth, over and above the growth now expected under the current zoning bylaws?

This subject was debated and discussed at a Planning Board meeting on June 15, 2006, and the following conclusions were drawn:

- The Comprehensive Wastewater Management Plan should be "growth-neutral"; that is it should not promote more growth than would otherwise occur under the zoning bylaw.
- No expansions of commercially-zoned districts are warranted.
- Traffic, parking and other issues will limit commercial growth, and provision of off-site wastewater facilities will typically not result in significant added growth in commercially-zoned areas unless those other restrictions are lifted.

Affordable housing projects constructed under Chapter 40B of Massachusetts General Laws could result in a higher density than permitted under the zoning bylaw. (Approximately 8.5% of Orleans dwelling units are considered "affordable", below the 10% threshold established under Chapter 40B.)

An analysis by the Planning Department determined that approximately 200 apartments could be built in 40B projects before the 10% threshold is reached. Accordingly, an allowance of 17,000 gpd of wastewater flow has been included in the future flow projections, based on expected annual average flows from similar apartment units. The Planning Department projects that those 40B projects would most likely be located in the commercial zones, although they could occur anywhere in Orleans.

3.7 SUMMARY OF CURRENT NEEDS

Table 3-8 summarizes the results of this needs assessment in terms of both numbers of properties and wastewater flow. Protection of surface waters from nutrient enrichment is by far the most important need in Orleans, affecting perhaps 50% to 55% of the developed lots. Needs associated with sanitary issues, convenience/aesthetics factors and economic development apply to only about 8% of the developed lots in town, in the aggregate.

Each of the five needs categories has been addressed separately in the paragraphs above. While it is important to characterize wastewater needs in these separate categories, it is also important to recognize that some properties in Orleans fall into more than one needs category. For example, a downtown commercial lot may have experienced high septage pumping (convenience/aesthetics need) and multiple Title 5 variances (sanitary need) and be located in an area where nitrogen control is needed and can be cost-effectively achieved (surface water protection). The summary block of data in Table 3-8 has been compiled to address this "overlap" of needs. Figure 3-9 shows the locations of individual lots in the sanitary, pond protection and convenience/aesthetics categories. This figure also depicts the commercial areas where economic development needs are expected, and the watersheds with different nitrogen control needs.

A review of Table 3-8 and Figure 3-9 reveals that the sanitary and convenience/aesthetics needs are concentrated in and near the downtown area. While MEP studies are yet incomplete on all of the Orleans-impacted embayments, it is expected that Rock Harbor and the "headwaters" systems in Pleasant Bay will have the greatest need for nitrogen control.

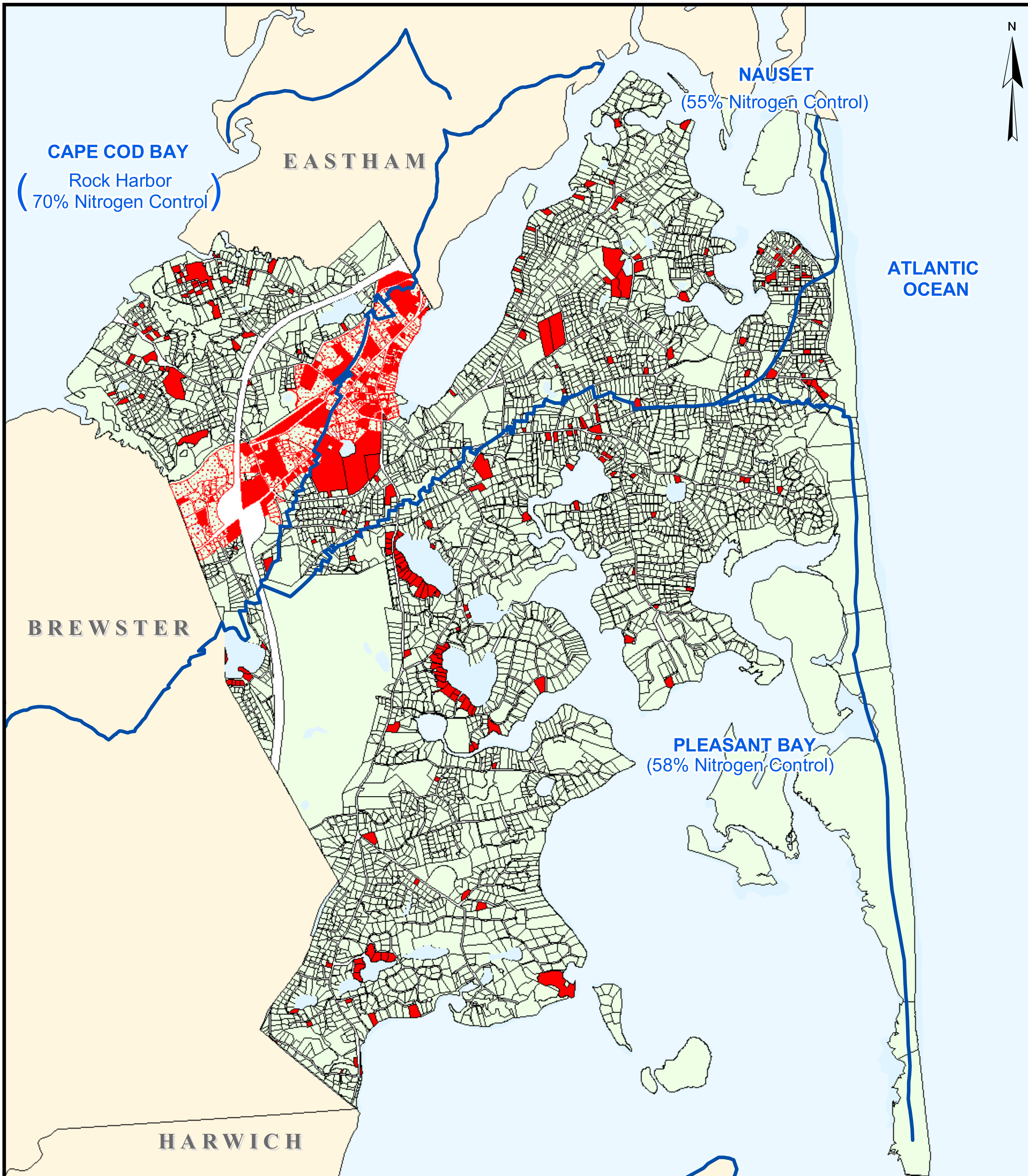
Table 3-8 shows that the nitrogen control needs in the Pleasant Bay system exceed the needs in all other categories in that watershed. That is, should a public sewerage system be built to collect and treat wastewater from that watershed to reduce nitrogen loading, that sewerage system could also address most of the sanitary needs and the convenience/aesthetics issues. Those properties with sanitary needs or convenience/aesthetic issues could be among the first priorities when selecting the lots for nitrogen control. In the other watersheds, the same general conclusions can be drawn if actual nitrogen control needs are determined to be of the same magnitude as the placeholder values included in this report.

TABLE 3-8
SUMMARY OF CURRENT NEEDS IN ALL CATEGORIES

NEEDS CATEGORY	MAJOR WATERSHED				TOWN-WIDE
	PLEASANT BAY	NAUSET SYSTEM	ATLANTIC OCEAN	CAPE COD BAY	
Sanitary					
Number of Parcels	48	79	5	66	198
Current Wastewater Flow, gpd	16,100	63,500	3,900	78,900	162,400
Water Supply Protection					
Number of Parcels	0	0	0	0	0
Current Wastewater Flow, gpd	0	0	0	0	0
Surface Water Protection (ponds)					
Number of Parcels	50	9	0	0	59
Current Wastewater Flow, gpd	5,800	2,400	0	0	8,000
Surface Water Protection (estuaries)					
Number of Parcels	1,480	790	0	220	2,490
Current Flow, gpd	200,000	134,000	0	52,000	386,000
Convenience and Aesthetics					
Number of Parcels	29	39	6	40	120
Current Flow, gpd	9,600	36,500	4,700	53,900	104,700
Economic Development					
Number of Parcels	0	5	0	5	10
Current Flow, gpd	0	0	0	0	0
Total					
Number of Parcels	1,545	837	11	257	2,644
Current Flow, gpd	213,000	170,000	8,600	101,600	493,200

Note: Town-wide totals are additive across the row. Totals by major watershed are not additive by column. The category total by watershed accounts for parcels that have more than one need.

The MEP technical reports document water quality conditions and nitrogen loads that existed in the early to mid years of the 2000-2009 decade. While this report uses the term "current needs" to describe these conditions, it should be noted that growth in the community, although small, may have resulted in somewhat higher wastewater volumes and a few more developed parcels than reported herein.



Individual Parcel Needs

Commercial District

Watershed Boundaries

Source: Parcel data obtained from Orleans Planning Dept. Watershed boundaries from MEP.

0 4,000 8,000 Feet

Orleans CWMP

Aggregated Needs

PROJ NO: 10645G DATE: Apr 2009

FIGURE: 3-9

WRIGHT-PIERCE
Engineering a Better Environment

Tuesday, September 23, 2008 7:58:15 AM W:\GIS_Development\Projects\10645B-Orleans\RecommendationPlan\Fig3-9.mxd

SECTION 4

FUTURE CONDITIONS

Wastewater management planning must address both current and future needs. As Orleans grows in population, wastewater management needs will increase. Wastewater flows will increase as vacant lots are developed, as seasonal homes are converted to year-round use (or are occupied a greater percentage of the year), and as commercial development expands to serve the larger population. Annual average wastewater flows have been selected as the common denominator to project future wastewater needs.

4.1 FUTURE WASTEWATER QUANTITIES

4.1.1 Definition of Terms

The term "current conditions" is intended to mean the general population, level of commercial activity and wastewater generation rates that existed in the middle of the 2000-2009 decade. The water consumption analysis, that has led to estimates of current wastewater volumes, is based on the average water use for the years 2002 to 2005. Given the relatively low growth rate and the year-to-year variability in the water use data, these "current" quantities may be appropriate through the completion of the CWMP.

For "future conditions", the following terms have been used:

Theoretical Build-out. The population and commercial activity associated with the ultimate development of Orleans to the fullest extent possible under current zoning and other regulations, regardless of economic issues.

Practical Build-out. The population and commercial activity associated with more realistic assumptions on the extent of build-out, factoring in such concerns as economic realities, other limitations on growth (such as infrastructure capacity), land protection efforts, and retention of estate properties.

Planning Horizon. A future population and level of commercial activity less than Practical Build-out that will be the basis for analyzing wastewater management options and for the design of whatever infrastructure may be recommended.

It is common practice to establish population estimates for these future milestones. However, given the large seasonal swings in population in Orleans and the importance of commercial activity (some of which is associated with growth in other towns), wastewater volumes have been used as the "measure" of future growth. It is possible to assign estimates of year-round and seasonal population once the future wastewater flows are determined. The estimates of wastewater flow are annual averages, without regard to how they will be treated and disposed of; some portion will continue to be handled in Title 5 systems, other portions will be collected and conveyed to satellite or centralized treatment systems. The projections of future wastewater quantities consider only the total volumes.

4.1.2 Theoretical Build-Out

The Town's GIS database was used to convert the Planning Department's lot-by-lot build-out assumptions into a projection of Theoretical Build-out wastewater flows. The result is summarized below:

Current Flows	
Residential	608,000 gpd
Commercial, etc.	171,000
Total	**779,000 gpd**
Increase through Theoretical Build-out	
Seasonal conversions and home expansions	164,000 gpd
New homes on existing or new lots	144,000
New accessory apartments in res. zones	115,000
New apartments in commercial zones	89,000
Commercial growth	144,000
Total increase	**656,000 gpd**
Theoretical Build-Out Flow	**1,435,000 gpd**

The estimate for seasonal conversions and new homes is the result of an analysis of water use for all existing homes, taking into account numbers of bedrooms and seasonal status. The projected increase is 26% of current residential wastewater flows. This figure represents the more intensive use of existing properties, and is independent of the number of new homes that might be built.

The estimate for new homes and apartments is based directly on the Planning Department's lot-by-lot assessment of where such dwelling units are allowed under the zoning bylaws. It includes 931 new residences, 1,490 new accessory apartments and 901 new apartments in the commercial zones. For town-wide purposes, this estimate is based on a single figure for residential water use per home, two-thirds of that figure for apartments, and one-half for accessory apartments.

The increase in commercial flows was assumed to be proportional to the overall increase in residential flows.

The projected wastewater flow at Theoretical Build-out represents an 84% increase over current flows.

4.1.3 Practical Build-Out

After development of the Theoretical Build-out projections, the Planning Department challenged all for the pertinent assumptions to inject a degree of "realism". The result is summarized below:

Current Flows	
Residential	608,000 gpd
Commercial, etc.	171,000
Total	**779,000 gpd**
Increase through Practical Build-out	
Seasonal conversions and home expansions	61,000 gpd
New homes on existing or new lots	112,000
New accessory apartments in res. zones	25,000
New apartments in commercial zones	44,000
Commercial growth	36,000
Total increase	**278,000 gpd**
Practical Build-out Flows	**1,057,000 gpd**

The estimated increase for seasonal conversions and home expansions was reduced from 26% to 10% of current wastewater flows. This latter figure is thought to better represent the actual experience in seasonal conversions over the past several years, and the fact that some home expansions may not involve much, if any, increase in flow.

The estimate for new homes and apartments is based on the Planning Department's judgment that only 90% of the potential new residences will ever be built, only 25% of the potential accessory apartments will be constructed, and 50 to 60% of the commercial-zone apartments will be developed. This translates to 838 new residences, 373 new accessory apartments, and 509 new commercial-zone apartments.

For commercial flows, the revised projection is based on an analysis of building permits for new or expanded buildings. The projected commercial wastewater flow at Practical Build-out represents a 21% increase over current flows, or about one-half of the percentage increase for residential flows. (By comparison, the same percentage increase was used for both residential and commercial in the Theoretical Build-out analysis.)

The projected wastewater flow at Practical Build-out represents a 36% increase over current flows.

Table 4-1 summarizes the principal assumptions behind the Practical and Theoretical Build-out analysis. Figure 4-1 illustrates the projections graphically. The February 2007 draft Needs Assessment Report contains some of the details associated with the projections, both town-wide and in the Village Center.

4.1.4 Planning Horizon

Whether it is the Practical or the Theoretical Build-out projection, Town officials have expressed the strong sense that neither condition will be reached within the traditional 20-year design life of the prospective wastewater facilities. Therefore, it is appropriate to select the planning horizon (in terms of both a date and the associated degree of growth) to better reflect intermediate-term needs. Three techniques were used to arrive at the planning horizon flows, as follows.

TABLE 4-1

SUMMARY OF ASSUMPTIONS USED IN BUILD-OUT ANALYSIS

SECTOR	PRACTICAL BUILD-OUT	THEORETICAL BUILD-OUT
Residential		
Seasonal Conversions and Home Additions	10% Increase in Per-Home Flow	26% Increase in Per-Home Flow
New Dwelling Units		
Residences	838	931
Per-Unit Flow, gpd	134	155
Accessory Apts. in Residential Zones	373	1,490
Per-Unit Flow, gpd	67	77
Apts. in Commercial Zone	509	901
Per-Unit Flow, gpd	86	99
Commercial		
Percent Increase Over Current	21%	84%
Overall Increase in Flow		
(Over Current)	36%	84%

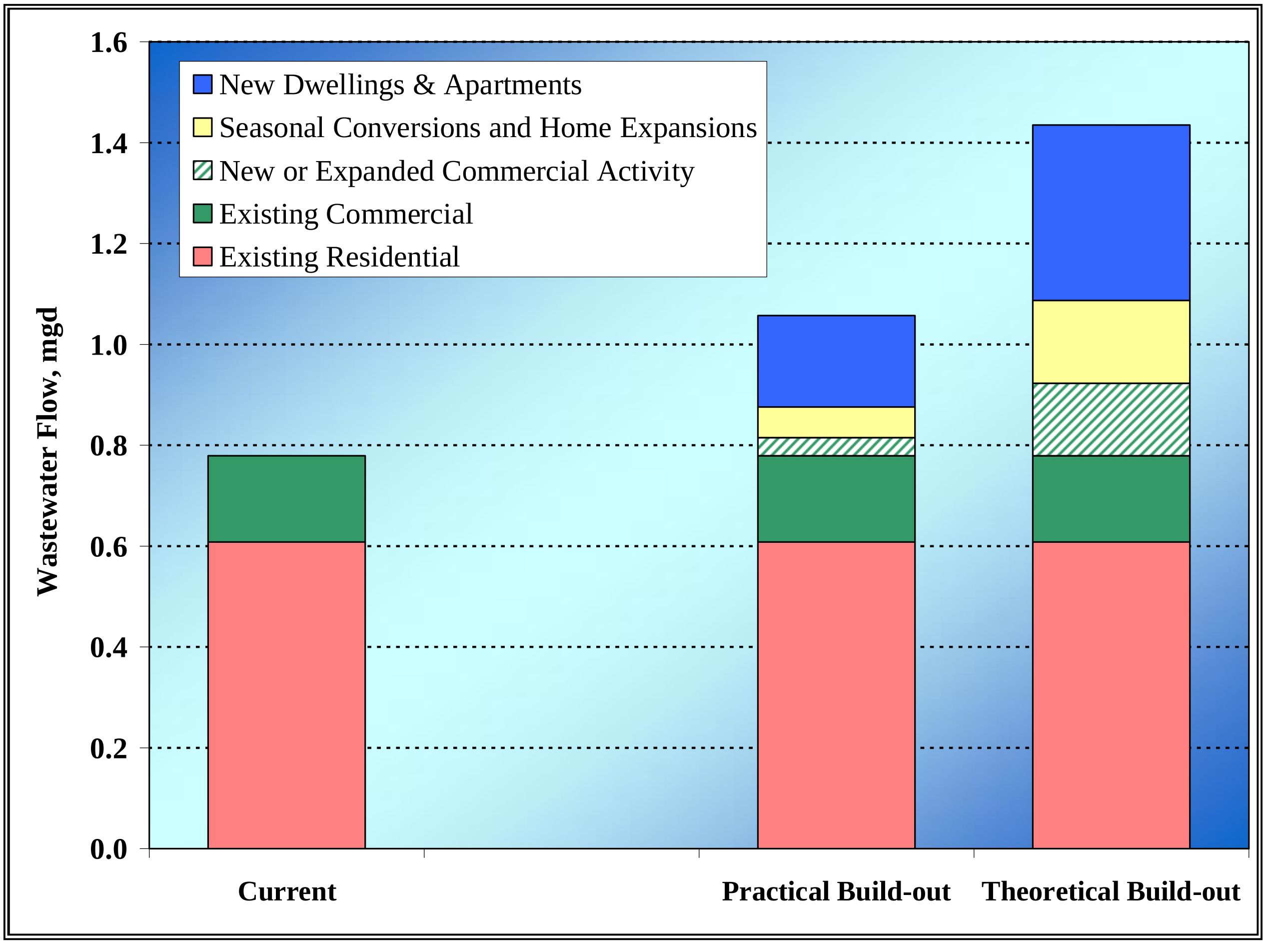
Note: See text for definitions
Source: Orleans Planning Dept.

Method 1. Select a date, and estimate how much of the Practical Build-out will occur by then, assuming a straight-line increase and current trends.

Recent experience has indicated a growth rate of 53 dwelling units per year. If Practical Build-out represents about 2,000 new dwelling units, then it would take 38 years to reach Practical Build-out. The 24-year interval from 2006 to 2030 (the end of the 2010-2030 planning period) represents about 63% of the time to build-out. Assuming that 63% of the increase in flow would occur in the next 24 years, this approach leads to an increased flow of 175,000 gpd, and a planning horizon flow of 954,000 gpd.

FIGURE 4-1

WASTEWATER FLOW PROJECTIONS AT BUILD-OUT



Note: See text for definitions
Source: Orleans Planning Dept.

Method 2. Select a date, and estimate how much of the practical build-out will occur by then, assuming build-out will extend further in time as "easy" development occurs first and "difficult" development occurs at an increasingly slower rate.

If current trends (53 dwelling unit per year) slow down over time, perhaps it will take 60 years (instead of 38) to reach practical build-out. With that thought, perhaps 55% of the increase will occur in the first 40% of the planning period (that is, will occur by 2030). This approach leads to an increase in flow of 153,000 gpd, and a planning horizon flow of 932,000 gpd.

Method 3. Consider other limitations on public infrastructure and design wastewater facilities for the same "breakpoint".

This approach is much more subjective and requires the analysis of each component of public infrastructure. That analysis has not been conducted. For discussion purposes, suppose that parking and traffic limit growth and economic activity in Orleans to the flow equivalent of a 25% increase over current population and commercial activity. For this hypothetical example, one might select a planning horizon flow of 973,000 gpd. This figure would be reached at the point where the other infrastructure becomes limiting, and not necessarily at 2030.

These three approaches yield the following flows at the planning horizon:

Method 1:	954,000 gpd	(22% higher than current)
Method 2:	932,000 gpd	(20% higher than current)
Method 3 (example only):	973,000 gpd	(25% higher than current)

Figure 4-2 illustrates graphically the trends associated with each method. After review of these data and graphs, the Wastewater Management Steering Committee selected a planning horizon flow of 950,000 gpd.

4.2 POPULATION PROJECTIONS

Analysis of water use and demographic data by Town staff indicates that Orleans' current population is approximately 10,700 on an annual average basis. This figure represents the average of all months of the year, including about 6,000 in January and about 22,000 in July and August. While peak summer populations and associated wastewater flows will determine the sizing of wastewater facilities, this needs assessment first considers how the annual average population will change through build-out and at the planning horizon.

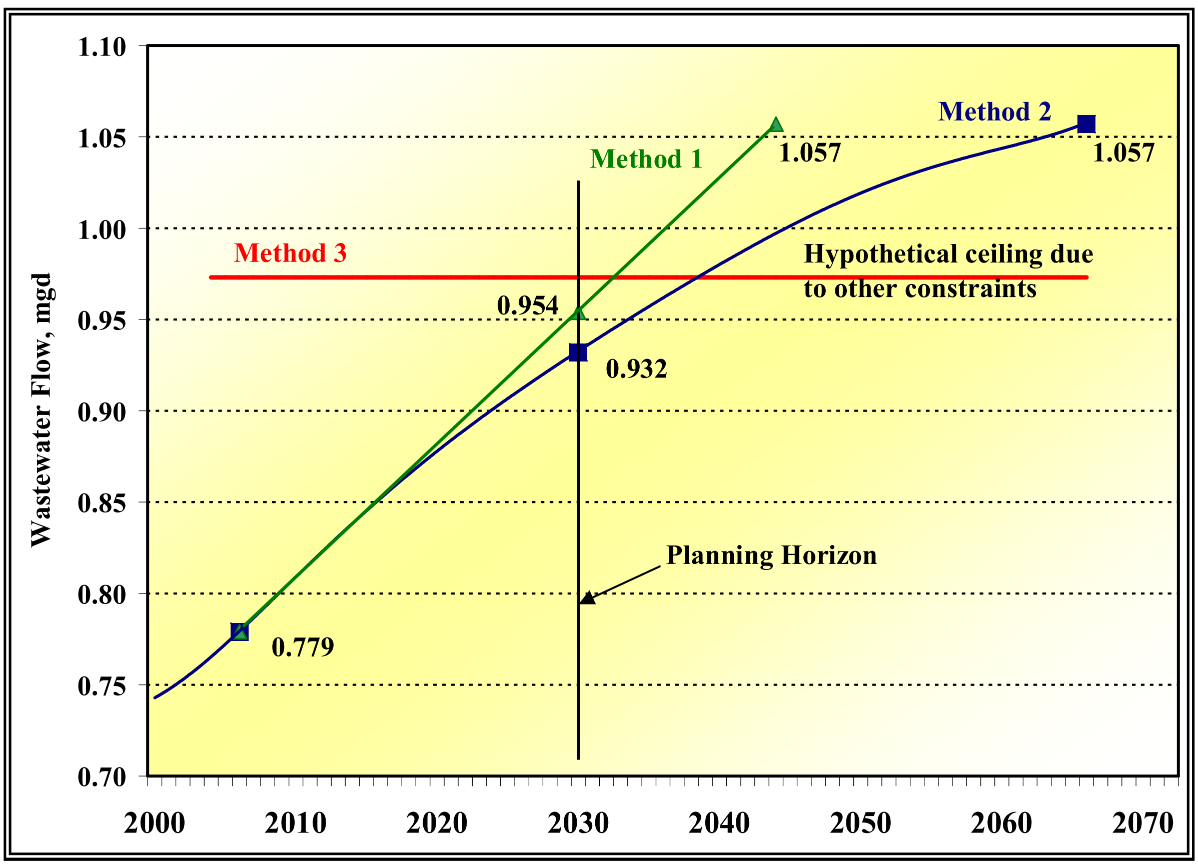
Assuming that the per capita water use and wastewater flow will not change over time, the wastewater quantities projected above can be converted to population estimates, as follows:

Planning Horizon	13,500 (26% increase over current)
Practical Build-out	15,000 (40% increase over current)
Theoretical Build-out	19,700 (84% increase over current)

As part of the evaluation of alternatives, summer peak flows will be estimated using peaking factors derived from Town water pumping records, with consideration given to the "flattening" of the population distribution by month. That is, a 26% increase in equivalent annual population may mean a larger percentage increase in year-round population and a smaller percentage increase in peak summer population.

FIGURE 4-2

DETERMINATION OF WASTEWATER FLOW AT END OF PLANNING HORIZON



Note: See text for definitions
Source: Orleans Planning Dept.

4.3 FUTURE WASTEWATER NEEDS

Future (planning horizon) wastewater flows have been computed for all lots in Orleans, and have been included in Table 4-2, the summary of future wastewater needs. Table 4-3 includes a tabulation of wastewater flows at the planning horizon for each sub-watershed.

Except for estuary protection, the increases in wastewater flow associated with each needs category reflect an 8% increase in commercial flows and a 26% increase in residential flows. With respect to nitrogen loading to embayments, these growth percentages also apply but a second factor is included. Since the nitrogen-based TMDL's are absolute ceilings, nitrogen control must be provided for 100% of the increase in wastewater nitrogen load in addition to the reduction in current load. Therefore future flows associated with this need category reflect a greater percentage increase over current flows then indicated for the other needs categories.

4.4 "NO ACTION" ALTERNATIVE

It is instructive to consider the nature of Orleans and its environment in the scenario where none of the documented wastewater management needs are formally addressed; that is under the "no action" alternative.

The sanitary needs assessment has identified 73 properties where significant Title 5 variances have been granted over the last 11 years. These are properties where an off-site wastewater solution, if it were available, might be desirable for the property owner and/or mandated by the Board of Health. Although the situation might be incrementally improved with off-site solutions, there are no demonstrable public health problems associated with these systems. The systems with significant Title 5 variances over the last 11 years represent less than 2% of the developed properties in Orleans, and, projecting to 20 years might increase that number to 4% of all developed properties. Given the limited number of these properties, lack of off-site wastewater solutions would not be expected to create serious unhealthful or nuisance conditions.

Continued use of on-site wastewater disposal for properties in the Zone IIs of public water supply wells would result in slightly more nitrates and other contaminants reaching the wellhead

TABLE 4-2

SUMMARY OF FUTURE NEEDS IN ALL CATEGORIES

NEEDS CATEGORY	WATERSHED PLEASANT BAY	NAUSET SYSTEM	ATLANTIC OCEAN	CAPE COD BAY	TOWN-WIDE
Sanitary					
Number of Parcels	48	79	5	66	198
Current Flow, gpd	16,100	63,500	3,900	78,900	162,400
Future Flow, gpd	19,600	77,500	4,800	96,300	198,200
Water Supply Protection					
Number of Parcels	0	0	0	0	0
Current Flow, gpd	0	0	0	0	0
Future Flow, gpd	0	0	0	0	0
Surface Water Protection (ponds)					
Number of Parcels	50	9	0	0	59
Current Flow, gpd	5,800	2,400	0	0	8,200
Future Flow, gpd	9,800	3,300	0	0	13,100
Surface Water Protection (estuaries)					
Number of Parcels	1,480	790	0	220	2,490
Current Flow, gpd	200,000	134,000	0	52,000	386,000
Future Flow, gpd	277,000	177,000	0	87,000	541,000
Convenience and Aesthetics					
Number of Parcels	29	39	6	40	120
Current Flow, gpd	9,600	36,500	4,700	53,900	104,700
Future Flow, gpd	11,700	44,500	6,100	72,000	134,300
Economic Development					
Number of Parcels	0	5	0	5	10
Current Flow, gpd	0	0	0	0	0
Future Flow, gpd	0	8,600	0	8,600	17,200
Total					
Number of Parcels	1,545	837	11	257	2,644
Current Flow, gpd	213,000	170,000	8,600	101,600	493,200
Future Flow, gpd	295,000	230,000	12,000	156,000	693,000

Note: Town-wide totals are additive across the row. Totals by major watershed are not additive by column. The category total by watershed accounts for parcels that have more than one need. The numbers of parcels does not reflect possible subdivisions.
Source: See text.

TABLE 4-3

ANNUAL AVERAGE WASTEWATER QUANTITIES BY WATERSHED AT PLANNING HORIZON

		Wastewater Flow, gpd		
Watershed	**# Parcels**	**Residential**	**Commercial**	**Total**
Areys Pond	65	8,500	500	9,000
Atlantic Ocean	155	22,000	6,100	28,100
Baker's Pond	11	1,200	-	1,200
Barley Neck	170	22,000	-	22,000
Boat Meadow	13	100	14,600	14,700
Crystal Lake	67	6,100	1,200	7,300
Deep Pond	21	2,400	-	2,400
Gould Pond Well_ORL	46	6,100	-	6,100
Kescayogansett Pond	77	8,500	1,200	9,700
Kescayogansett River	13	1,200	-	1,200
Kescayogansett Stream	18	600	100	700
Little Namskaket	346	62,200	13,400	75,600
Lower River	220	28,100	-	28,100
Meetinghouse Pond	333	51,200	9,800	61,000
Multiple watersheds	13	-	-	
Namequoit River	147	20,700	-	20,700
Namskaket Creek	289	36,600	28,100	64,700
Nauset Harbor	638	85,400	500	85,900
Paw Wah Pond	112	13,400	1,200	14,600
Paw Wah Pond Bog	12	1,200	-	1,200
Pilgrim Lake	61	7,300	2,400	9,700
Pleasant Bay	429	57,300	1,200	58,500
Pochet Neck	209	28,100	-	28,100
Pochet Neck Stream	153	22,000	-	22,000
Quanset Pond	44	9,800	-	9,800
Quanset Pond Bog	6	500	-	500
Rock Harbor	328	57,300	39,000	96,300
Sarah's Pond	63	8,500	-	8,500
Shoal Pond	34	4,900	-	4,900
Tar Kiln Stream	35	3,700	600	4,300
The Horseshoe	11	1,200	-	1,200
Town Cove	975	119,600	89,100	208,700
Twinings Pond	50	6,100	-	6,100
Uncle Harvey's Pond	16	2,400	-	2,400
Uncle Seth's Pond	23	4,900	-	4,900
Upper River	150	20,700	100	20,800
Well 7 Well ORL	57	9,800	-	9,800
Total	**5,410**	**741,600**	**209,100**	**950,700**

than would occur with wastewater collection, treatment and disposal outside the Zone II. The analysis reported herein, however, indicates the continuation of current on-site disposal practices posed no significant risk to the water supply.

With respect to surface water protection, failure to address excessive nitrogen loading to estuarine waters will allow the currently observed degradation to continue and worsen. The degradation that has already occurred and been documented in Pleasant Bay could led to sharply reduced fishing and swimming, and the eventual decline in property values. Given the great importance of coastal water quality in the Town's character and economy (of great value to both year-round and seasonal residents), lack of actions to control nitrogen loading could have very serious long-term impacts on the very resources that define the Town. With the issuance of nitrogen-based TMDLs, an enforcement mechanism will be in place that could be used by DEP to require nitrogen control. Orleans' failure to act in that setting will expose the Town to serious legal penalties and associated financial impacts. For some of Orleans' freshwater ponds, failure to remove phosphorus sources will appreciably accelerate water quality degradation.

By definition, wastewater needs associated with convenience and aesthetic factors do not pose substantive risks to the town if they are not addressed with off-site solutions.

The Town of Orleans intends to develop a growth-neutral wastewater management plan that neither restricts nor promotes growth different than allowed under current bylaws and regulations. Therefore, failure to implement wastewater management solutions should not impact economic growth. However, as new development occurs on lots that have more development challenges, the absence of public wastewater infrastructure could result in more I/A systems, more Title 5 variance requests and more Title 5 monitoring and compliance problems then would occur if public wastewater facilities were constructed. With respect to 40B housing, failure to provide off-site wastewater management capacity could restrict the options for affordable housing developers and conceivably create an impetus to locate such projects in less densely developed areas of town.

The "no action" alternative is explicitly contrary to the Orleans Comprehensive Plan. The Comprehensive Plan, as adopted on December of 1995 and amended in October 2006, sets forth the following explicit goals:

- To preserve and improve the ecological integrity of fresh and marine waters.
- To maintain coastal water quality that allows fishing, shellfishing, and/or swimming in all three estuaries, and to protect those coastal ecosystems which support shellfish and finfish habitat.

Inaction related to the documented needs to protect ponds and estuaries is directly contrary to these important Comprehensive Plan goals.

In some areas of wastewater need (sanitary/public health, water supply protection, convenience/aesthetics and economic development), continuation of current practices should not pose significant environmental or public health risks to the Town. With respect to protection of surface waters, however, the ramifications of "no action" would be severe. These impacts include:

- degradation of fisheries;
- impairment of water clarity and associated deterioration to swimming and other water contact sports;
- reduced opportunities for recreational and commercial shellfishing;
- floating algal mats and associated odor and visual impact;
- reduction in property values; and
- negative impact on the tourism economy.

In that the impacted resources are part of the very fabric of life in Orleans, these documented needs for surface water protection warrant serious concerted attention.

SECTION 5

IDENTIFICATION AND EVALUATION OF WASTEWATER PLAN COMPONENTS

A municipal wastewater system has three principal components, as illustrated in Figure 5-1:

- Collection
- Treatment
- Disposal or Reuse

This section of the report identifies and evaluates feasible options applicable to Orleans for each of these components. It also looks into methods to reduce current and future wastewater flows and associated pollutant loads so that each component can be smaller and less expensive. Also reported are the results of a search for sites for wastewater treatment and disposal. The last portion of this section discusses non-traditional methods for reducing nitrogen loads from wastewater and other sources.

5.1 WASTEWATER FLOWS AND LOADS

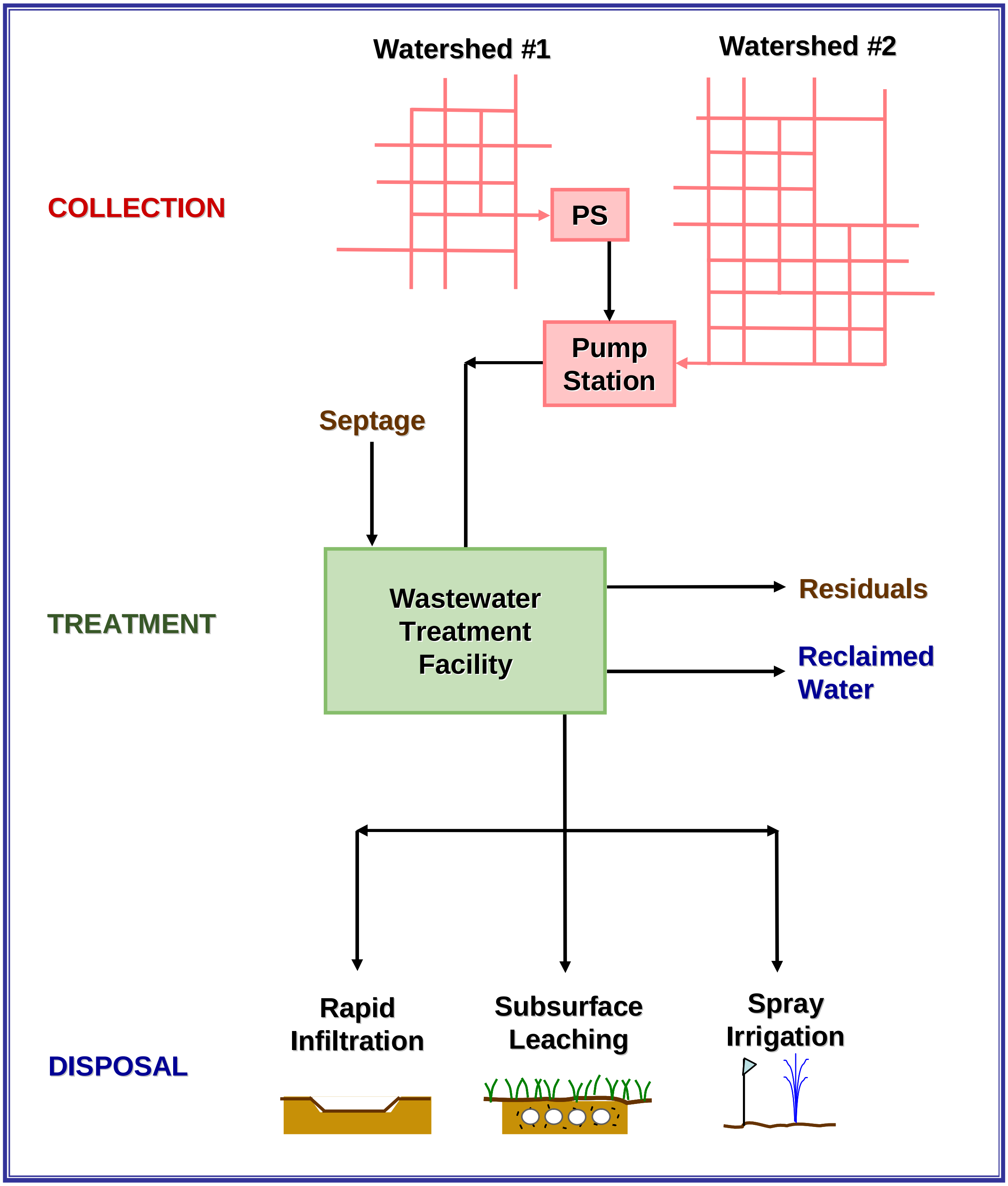
Before alternative wastewater management options can be identified and evaluated, it is first necessary to document the quantities of wastewater that must be managed. It is also important to consider ways to reduce the wastewater volume, or manage its rate of growth, and to reduce the contaminants contained in the wastewater.

5.1.1 Summary of Wastewater Management Needs

The needs assessment is presented in Sections 2, 3 and 4 of this report. Table 4-2 is a summary of that assessment. For each of the major watersheds in Orleans, this table documents the

FIGURE 5-1

GENERIC WASTEWATER MANAGEMENT SYSTEM



number of parcels and the current and projected future wastewater flows for five categories of need, as follows:

1. Ensuring sanitary conditions
2. Protection of public and private drinking water supplies
3. Protection of surface waters against nutrient enrichment
    - Nitrogen loading to embayments
    - Phosphorus loading to freshwater ponds
4. Addressing convenience and aesthetic issues
5. Enabling sustainable economic development

It is clear from Table 4-2 that the control of nutrient loading to surface waters (specifically nitrogen loading to embayments) is the principal wastewater need in Orleans. Surface water protection accounts for a large fraction of needs in the Pleasant Bay and Nauset estuary systems. In the Cape Cod Bay watersheds, nitrogen control, sanitary issues and convenience/aesthetics are all significant.

5.1.2 Strategies for Reductions of Flows and Loads

As technologies are identified to address the needs summarized earlier, it is appropriate to ask: "Could the costs for satisfying these needs be reduced if the quantities of wastewater or the associated pollutant loads were reduced at the source?"

"Wastewater flows" are the volumes of wastewater generated over a given time period, expressed in such units as gallons per day (gpd). "Wastewater loads" are the quantities of pollutants contained in the wastewater, expressed in mass-per-time units such as pounds per day.

Table 5-1 lists all of the alternative wastewater components that have been considered in this report. The first column of that table summarizes the wastewater flow and load reduction measures that may be appropriate to Orleans. These options are discussed in detail in Appendix B. The highlighted technologies in Table 5-1 are those considered most applicable to Orleans and are candidate "building blocks" for composite wastewater management plans. These options are:

Low-flow plumbing fixtures: Low-flow washing machines and sink and shower fixtures are now readily available that can reduce water consumption by at least 10% over older devices. Reducing water consumption with modern fixtures will reduce the wastewater production, save costs for wastewater treatment and disposal, and perhaps reduce the number of effluent disposal sites that must be developed.

Outside showers: Outdoor showers are widely used on Cape Cod in the summer time. This current practice provides a significant reduction in wastewater generation by removing this otherwise indoor activity from the wastewater stream. While there are benefits to wastewater system sizing and cost, this practice is not allowed under current DEP regulations.

Progressive water pricing: Water service pricing is an effective tool for promoting flow reduction. A progressive pricing structure includes fees that are based on the size of the service and the quantity of water used. The larger the service connection, the higher the quarterly fee. The quantity of water used is billed incrementally. Generally, the first fee bracket covers the majority of the water used in a water-conserving single-family residence. Subsequent brackets are associated with higher fees. Water pricing can also vary seasonally. It is feasible to charge increased rates in the summer when demand is the highest. All of these practices can provide an economic incentive to reduce water consumption and subsequently reduce wastewater generation rates and wastewater management costs.

Elimination of Garbage Grinders: Disposing of food waste through garbage grinders adds pollutant load to the wastewater stream. Instituting a ban on this practice, or enforcing existing such rules, will help reduce the cost of wastewater management. Conventional wastewater constituents would be reduced by about 25% and nitrogen load would be reduced by about 5%. (Removing food waste from the wastewater stream means that it must be incorporated into an alternative waste stream, such as municipal refuse or home composting. Proper disposal or reuse of food waste is important to prevent nutrients from reaching receiving waters by other means.)

TABLE 5-1
SUMMARY OF ALTERNATIVES FOR
WASTEWATER MANAGEMENT COMPONENTS

A Flow and Load Reduction	B Wastewater Collection	C Wastewater Treatment	D Effluent Disposal	E Effluent Reuse	F Non-Traditional Nitrogen Control
Low-flow Plumbing	**Conventional Gravity**	<u>**Large Scale**</u>	**Subsurface Leaching**	**Landscape Irrigation**	**Fertilizer Controls**
Progressive Pricing	Low Pressure STEP	**Sequencing Batch Reactors**	**Rapid Infiltration**	**Toilet Flushing**	**Stormwater Management**
Outside Showers	**Grinder Pumps**	**Oxidation Ditches**	**Spray Irrigation**	Aquifer Recharge	**Density Controls**
Waterless Toilets	Small diameter	Rotating Biological Contactors	**Drip Irrigation**		**Natural Attenuation**
Eliminate Garbage Grinders	Vacuum	**Membrane Bioreactors**	**Wicks**		Permeable Barriers
		Biological Aerated Filters			**Flushing Enhancements**
		<u>**Small Scale**</u>			Sediment removal or Alteration
		Amphidrome			Aquaculture
		Bioclere			
		FAST			
		Nitrex	**Legend:**		
		Chromoglass	**Included in plans for more detailed review** Not evaluated further		

There is a disincentive for garbage grinder use built into Title 5. Homes that have garbage grinders are required to have two-compartment septic tanks and to oversize their leaching systems by 50%. That disincentive disappears when a homeowner ties into a public sewer system. The Orleans Board of Health should institute a ban on garbage grinders to both sewered and unsewered properties, and the public outreach program associated with this CWMP should emphasize the importance of this ban.

Waterless toilets were investigated as a means of reducing both wastewater flows and pollutant loads. While some significant benefits may accrue, this option is not likely to gain sufficient public acceptability for it to be widely used. It has not been carried forward as a principal part of this program, but may have applicability in certain circumstances in Orleans. A pilot program may be warranted to better assess effectiveness and public acceptability.

5.2 WASTEWATER COLLECTION

To address the wastewater needs identified in Orleans, wastewater from certain homes and businesses must be collected and conveyed to one or more locations for treatment and disposal. The collection system is a major structural component of a municipality's wastewater management system. The best type of collection system for a given community is determined by comparing use, capacity, costs, operation and maintenance requirements, and benefits to the specific environment and landscape. The collection system includes all components from the source of the wastewater (typically the internal building plumbing) to the treatment plant. (The pipe from the home or business to the public system in the street is called the "service connection" and it is usually the responsibility of the property owner.) With some collection system options, the publicly-owned system may include components on the property to be served.

In addition to selecting collection technology, Orleans must also develop a strategy for determining which properties will be served by the collection system.

5.2.1 Collection System Options

As listed in Table 5-1, the proven technologies for wastewater collection include conventional gravity systems, low pressure (STEP and grinder pump) systems, vacuum systems, and small diameter gravity systems. Appendix B provides a detailed description of each of these options, lists their advantages and disadvantages, and provides local examples.

This evaluation of alternatives has identified the most appropriate system for Orleans; see the highlighted technologies in Table 5-1. The Town should plan to use a conventional gravity sewer system, supplemented with grinder pumps and low pressure sewers in those locations where gravity system is expensive or environmentally disruptive. This choice provides ease in long-term maintenance, cost-effectiveness, lowest energy use and the best ability to deal with power outages.

5.2.2 Criteria for Identifying Properties to be Served

The Needs Assessment has shown that nitrogen control is the largest driving factor for municipal wastewater systems. In certain areas of town, sanitary needs, pond protection, and convenience/aesthetic factors also come into play. As town-wide plans are developed, certain criteria should guide the layout of a wastewater collection system. Important considerations include:

- Connect the lots with the highest wastewater nitrogen load per lot. The Town's lot-by-lot database will allow for the identification of those parcels with the highest water use which generally indicates the highest wastewater nitrogen load. If, say, a 65% nitrogen load reduction is required is a certain watershed, it should be possible to achieve that goal with fewer than 65% of the properties sewered.
- Connect all commercial lots in areas with nitrogen needs. These parcels tend to have higher-than-average water use and may have higher nitrogen concentrations in their effluents.
- Focus on those streets with the highest wastewater flow per mile of street length. This approach should result in the most "efficient" sewer systems, that is, the least amount of pipe per property served.

- Give priority to lots closest to the embayment or pond to be protected, preferably within the 10-year groundwater travel time.
- Other factors being equal, avoid those neighborhoods requiring grinder pumps or numerous conventional pump stations. (Note that this goal may be contrary to focusing on lots nearest the shore from a travel-time perspective.)
- Provide sewer service that can address multiple needs. That is, try to include those parcels with sanitary or other non-nitrogen needs as part of the overall nitrogen-control goal. Even where a documented need does not exist, try to include those properties that face high costs for future Title 5 replacement.
- Consider opportunities for natural attenuation of nitrogen in wetland systems (avoid reliance on ponds for natural attenuation due to potential for negative impacts).
- Locate neighborhoods that could be easily added to the core system when growth dictates the expansion of the system to offset new nitrogen loads.
- Consider the locations of potential treatment sites to minimize transport costs.
- Consider connecting more properties than indicated by Orleans' strict pro-rata share of Pleasant Bay nitrogen control needs to account for areas in Brewster that are not easily served by public facilities.

When wastewater collection, treatment and disposal alternatives are combined into composite plans, these collection priorities should be accounted for.

5.3 WASTEWATER TREATMENT

Where high levels of nitrogen removal are required to protect estuarine water quality, wastewater treatment systems will be needed as the principal nitrogen control mechanism. Wastewater treatment can also provide high levels of phosphorus removal if necessary for pond protection. It is important to consider the likely effluent limitations that will govern wastewater treatment, the proven technologies available to meet those limits, and the handling of residual solids that are a byproduct of treatment.

5.3.1 Effluent Limitations and Expected Performance

The selection of technologies for wastewater treatment must be driven by two goals:

- Adherence to effluent limitations established by a DEP Groundwater Discharge Permit and
- Ability to achieve low effluent nitrogen concentrations to ensure TMDL compliance at the lowest possible cost.

Table 5-2 summarizes the effluent limits that have been established by DEP for a range of applications, as well as assumptions related to the phosphorus limits that might also be put in place in the future. Table 5-2 addresses the conventional parameters, such as Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS), as well as the principal nutrients of concern (nitrogen and phosphorus). The expected effluent limitations for these parameters are shown for 5 scenarios, as follows:

1. Traditional groundwater discharge permit standards, such as are in force for numerous small wastewater treatment plants across Cape Cod.
2. A higher level of nitrogen removal for those cases where this nutrient must be reduced to the minimum concentration achievable by current technology.
3. Conventional removal of phosphorus using low-cost chemical addition.
4. A higher level of phosphorus removal, as might be needed where phosphorus must be reduced to the lowest level possible with available technology; and
5. Effluent reuse standards, that apply to three categories of reuse (landscape irrigation, toilet flushing and aquifer recharge).

The traditional limits of a groundwater discharge permit are common and well established. The DEP's Reclaimed Water Guidelines define the reuse standards quite definitively. For phosphorus removal and the higher level of nitrogen control, there is much less precedent on the effluent limits. Therefore, it will be important to gain DEP's concurrence on the projected limits on phosphorus limits that might in the future be included in groundwater discharge permits.

The wastewater treatment technologies that are selected for more detailed evaluation must of course be capable of meeting the various standards shown in Table 5-2. As a practical matter,

TABLE 5-2
EXPECTED EFFLUENT LIMITATIONS

	Effluent Discharged to Groundwater				5. Effluent Reuse			
							Zone II Recharge	
	1. Traditional GWD Permit	2. High Level N Removal	3. Average P Removal	4. High Level P Removal	Landscape Irrigation*	Toilet Flushing	<2-yr Travel	>2-yr Travel
BOD, mg/l	30	30	30	30	10	30	10	30
TSS, mg/l	30	30	30	30	5	10	5	10
Nitrogen, mg/l								
Nitrate/Nitrite	10	5	10	10	---	---	---	---
Total	10	5	10	10	10	10	10	10
Oil & Grease, mg/l	15	15	15	15	15	15	15	15
pH, Standard Units	6.5 to 8.5	6.5 to 8.5	6.5 to 8.5	6.5 to 8.5	6 to 9	6 to 9	6 to 9	6 to 9
Phosphorus, mg/l	---	---	1.0	0.3	---	---	---	---
Turbidity, NTU								
Average	---	---	---	---	2	5	2	5
Maximum	---	---	---	---	5	5	5	5
Fecal Coliform, #/100 ml								
Mean	200	200	200	200	---	---	---	---
Median	---	---	---	---	0	---	0	0
Maximum	---	---	---	---	14	100	14	200

*Includes use at golf courses and landscape nurseries.

most technologies are capable of even better performance, and will be conservatively designed to meet the applicable standards with a safety margin. Since the embayments are sensitive only to annual average nitrogen loads, it is the average effluent concentration, not the monthly permit limit, that is pertinent to TMDL compliance. Therefore, in formulating composite wastewater systems for more detailed evaluation, it is important to predict the annual average performance of each technology. Table 5-3 presents information on the expected performance of conventional technologies at various sized plants.

The performance of any given wastewater technology is very size-dependent. The smaller the facility, the less its ability to adapt to changing influent flows and loads, which become relatively more pronounced at lower flows. For the smallest satellite plants, it should be assumed that the average performance will be very close to the permit limits. At plants greater than 200,000 gpd, the average effluent concentration will be 30 to 50% below the permit limits.

The performance estimates in Table 5-3 are very important. The extent of sewers needed to reach the TMDL, other things being equal, will be proportional to the average nitrogen concentration in the treatment plant discharge. That is, a collection system leading to a treatment plant with a 7-mg/l average nitrogen discharge will be about 10% smaller than a collection system leading to a plant with a 10-mg/l discharge. Therefore, it is very important to accurately predict the average performance of these systems, and it is critical that DEP concur in these estimates.

This concept also provides support for a phased program. If the Town moves forward with a treatment plant based on an expected effluent quality of 8 mg/l, and the plant actually produces 7 mg/l, then later phases of the program can be scaled back or deferred accordingly.

TABLE 5-3
EXPECTED EFFLUENT QUALITY

			Nitrogen, mg/l		Phosphorus, mg/l	
	Flow Range, gpd		Effluent Limit	Expected Performance	Effluent Limit	Expected Performance
	From	To				
Title 5 Systems						
Individual	400	2,000	None	35	None	10
Cluster	2,000	10,000	None	35	None	10
Title 5 Systems w/ Enhanced Treatment						
Individual	400	2,000	19	19	N/A	9
Cluster	2,000	10,000	19	15	5	5
Satellite Systems						
Small						
Traditional GWD Permit	10,000	25,000	10	10	N/A	9
High Level N Removal	10,000	25,000	N/A	N/A	N/A	9
P Removal	10,000	25,000	---	---	2	2
Medium						
Traditional GWD Permit	25,000	75,000	10	8	N/A	9
High Level N Removal	25,000	75,000	N/A	N/A	N/A	9
P Removal	25,000	75,000	---	---	1	1
Large						
Traditional GWD Permit	75,000	200,000	10	7	N/A	9
High Level N Removal	75,000	200,000	5	5	N/A	3
P Removal	75,000	200,000	---	---	1	0.5
High Level P Removal	75,000	200,000	---	---	0.3	0.3
Centralized Systems						
Traditional GWD Permit	200,000	1,500,000	10	7	---	---
High Level N Removal	200,000	1,500,000	5	3	---	---
P Removal	200,000	1,500,000	---	---	1	0.5
High Level P Removal	200,000	1,500,000	---	---	0.3	0.2

In some cases, phosphorus control is the primary concern with respect to surface water protection. Phosphorus removal from wastewater is easily achieved by chemical addition to the secondary or tertiary treatment process. Once a nitrogen removal technology is selected, an "add-on" for phosphorus removal is easily incorporated into the treatment design for those systems that serve areas tributary to freshwater ponds and lakes that require phosphorus load reduction. For this reason, this report focuses on a detailed evaluation of nitrogen-removing technologies.

An important decision in wastewater planning is the number and size of wastewater treatment facilities that will be developed. Many towns elect to build a single centralized plant. Other towns have developed decentralized systems that combine a number of small-scale plants. It is helpful to consider four categories of wastewater systems:

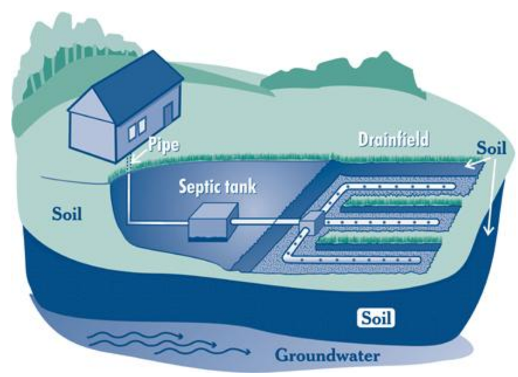
- Individual on-site systems,
- Cluster systems,
- Satellite plants, and
- Centralized plants.

These terms are defined and illustrated in Table 5-4. The first three types of systems are the building blocks of a decentralized system. Decentralized options are best suited to serving dispersed pockets of wastewater needs, because they reduce costs for transporting wastewater long distances. They also are well-suited for communities with no large sites for centralized plants.

This evaluation of wastewater treatment technologies looked separately at large-scale (design flows over 200,000 gpd) and small-scale (smaller than 200,000 gpd) applications. Large-scale options relate to centralized and larger decentralized plants. Small-scale technologies are applicable to decentralized plans.

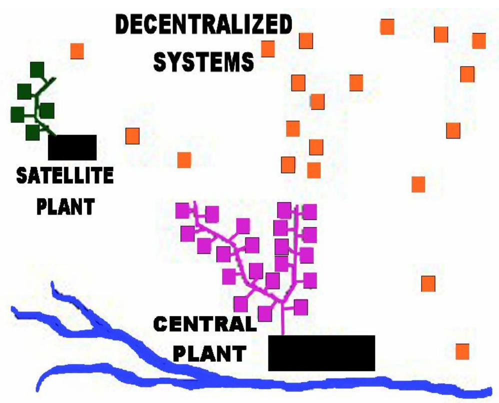
TABLE 5-4

GENERAL CATEGORIES OF WASTEWATER SYSTEMS



Individual On-site Systems: generally, septic tank and leaching field systems serving a single home or business, and located on the same parcel as the home or business. In Massachusetts, these are typically referred to as Title 5 systems, which imply treatment in a simple septic tank prior to discharge to a subsurface disposal system. Some individual on-site systems involve nitrogen and/or phosphorus removal. These systems are permitted by local boards of health and managed by individual property owners.

Cluster Systems: systems for wastewater collection, treatment and disposal that involve multiple parcels and multiple wastewater generators, served by a single system. Cluster systems typically have capacities between 1,000 and 10,000 gallons per day (gpd). In Title 5 these are also called "shared systems". Cluster systems may be as simple as gravity pipes leading to a shared septic tank and shared disposal field, but may also include grinder pumps, low pressure sewer systems and modular plants providing enhanced treatment. These systems are typically permitted by local boards of health and by DEP, and are managed by associations of property owners.



Satellite Systems: those facilities for wastewater collection, treatment and disposal that require a DEP groundwater discharge permit (that is, have wastewater flows exceeding 10,000 gallons per day) and are intended to serve a closely defined area. Many of the satellite systems on Cape Cod have been built by private developers to serve condominium projects, nursing homes, and shopping centers. While many are privately developed, satellite systems can be publicly owned. Private satellite plants are typically managed by the commercial property owner or condominium association; publicly-owned satellite plants are managed by the local public works department, school department or other town entity.

Centralized Wastewater System: the provision of public sewerage through a wastewater collection system leading to a publicly-owned wastewater treatment plant with effluent disposal. These systems are typically managed by local sewer commissioners or departments of public works.

Source: Wright-Pierce, "Enhancing Wastewater Management on Cape Cod: Planning, Administrative and Legal Tools", July 2004.

Column C of Table 5-1 lists the wastewater treatment technologies considered for Orleans. Appendix B contains a description of each technology, as well as a discussion of advantages and disadvantages and a listing of local examples. The highlighted technologies in Table 5-1 are those considered most applicable to Orleans and are candidate "building blocks" for composite wastewater management plans.

Large-Scale Alternatives

The most applicable large-scale technologies for Orleans are all variations of biological treatment systems that use bacteria to remove organic matter and nitrogen. They differ in the manner in which the bacteria are exposed to the wastewater and the means by which the bacterial culture is then removed and recycled. The best options are:

Sequencing Batch Reactors (SBRs): SBR systems operate on a very simple concept of introducing a quantity of waste to a reactor and providing several process steps in a sequence that would traditionally require a single tank for each step. That sequence includes filling the reactor with wastewater, and then providing sequential periods of aerobic treatment, settling, and anaerobic treatment. Then the effluent can be decanted and a portion of the sludge removed before the process is repeated. Combing several treatment steps into a single tank reduces the land area requirement over other technologies, and the tanks are covered.

Oxidation Ditches: Wastewater is treated as it flows around a long oval-shaped concrete channel. Instead of providing several process tanks like some other technologies, the length of the channels allows for different types of treatment to occur as the wastewater moves around the ditch. Wastewater alternately passes through aerobic and anoxic zones allowing a mixed culture of bacteria to remove organic matter and nitrogen. A separate tank (a clarifier) is needed for removing and recycling the bacteria. This technology requires a relatively large footprint to accommodate the ditch. Unlike other technologies, the oxidation ditch is nearly always located outside. It has been widely used in the U.S. and is capable of reliably achieving a low nitrogen concentration.

Membrane Bioreactors. Membrane Biological Reactors (MBRs) include a semi-permeable membrane barrier system, either submerged in, or following an activated sludge process, that provides the solids separation that is accomplished in a clarifier with other technologies. This technology ensures removal of virtually all suspended pollutants.

The membrane technology is relatively new, and operating data from systems installed in the past few years is promising, with results indicating very high effluent quality is achievable. Membranes are expensive and require regular cleaning and periodic replacement. The cost of the membrane is partially offset by the smaller building needed to house the system, compared to other technologies. This treatment process requires a relatively small footprint, and above-grade or below-grade installation of the treatment process is possible.

Biological Aerated Filters (BAFs): This system consists of flooded tanks filled with polystyrene beads which provide the required surface area for biological growth and filter the wastewater as it passes through. The BAF unit acts is a "fixed film" process resulting in reduced sludge production, roughly 60%, in comparison to SBR, oxidation ditch and MBR "suspended" growth processes. The BAF unit can be housed inside or outside and either above or below grade. The overall footprint of this process can be very small relative to traditional alternatives.

Small-Scale Alternatives

As with the large-scale systems, the most applicable small-scale technologies for Orleans are all variations of biological treatment systems that use bacteria to remove organic matter and nitrogen. The small-scale systems are largely proprietary modular systems consisting of factory-built components installed with pre-cast concrete tanks. The best options are: 1) Amphidrome, a fixed-film sequencing batch reactor; 2) Bioclere, which uses a fixed-film trickling filter process; 3) Cromaglass, which provides treatment in a sequencing batch reactor sludge system; 4) MBRs as described above; and 5) FAST, which utilizes both fixed- and suspended-growth nitrogen removal methods. Nitrex is a new technology that uses a nitrate-reactive media to convert nitrate to nitrogen gas, following a nitrification step to convert other nitrogen forms to nitrate. Early testing shows promise, but the long-term cost and performance are yet unproven.

These small-scale technology choices have been widely used for flows less than 50,000 gpd. For larger decentralized systems (50,000 gpd to 300,000 gpd), the large-scale technology options are more appropriate.

5.3.2 Management of Residuals

Wastewater treatment systems (whether they are on-site septic systems, cluster systems, satellite plants or centralized wastewater treatment facilities) purify wastewater and create concentrated byproducts in various forms. These "residuals" fall into the following categories: 1) septage, including grease; 2) grit and screenings; 3) liquid sludge; and 4) dewatered sludge or sludge "cake". The CWMP must include cost-effective and environmentally sound means to handle these residuals.

The Tri-Town Septage Treatment Facility (see Figure 5-2) is near Namskaket Marsh and is owned by the Orleans Brewster Eastham Groundwater Protection District. It now receives septage from Orleans, Brewster and Eastham (the members of the three-town District), septage from other Lower Cape towns, and some limited quantities of liquid sludge from small-scale wastewater treatment systems (cluster and satellite plants). The sludge generated from processing this incoming waste is dewatered on-site and hauled by contractor to out-of-town disposal locations. A study of the Tri-Town facility, conducted in 2005 and 2006, showed that it has capacity to receive septage generated in the three District towns well into the future, albeit with some upgrading needs. If Orleans were to build wastewater treatment systems elsewhere in town, either a single centralized plant or a series of decentralized facilities, Tri-Town is the only logical destination for the liquid sludges generated from those wastewater facilities. The sludge produced through wastewater treatment would be offset by the reduction in Orleans septage quantities (resulting from elimination of septic systems on those lots served by public sewers).

If the Tri-Town site were the home of a new wastewater treatment plant, that facility would be designed to thicken and dewater its own sludge. That new sludge handling equipment could be easily enlarged to handle the septage now received at the existing Tri-Town plant, allowing the demolition of the now 20-year-old facility. Out-of-town disposal of dewatered sludge is the best method for Tri-Town because the site is not large enough for processing options such as composting, and their cost-effectiveness is hampered by the relatively small quantities of sludge. For the same reasons, any new wastewater facility would be best served by out-of-town sludge disposal. The transport and disposal of dewatered sludges is a mature industry with significant competition. The Town of Orleans should make use of those private options for both sludge cake and grit/screenings. Therefore, no detailed evaluation of on-site sludge processing facilities is recommended.

FIGURE 5-2

TRI-TOWN SEPTAGE TREATMENT FACILITY

5.4 WASTEWATER REUSE AND DISPOSAL

Once wastewater is collected and treated, it must then be properly disposed of or put to productive use. Unlike other parts of the country where surface water discharge is a viable option, effluent disposal on Cape Cod must be land-based and is land-intensive. The available disposal technologies must be carefully considered to match the availability of appropriate disposal sites. Given the site limitations in Orleans (see Section 5.5), the Town should consider opportunities for reuse of effluent that allow more sites to be considered.

5.4.1 Wastewater Disposal Technology

Five technologies are listed in Column D of Table 5-1 that are applicable for effluent disposal in Orleans.. These include subsurface leaching, rapid infiltration, spray irrigation, drip irrigation and wicks. Appendix D provides a detailed description of each of these option, lists their advantages and disadvantages, and provides local examples. All of the identified effluent disposal options may have applicability to Orleans. Two alternatives, wicks and drip irrigation, are less common and subject to more regulatory constraints, and should be considered further only if the more traditional options prove inadequate. (Drip irrigation may have applicability for effluent disposal on ballfields in either the "disposal" or "reuse" setting. Experience with this technology has expanded significantly in recent years and it is viewed favorably by DEP in some circumstances.) The three more traditional alternatives should be part of the composite plans that are evaluated in more detail. Those traditional effluent disposal options are:

Subsurface leaching: By far the most common example of this type is the soil adsorption system found in the backyard of the typical Cape Cod home. A soil adsorption system includes of a network of rigid perforated piping buried below grade that distributes effluent into surrounding gravel trenches or beds that provide dispersal of effluent over a large area at a low dosing rate. If well maintained, these systems last for at least 20 years. Land must be available for the active disposal area as well as additional space earmarked as reserve, which can be developed in the event of a failure. These systems are designed to operate year-round and work best with regular dosing of effluent. The entire disposal system is buried which eliminates the chance of human contact, and can be located under public parks or sports fields, and under parking lots with proper design. Subsurface leaching requires more land than rapid infiltration (see below) and is usually more expensive.

Rapid Infiltration: Also referred to as open sand beds, these systems can operate at high loading rates on sites with good permeability and significant depth to groundwater. Year-round application is routine, but there is little opportunity for dual use of a site. The significantly reduced footprint compared with other technologies often outweighs the benefit of dual use. A smaller disposal footprint also broadens the number of parcels that could be viable disposal sites. The reduced footprint sometimes allows a single site to provide both treatment and disposal, which is less likely for other systems. Locating the treatment and disposal processes on the same site minimizes the transport costs.

Spray irrigation: Landscape irrigation is another example of technology that can be used on a site with another use. Effluent can be applied to parks, sports fields, golf courses, or landscaping. All of these activities are associated with human interaction and require meeting the effluent reuse guidelines, which usually adds to the cost of wastewater treatment (see Section 5.4.2 below). Irrigation is certainly restricted to seasonal operation which requires either winter storage or a complementary effluent disposal system, either of which can add substantially to the cost. This technique uses moderate application rates. Spray irrigation can also be accomplished at public-access-controlled sites, which with adequate buffers, may be permissible without meeting the effluent reuse requirements.

5.4.2 Wastewater Reuse Opportunities

Given the lack of large traditional effluent disposal sites in Orleans, the Town should consider a formal effluent reuse program. The fundamental premise behind any reuse program is recognition of the value of water and the nutrients it may carry, tempered by the public health aspects of public contact with wastewater-derived material. The allowable effluent disposal methods following traditional wastewater treatment (rapid infiltration, subsurface disposal, etc.) are in large part aimed at getting the effluent into the ground, and keeping it there, thus protecting the public from contact with a liquid that retains some undesirable characteristics even after tertiary treatment. The DEP reuse program stipulates higher levels of treatment that address those undesirable characteristics so that certain levels of human exposure are tolerable.

Massachusetts DEP has established a program to guide the reuse of wastewater effluents. Its publication "Interim Guidelines on Reclaimed Water" was issued in January 2000, and is expected to be updated in 2008. The current guidelines allow four types of reuse:

- Spray irrigation of golf courses,
- Reuse at landscape nurseries,
- Artificial aquifer recharge, and
- Toilet flushing.

More uses may be allowed under the new guidelines, perhaps including private lawn irrigation.

The use of reclaimed water requires a higher level of treatment than traditional effluent disposal techniques. The more stringent effluent limits relate primarily to suspended solids and bacteria (see Table 5-2). The treatment technologies recommended in Section 5.3 can be readily adapted to meet the Reclaimed Water Guidelines, albeit at additional cost for enhanced solids removal and high-intensity disinfection. If membrane bioreactors are chosen for traditional wastewater treatment, they can most easily meet those reuse requirements with only minor cost increases.

A large number of possible reuse applications have been identified: see Appendix B. The most attractive alternatives include:

- Toilet flushing at public buildings,
- Lawn irrigation at public sites,
- Irrigation of ballfields,
- Irrigation of golf courses, and
- Use of reclaimed water in concrete production.

Serious consideration has been given to including reuse in the composite wastewater plans that are evaluated in more detail in Section 7, either as primary means of effluent disposal or as seasonal supplements to traditional methods.

5.5 SITING OF WASTEWATER TREATMENT AND DISPOSAL FACILITIES

5.5.1 Initial Site Identification and First-Level Screening

The staff of the Orleans Planning Department, with assistance from Wright-Pierce, used the Town's geographic information system (GIS) to identify potential sites for wastewater facilities. This GIS search first considered undeveloped sites of 5 acres or greater, with ground surface elevation higher than 30 feet, located outside the water supply Zone IIs. Particular emphasis was placed on sites in public ownership. This search identified only a few such sites, clearly not sufficient for the overall town wastewater needs.

The site search was then expanded to consider all sites greater than 2 acres in size, including privately-owned land. While vacant parcels are preferred, this second search also considered some larger sites that are currently only partially developed (for example, a 5-acre site with a home in one corner, or a site used only for parking).

The sites identified in the GIS search were then reviewed by Wright-Pierce, both from aerial photography and by direct observation in the field. Some sites were eliminated due to significant development constraints. A total of 30 sites were deemed suitable for further investigation.

5.5.2 Target Effluent Disposal Capacity

The Needs Assessment determined that a municipal wastewater system, aimed at satisfying a broad range of current wastewater needs, would accept an average wastewater flow of approximately 500,000 gpd. At the planning horizon, that flow would grow to about 700,000 gpd. (By strategic sewer layouts--see Section 5.3.2--smaller wastewater volumes are possible.) Summer peak flows must be accounted for in the sizing of wastewater facilities, and effluent disposal systems are designed for the short-term (one-day or two-day) peak flows during the summer season. Peaking factors were derived from Town water records, and when applied to the estimated annual average wastewater flows, the following general target capacities were established for site identification and screening:

- Current 1.2 million gallons per day (mgd)
- Planning Horizon 1.7 mgd

Given the uncertainties associated with determining actual site capacities, the goal of the site search was to identify as much at 3 mgd of apparent capacity.

5.5.3 Second-Level Site Screening

Data were compiled on each of the 30 sites identified by GIS methods. This information included surficial soils descriptions, location with respect to ACECs, ready accessibility of public water service, depth to permanent groundwater, potential for perched water table, and distance to the nearest boundary of a public water supply Zone II.

The next step was to prepare scale drawings of each site, using aerial photography from the Mass GIS system. A conceptual layout was prepared for each site, assuming rapid infiltration or subsurface leaching, the most common effluent disposal methods. These conceptual designs were based on effluent loading rates of either 3 gallons per day per square foot (gpd/sf) for subsurface leaching or 5 gpd/sf for rapid infiltration. Set backs were assumed to be:

From property lines of developed parcels:	100 feet	(rapid infiltration)
	50 feet	(subsurface leaching)
From property lines of protected parcels:	50 feet	(rapid infiltration)
	30 feet	(subsurface leaching
From wetlands:	100 feet	(all cases)

Provision was made for access roads and other peripheral facilities.

Based on these conceptual designs, each site was assigned an estimated capacity range. (Five of the 30 sites were deemed suitable only with non-traditional disposal technologies, such as wicks or drip irrigation, and capacities were not estimated for these 5 sites.) Table 5-5 lists the 25 sites where rapid infiltration or subsurface leaching designs were prepared, and includes the range of estimated disposal capacity.

As shown in Table 5-5, the conceptual designs indicate an aggregate disposal capacity of 3.8 to 4.6 mgd, well in excess of the 3 mgd target. While this is a favorable finding, it must recognized that there are many reasons why the actual capacity could turn out to be less than these estimates:

- The soils may not allow the relatively favorable application rates that were assumed.
- There may be site constraints, such as steep slopes or pockets of poor soils that are not apparent from the available mapping.
- Detailed site design may find that larger setbacks are appropriate.
- Some portion of these sites may be needed for modular wastewater treatment facilities.
- The nitrogen control needs of certain embayments may not allow as much effluent disposal as the site would allow.
- Groundwater mounding may limit the disposal volume.
- Private sites may be available only at very high cost or through an adversarial process.

On the other hand, there may be more suitable area than was assumed and favorable soils, once fully tested, might allow higher loading rates than DEP currently permits for these disposal technologies.

While a relatively large aggregate disposal capacity was identified, there are several factors that complicate the analysis:

- Only one-third of the apparent capacity is located at sites owned by the Town or by quasi-municipal entities. Land acquisition negotiations and costs for private sites represent significant hurdles.

TABLE 5-5
INITIAL CAPACITY ESTIMATES FOR IDENTIFIED DISPOSAL SITES

Site ID	Total Acres	Ownership	Development Status	Disposal Technology	Capacity, gpd	
					Low	High
111	< 2	Private	Parking	SL	60,000	60,000
112	2 to 5	Public	Parking	SL	75,000	75,000
121	5 to 10	Private	Dev--Residential	SL	150,000	150,000
161	< 2	Private	Vacant	SL	30,000	40,000
162	2 to 5	Private	Dev--Residential	SL	125,000	125,000
172	5 to 10	Private	Dev--Residential	SL	150,000	150,000
173	2 to 5	Private	Vacant	SL	60,000	60,000
181	5 to 10	Private	Dev--Recreational	SL	150,000	150,000
191	5 to 10	Private	Dev--Resid/Agric.	SL	50,000	75,000
Pleasant Bay Subtotal					**1,350,000**	**1,415,000**
221	2 to 5	Private	Vacant	SL	70,000	75,000
222	5 to 10	Private	Dev--Commercial	SL	100,000	150,000
231	5 to 10	Private	Dev--Recreational	SL	150,000	150,000
241	> 10	Public	Dev--Utility	RI	500,000	750,000
244	5 to 10	Private	Dev--Utility	RI	200,000	225,000
245	5 to 10	Private	Dev--Resid/Agric.	SL/RI	150,000	200,000
246	> 10	Private	Dev--Commercial	SL	150,000	225,000
247	2 to 5	Private	Dev--Commercial	SL	45,000	60,000
Cape Cod Bay Subtotal					**1,365,000**	**1,835,000**
312	2 to 5	Private	Dev--Utility	SL	50,000	75,000
313	> 10	Public	School	SL/DI	150,000	150,000
314	> 10	Public	School	SL/DI	300,000	300,000
316	> 10	Public	Gardens	SL	120,000	250,000
321	> 10	Private	Dev--Residential	SL	120,000	270,000
322	5 to 10	Private	Dev--Residential	SL	150,000	150,000
323	5 to 10	Private	Dev--Residential	SL	50,000	55,000
Nauset Subtotal					**940,000**	**1,250,000**
411	5 to 10	Private		RI	100,000	120,000
Atlantic Ocean Subtotal					**100,000**	**120,000**
Town Wide Total					**3,755,000**	**4,620,000**

Disposal Technology
RI Rapid Infiltration
SL Subsurface Leaching
DI Drip Irrigation

- There are very few large sites, and providing adequate capacity for all wastewater needs will likely require several sites.
- Only about 5% of the identified capacity is associated with vacant land. Including land now associated with parking or utility uses increases that percentage to 12%.
- The identified capacity is well distributed across the major watersheds, although there is a deficit in the Pleasant Bay watershed when aggregate needs are considered.

This analysis leads to the following conclusions:

- The Town may need more than one disposal site, even in a centralized solution.
- Focused subsurface explorations are needed to obtain better estimates of capacity at the most favorable sites.
- Dual use of disposal sites is likely, such as effluent disposal under parking lots or ballfields.
- Sites for significant spray irrigation of effluent do not exist, given Orleans' lack of golf courses. If large-scale spray irrigation is to be considered, it must occur at an out-of-town site.

This site identification and screening process has focused on effluent disposal. The 25 sites listed in Table 5-5 were also evaluated as possible sites for wastewater treatment plants. The traditional 50-plus-acre undeveloped site in a remote area simply does not exist in Orleans. The most favorable sites for a centralized treatment plant are Site 241 (the location of the existing Tri-Town Septage Treatment Facility, where effluent disposal is also possible) and the existing Town landfill (where traditional effluent disposal is not feasible). Other sites for centralized facilities would require acquisition of privately owned land, demolition or relocation of existing structures, and very serious attention to design and set-back issues. Small modular wastewater treatment facilities could be accommodated at many of the effluent disposal sites listed in Table 5-5, albeit with reduced disposal capacity. If further investigation of the sites leads to unidentified constraints, the Town may need to expand its search to include sites in adjacent towns.

5.5.4 Site-Specific Exploration Needs

One drawback to developing multiple small sites is the potential cost of subsurface explorations to better define disposal capacity. Therefore it is recommended that the Town embark on a phased program of subsurface explorations that focuses first on the largest and best-situated sites.

Eight sites were selected for the initial exploration program; they fall in the following categories:

- Publicly-owned sites that are vacant or only partially developed
    - Site 241
- Publicly-owned sites that are developed in compatible uses
    - Site 313
    - Site 314
- Quasi-public sites developed in compatible uses
    - Site 244
    - Site 312
- Privately-owned sites developed in compatible uses
    - Site 246
    - Site 247
    - Site 222

Further study should include these steps:

- Compilation of existing data on soils properties and groundwater levels
- Test pits and percolation tests to supplement existing data
- Hydraulic loading tests and groundwater modeling

The Tri-Town site was evaluated previously by Wright-Pierce (see report dated August 2005). This site should be included in the first round of site-specific testing because it has the greatest potential for large-scale effluent disposal. The results of testing at Tri-Town would then help guide the next phase of this program.

5.5.5 Next Steps

Certain sites listed in Table 5-5 should be included in the town-wide wastewater plans that are to be subject to more detailed evaluation in the next phase of the CWMP. The formulation of those plans must consider all of the wastewater system components (collection, treatment, disposal, etc., as discussed elsewhere in this report), as well as nature of the wastewater needs in each major watershed and the logistics of linking needs with sites. This formulation and detailed evaluation of wastewater plans should be accomplished concurrently with the site-specific investigations noted above. It is conceivable that sites could be eliminated from consideration for non-technical reasons including public concerns, cost-effectiveness of decentralized options, acquisition problems with private parcels, etc. Expenditures on detailed site investigations should not precede steps to determine if targeted sites might be eliminated for these reasons.

Many of the candidate disposal sites are located near the boundaries between the major watersheds. Large-scale application of effluent at these sites could cause those boundaries to shift, resulting in nitrogen migration to a different embayment than is currently the case. This potential for shifting boundaries must be addressed if any of the composite wastewater plans includes large discharges at these locations.

Due to this lack of large suitable disposal sites in Orleans, the Town should closely review flow and load reduction measures, and such non-traditional nitrogen control methods as fertilization reductions (see Section 5.6). This situation should also trigger discussions with neighboring towns about disposal sites, including golf courses, and multi-town facilities.

5.6 NON-TRADITIONAL NITROGEN CONTROL MEASURES

In the needs assessment phase of the CWMP, it has been shown that the control of nitrogen is the largest driving force toward improved wastewater management in Orleans. Nitrogen reaches the embayments from various sources and through multiple pathways. The "traditional" approach to controlling nitrogen is to replace septic systems with public wastewater facilities that remove large amounts of nitrogen, and discharge the effluent either at appropriate locations within the watershed, or in the watershed of a less sensitive embayment. While public sewerage is a readily permitted and predictable method for nitrogen control, it can also be very expensive. There are a number of "non-traditional" methods for nitrogen control that offer significant cost savings.

In broad terms, non-traditional controls fall into the following categories:

- Options that prevent future nitrogen loads;
- Options that reduce current nitrogen loads before they reach the groundwater;
- Options that take advantage of natural processes that impact groundwater quality as it moves toward the embayments;
- Options that improve the ability of the embayments to assimilate nitrogen loads; and
- Options that remove nitrogen from the water column or sediments within the embayments.

Eight alternatives are listed in Column E of Table 5-1 that are potentially applicable to nitrogen control in Orleans. Appendix B provides a detailed description of each of these options, lists their advantages and disadvantages, and provides local examples. Five of these alternatives (highlighted in Table 5-2) should be considered further and included as supplements to the composite plans that are subject to more detailed review.

Control of Fertilization: When lawn and garden fertilizer is applied, some portion of the nitrogen nourishes the plants, another portion is converted to harmless nitrogen gas by soil organisms, and the excess nitrogen leaches to the groundwater. The MEP technical report for Pleasant Bay estimated that 30% of the un-attenuated nitrogen load from the watershed comes from fertilizer and stormwater runoff, with most of that from fertilizer. Therefore, after septic nitrogen, fertilizer nitrogen is the next largest source. In the Pleasant Bay sub-watershed (one portion of the overall watershed), nearly one-half of the watershed nitrogen load comes from lawn fertilization, principally from three golf courses within that watershed.

There are many steps that can be taken to reduce fertilizer nitrogen load to the groundwater. First, fertilized lawn area can be reduced. Second, where fertilizer is used, the application rate can be reduced, and the timing of applications can be spread out. Third, fertilizers with organic slow-release nitrogen can be substituted for traditional inorganic forms. These steps can be taken by all fertilizer users, but the greatest potential for reduction is where large fertilizer use occurs, which includes golf courses, town parks, and school district ballfields.

Education of the public on the need to modify lawn care practices should occur regardless of other steps. In addition, the Town should institute changes in its own practices and should work with the Nauset Regional School District in a similar fashion. Other possible steps include restriction on lawn area in new development, working with local lawn and garden retailers to stock only more appropriate fertilizer products, and working with the County to institute a fertilizer ban. While not within the direct control of Orleans, every effort should be made to reduce the very large fertilizer use in the Pleasant Bay sub-watershed at golf courses in Brewster, Harwich and Chatham. Controls on fertilizer use on cranberry bogs should also be considered as appropriate.

Stormwater Management: Precipitation that falls on impervious surfaces runs off and takes with it a variety of pollutants, including nitrogen. If stormwater is discharged directly to a pond or embayment (or to a pipe or channel leading directly there) it is considered a "point source". If runoff infiltrates into the ground and transports pollutants to the groundwater it is considered a "nonpoint source". In either case, actions are warranted to reduce the pollutant load from stormwater. For all of Pleasant Bay, runoff from impervious surfaces is estimated to produce 9,000 pounds of nitrogen per year, or 9% of the total un-attenuated load from all watershed sources.

In general, the Town should try to remove all point sources by infiltrating stormwater instead of discharging it to surface waters. Where this is not possible, some "end-of-pipe" treatment may be warranted, such as exists at Lonnies Pond. While infiltration is most efficient through bare soil, vegetated surfaces provide considerable pollutant removal. Pollutants in runoff can also be addressed at the source, through such programs as regular street sweeping, owner control of pet wastes, requirements for nutrient management plans for large developments, etc.

There are many reasons why stormwater management should occur in Orleans independent of nitrogen control. Phosphorus transport to ponds is an important issue, as is bacterial contamination at beaches and shell fishing areas from road runoff. These reasons for stormwater management are important enough on their own to warrant a town-wide plan. Implementation of that plan will also reduce nitrogen loads to embayments.

Density Controls through Municipal Bylaws and Regulations: The Needs Assessment documents how current wastewater generation rates in Orleans are expected to increase by 22% over the planning period ending in 2030. Considering a somewhat lower rate of increase in non-wastewater nitrogen sources (such as lawn fertilization), the town-wide nitrogen load may increase by about 20% as a result of growth in the community. Town-wide, the **current** nitrogen load must be reduced by perhaps 20% to 25% (depending on the findings of the MEP studies for the Nauset system). The **growth** in nitrogen load is approximately the same as the amount of the **current** load that must be removed. Any steps the Town can take to slow the growth in nitrogen load will directly impact the extent and cost of structural solutions.

A number of actions have been discussed among the WMSC, the Board of Health and the Planning Board. The most promising ones include:

- Reducing minimum lot sizes for new residential development or reducing the allowable development intensity on commercial properties;
- Instituting nitrogen-based performance standards for expansions and redevelopment, such as the "no net nitrogen increase" approach or a maximum pound-per-acre load (the "fair share" approach);
- Accelerating land purchases or conservation easements; and
- Instituting a "checkerboard" sewer system with limitations on increased flows from properties not served.

Natural Attenuation: As groundwater moves toward and into embayments, it may pass through freshwater ponds and bogs and through salt marshes. In these environments, there may be some removal of nitrogen by natural means that lessens the impact on the embayment. These processes are called "natural attenuation". Natural attenuation has been included in the modeling of embayments on Cape Cod as part of the Massachusetts Estuaries Program. For Pleasant Bay as a whole, natural attenuation is estimated to reduce the raw watershed nitrogen load by 4%.

Natural attenuation can be part of Orleans' overall plan in several ways. First, the selection of properties to be connected to traditional wastewater systems should focus on those properties that are not subject to natural attenuation; that is, once pond protection needs are addressed by sewering in areas immediately upgradient of ponds, wastewater collection should focus first on those properties that are downgradient from the ponds and wetlands that provide natural attenuation.

Second, effluent disposal sites can be located upgradient from these natural attenuation resources to allow further pollutant removals as the effluent-impacted groundwater moves toward the embayment. Great care must be taken to avoid secondary impacts, however, such as overloading the nitrogen attenuation capacity or introducing more phosphorus than is appropriate. Some studies have shown that salt marshes may have significant nitrogen removal capability with less potential for overloading than freshwater systems. In Orleans, where pond protection has high priority, salt marshes represent the best opportunity for natural attenuation and should be considered in effluent disposal siting. The Tri-Town site in Orleans is upgradient from Namskaket Marsh, and the marsh that may now be providing renovation of the Tri-Town plume and might provide attenuation of nitrogen from wastewater effluent infiltrated at the Tri-Town site. Similarly, the salt marshes separating Pochet Neck from Pochet Creek might provide a similar benefit for effluent disposed of in areas that are immediately upgradient.

The third opportunity for taking advantage of natural attenuation is in the restoration of damaged wetlands or the conversion of abandoned cranberry bogs. Some natural attenuation may be occurring at these locations, and restoring them to their original state may allow additional attenuation. In cranberry bogs, deepening the bog or increasing the water surface may increase the detention time of groundwater passing through these systems and allow for greater natural attenuation.

Flushing Enhancement: The residence time of nitrogen in an embayment in part determines the susceptibility of that embayment to water quality degradation. Enhancing the flushing rate of the embayment can improve water quality and lessen the impacts of a given nitrogen load. Dredging channels, widening inlets, and replacing constricting culverts are all ways to enhance tidal flushing. A number of sub-embayments in the Pleasant Bay system (for example Lonnie's Pond and Areys Pond) and perhaps Rock Harbor could potentially benefit from dredging to deepen their inlets. It is expected that less nitrogen control would be needed in the watersheds of these sub-embayments after dredging of their inlets, although additional modeling of the hydrodynamics and water quality would be needed to quantify the impact. (It is important to note that enhanced flushing in "headwaters" sub-embayments does not reduce the overall load to the Pleasant Bay system, but merely moves the load downstream more quickly. In that these sub-embayments are influenced by the quality of the downstream waters that flush them, this technique is less attractive than similar actions in embayments that discharge directly to the Atlantic Ocean or Cape Cod Bay.)

(The MEP technical report for Pleasant Bay predicts that a significantly higher level of nitrogen control will be needed if the current breach off Chatham reverts to its prior, more southerly location. The principal behind this conclusion is the same as discussed above. The towns around Pleasant Bay should formulate a plan to deal with this possible "flushing diminishment".)

Flushing enhancement options have many advantages and disadvantages. Any modifications to the coastal environment require significant permitting. Dredging is only permittable in the ACECs if that location has been previously dredged. (Historical dredging has occurred in Areys Pond, Lonnies Pond and Paw Wah Pond, and perhaps others.) The nitrogen control needs documented in the MEP technical report are intended to restore eelgrass and habitat for benthic organisms. Dredging would certainly destroy, at least temporarily, some of the habitat that the nitrogen control is intended to benefit. Dredging, if permittable, would not be a one-time event, but would need to be repeated over time to maintain the flushing enhancement.

The Town has met with DEP to discuss the merits of these non-traditional nitrogen control approaches. DEP officials have instructed the Town to focus its efforts on the structural aspects of this program and not delay progress to evaluate non-structural elements. Nevertheless, well-documented demonstrations of nitrogen removal through non-traditional means may help reduce the cost of later phases of the project.

SECTION 6

FORMULATION OF COMPOSITE WASTEWATER PLANS

Sections 5.2 through 5.6 review the elements of town-wide wastewater management plans and recommend those components that are most applicable to Orleans. Based on that review, many plans were formulated that utilize these components. Those plans were evaluated and three were selected for detailed evaluation.

6.1 INITIAL PLAN FORMULATION

Over the course of nine meetings, the WMSC discussed the advantages and disadvantages of options for each of the major components of a town-wide management plan, as summarized in Table 5-1. During that same period, the MEP released its technical report on Pleasant Bay, and members of the WMSC reviewed this document in detail and participated in workshops sponsored by the Pleasant Bay Alliance related to TMDL setting and compliance. Also during that period, the WMSC heard a presentation by senior DEP staff members on the DEP water reuse program, and participated in a search for wastewater treatment and disposal sites. As a result of all of these meetings and discussions, a number of broad principles emerged as important to the formulation of town-wide wastewater management plans in Orleans:

- Collection and treatment of wastewater from the Pleasant Bay watershed with disposal in another, less sensitive watershed would provide the highest level of protection of Pleasant Bay.
- The lack of large and publicly-owned vacant sites, remote from residential development, prompts the consideration of decentralized solutions that are compatible with a larger number of small dispersed sites.
- The significantly degraded nature of certain coastal waters, particularly the "headwaters" sub-embayments in the Pleasant Bay system, may warrant the implementation of focused early actions to remove wastewater nitrogen from their watersheds as the first priority in a phased plan.

- The Tri-Town site is already used for wastewater-related functions and has some significant undeveloped area that makes it the most likely candidate site for a centralized plan.
- There are many opportunities for reuse of wastewater effluent that allow the recycling of nutrients and water in a controlled fashion with significant protection of the public.
- The most viable reuse alternative at large scale, the irrigation of golf course fairways, is not possible in Orleans, where no golf courses exist. Golf course irrigation may be feasible in the neighboring towns of Brewster and Harwich.
- Regional solutions have the benefits of economies of scale and effectiveness of treatment, but site availability and embayment nutrient sensitivity may make such solutions difficult.

Given these findings, the WMSC and its consultant developed a set of nine town-wide wastewater management plans for more detailed review. The plans are described in Table 6-1, and include centralized and decentralized options and a range of effluent reuse and disposal methods.

As a starting point, it was agreed that each of these plans would be assumed to address all of the needs documented in the draft Needs Assessment (that is, needs in the categories of sanitary, water supply protection, surface water protection, aesthetics/convenience, and economic development). Each plan should also have those applicable non-structural and non-traditional measures that reduce flows and loads and to minimize environmental impact.

6.2 EVALUATIVE CRITERIA

Once the nine wastewater plans were formulated, the WMSC identified a wide range of criteria that should be used to compare and contrast the plans. These criteria are summarized in Table 6-2.

TABLE 6-1
INITIAL PLAN IDENTIFICATION

A. Tri-Town--Orleans Only. All of the collected wastewater would be transported to the Tri-Town site where it would be treated to the typical 10-mg/l level of effluent nitrogen. Effluent disposal would be at the Tri-Town site, and at other nearby sites.

B. Tri-Town--Regional. This plan is similar to Plan A, but would include the receipt of wastewater from Brewster and/or Eastham. More effluent disposal sites would probably be needed nearby, compared with Plan A.

C. Tri-Town--Reuse. The Tri-Town plant would receive all of Orleans wastewater flows and provide a very high degree of treatment so that effluent could be reused under DEP's Reclaimed Water Guidelines. This high degree of treatment allows effluent to be used to irrigate Town parks and cemeteries, and be used for toilet flushing in public buildings. Effluent reuse during the summer peak conditions would reduce the need for effluent disposal at other sites.

D. Decentralized Plan #1 (Pleasant Bay). This plan would use the Tri-Town site for wastewater treatment from the Nauset and Cape Cod Bay watersheds, and use two decentralized plants for treating wastewater collected in the Pleasant Bay watershed. One such plant would be located in East Orleans; the other would be located in South Orleans and would discharge to sites in the Areys Pond and Namequoit River sub-watersheds.

E. Decentralized Plan #2 (Nauset and Pleasant Bay). This plan is similar to Plan D, and also involves three plants. It includes a larger decentralized treatment plant in East Orleans, to treat both Pleasant Bay and Nauset wastewaters, with disposal in both the Pochet Neck and Nauset Harbor sub-watersheds. This plan goes further than Plan D in keeping wastewater local and reducing the demand on disposal sites at or near Tri-Town.

F. Decentralized Plan #3 (Sub-Watersheds). In this plan, small decentralized plants would be constructed in the "headwaters" sub-embayments (Meetinghouse Pond, Arey's Pond, Lonnie's Pond and Pah Wah Pond) to facilitate early progress in the most critical areas, with the remainder of the plan similar to Plan E. This plan would include five plants.

G. South Orleans--Orleans Only. In this plan, all Orleans wastewater would be transported to a site in South Orleans for treatment. Effluent disposal would occur on one or more golf courses in Brewster and/or Harwich, either by spray irrigation in the warm months or by subsurface leaching in the winter. This plan takes advantage of spray irrigation, both as a low-cost way to polish the effluent, and as a means to reduce fertilizer use at the golf courses.

H. South Orleans--Regional. This plan is an extension of Plan G that adds the treatment and disposal of wastewaters from portions of Brewster and Harwich.

I. Two Regional Plants. This plan combines Plan B with Plan H. There would be two moderately-sized plants, one at Tri-Town and one in South Orleans, and each would receive flow from neighboring towns.

TABLE 6-2
EVALUATIVE CRITERIA
USED IN RATING WASTEWATER PLANS

• Overall Cost	• Need for Land Purchase and/or Easements
• Use of Proven Technology	• Potential for Neighbor Impacts
• Regulatory Acceptability	• Benefits from Natural Attenuation
• Environmental Impact	• Retention of Water in Water Supply Area
• Energy Consumption	• Removal of Contaminants of Emerging Concern
• Ease of Operation	• Nitrogen and Phosphorus Removal
• Production of Residuals	• Expandability for Regionalization
• Overall Public Acceptability	• Extent of Collection System

Wright-Pierce scored each plan in these categories on a one-to-three scale, with the higher scores representing the most favorable. For example, the plans that require the most energy use were given a score of 1, and the most energy-efficient plans were given a score of 3. The scores for each plan and criterion are presented in the draft Alternatives Screening Report. Spreadsheets were prepared that allowed each member of the WMSC to individually rate the nine plans against these 16 criteria. Ratings were first prepared using each member's choice of weighting factors from one to four. That is, if an individual placed high priority on cost, he or she could use a weighting factor of 4, versus a weighting factor of 1 for a less important factor to him or her. Scores were aggregated and analyzed to determine which criteria contributed most significantly to the overall rating. Then the scoring was repeated using weighting factors of one to ten, and the aggregate scores were again analyzed for the most significantly contributing criteria. Conclusions of this exercise were:

- Plan A had broad support, but only by a small margin.
- The criteria that added most significantly to the high scores varied by committee member, but cost, public acceptability, need for land acquisition and environmental impact were often mentioned.
- An evaluation of the scoring revealed that the lack of a single clear favorite may have related to the large number of evaluative criteria, some of which overlap (for

example, "high energy consumption" contributes to "high cost", both of which detract from "public acceptability"). Although clear consensus was not gained for any one or two plans, there was support for regionalization (based in large part on economies of scale), decentralization (reduction of transport costs and suitability for small dispersed sites), and the Tri-Town options (no need for land acquisition and public acceptability for continuation of wastewater-related activities there).

6.3 OVERVIEW OF WASTEWATER PLANS RECOMMENDED FOR DETAILED EVALUATION

The initial set of nine plans was consolidated to three plans to be the subject of detailed evaluation. Those three plans are:

Plan 1. Decentralized Treatment and Disposal in All Major Watersheds

Plan 2. Centralized Treatment at the Tri-Town Site with Disposal in the Cape Cod Bay Watershed

Plan 3. Centralized Treatment in South Orleans with Disposal on Golf Courses in the Pleasant Bay Watershed.

Plan 1 is described in more detail in Table 6-3 and Figure 6-2 and 6-3. Similarly, Tables 6-4 and 6-5 summarize Plans 2 and 3, which are shown graphically in Figures 6-4 through 6-7. These figures show the number of properties served and the associated wastewater flow collected in each watershed. Also shown are the watershed locations and capacities of the treatment and disposal facilities. Figure 6-1 provides a legend to aid in interpretation of the wastewater plan schematics.

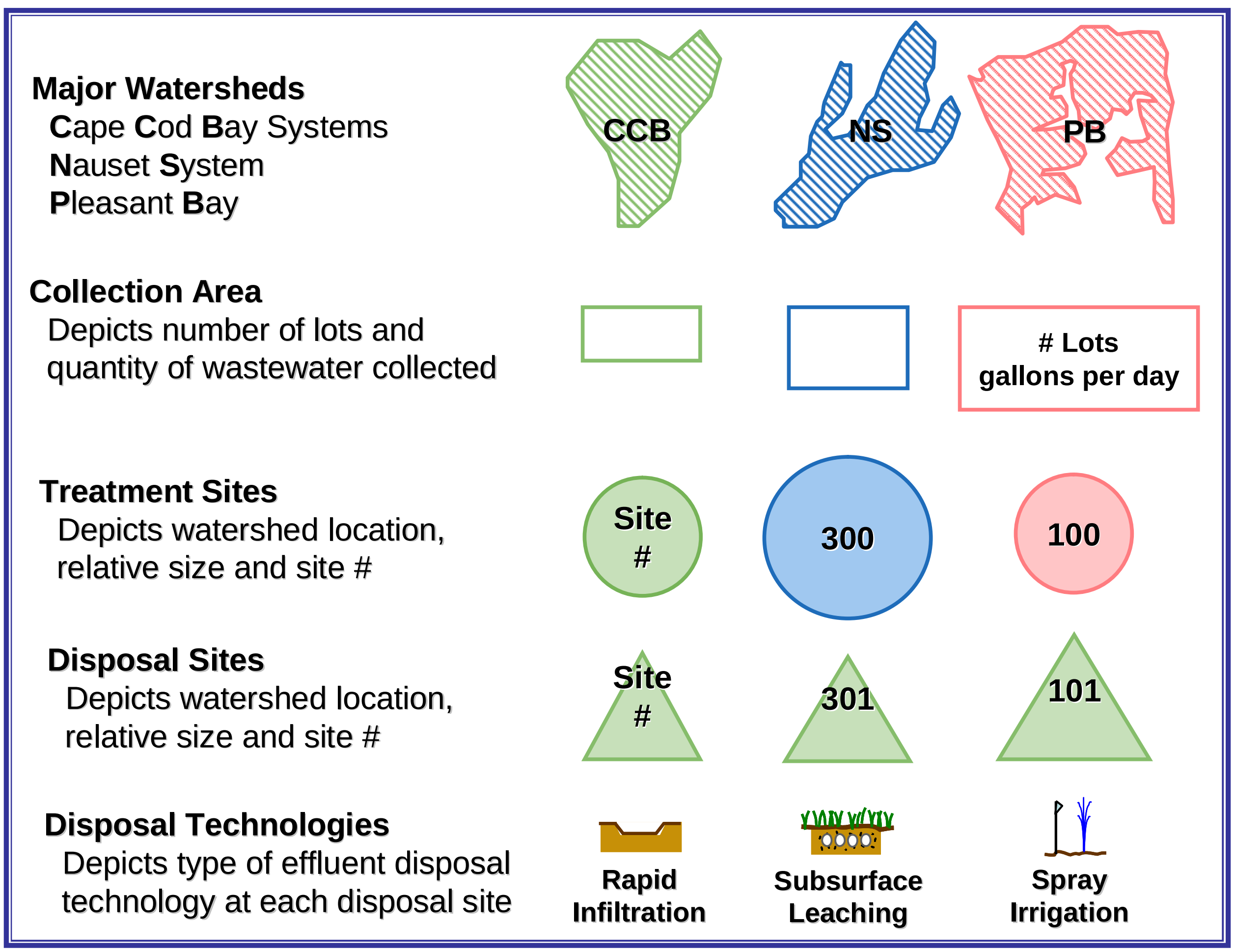
During the evaluation of the nine initial plans, it became clear that the WMSC places great importance on low-cost solutions. Perhaps the greatest potential for cost savings lies with regionalization. Therefore each of the three plans was evaluated as to its ability to accommodate wastewater flows from adjacent towns; that is, from Eastham and Brewster.

The environmental benefits of effluent reuse are also important factors in the WMSC deliberations, both for recycling water and nutrients and to open up the possibility of better nutrient and water management at local golf courses. The use of reclaimed water on golf courses is a fundamental element of Plan 3. Effluent reuse opportunities have been be investigated as adjuncts to Plans 1 and 2.

It is important to note that none of the original nine plans was "eliminated". The three plans, together with the parallel investigations of reuse and regionalization, represent all nine of the original plans.

The three wastewater plans are summarized and compared in Table 6-6.

FIGURE 6-1
WASTEWATER PLAN LEGEND



The common elements of all three plans are:

- Traditional gravity sewer systems supplemented by sections of low-pressure sewer and grinder pumps where necessary to overcome steep terrain and difficult-to-access properties;
- Collection system layouts intended to primarily address nitrogen control needs, with other needs met where convenient;
- Wastewater and effluent transport by conventional pump stations and force mains;
- A high level of nitrogen removal at treatment facilities using well-proven biological treatment methods, followed by ultraviolet disinfection;
- Liquid sludge processing at a central location to include dewatering and out-of-town disposal of dewatered solids;
- Septage handling facilities to receive and treat the liquid sludge pumped from septic tanks at those properties in Orleans that are not connected to the public sewer, as well as from unsewered homes and businesses in Eastham and Brewster (Orleans' partners in the Tri-Town district);
- A fertilizer control program to reduce non-wastewater nitrogen loads; and
- A cluster system at Baker's Pond to reduce phosphorus loading.

The principal differences among the three plans are:

- Two of the plans are based on the traditional municipal sewerage concept of a single centralized facility to meet all the Town's needs. By contrast, one of the plans can be characterized as "decentralized", using smaller modular treatment facilities located close to or in the areas where the wastewater is to be collected.
- Three types of effluent disposal are included in the plans: subsurface leaching (a larger version of the leaching trenches or fields that serve many individual homes); rapid infiltration (open sand beds that accept high rates of effluent application); and spray irrigation (recovery of the water and nutrients in the effluent by application on vegetated surfaces);

- Two of the plans involve fairly large treatment facilities sites in industrial areas with limited nearby residential development, while the decentralized plan includes sites in residential neighborhoods.
- Not all of the plans involve publicly-owned sites, and some purchase of private land for treatment and disposal is necessary in one or two of the plans.
- Two of the plans can be implemented by the Town of Orleans acting on its own, while one requires cooperation from a nearby town.

6.4 PLAN DESCRIPTIONS

Table 6-6 presents key statistics on each of the three wastewater management plans, which are described below:

Plan 1--Decentralized Wastewater Treatment and Disposal

Wastewater would be collected in all areas of Orleans that are tributary to nitrogen-sensitive embayments, in proportion to the nitrogen control needs determined by MEP studies. The distinguishing feature of this plan is four decentralized wastewater treatment facilities, located across all of the major watersheds in Orleans; see Figure 6-3. One of the facilities would be located at the site of the existing Tri-Town Septage Treatment Facility, where effluent would be disposed of by rapid infiltration. For the other three decentralized facilities, effluent disposal would be by subsurface leaching at nine sites at or near the treatment facilities. The other three facilities would be located near Meetinghouse Pond, near Areys Pond and in the Nauset watershed; more information on these sites is presented in Sections 5 and 7. This decentralized plan was formulated, in part, to allow early Town expenditures toward improving water quality in the "headwaters" sub-embayments of Pleasant Bay where the highest nitrogen control needs have been indentified.

In the aggregate, Plan 1 would serve areas of town that now generate an annual average wastewater flow of 395,000 gallons per day (gpd). The future peak flows handled at the four facilities would range from 110,000 gpd to 730,000 gpd, compared to about 1.2 to 1.3 million gallons per day (mgd) in the centralized plans. These smaller plants can be located more easily than large plants, yet are still large enough to reliably provide a high level of nitrogen removal.

Each of the decentralized wastewater treatment facilities would generate a liquid sludge that would periodically be removed from the treatment process. For three of the facilities, this liquid would be trucked to the Tri-Town site for co-disposal with the liquid sludge produced by the new wastewater facility there, together with the septage (from Orleans and other communities) received by an upgraded Tri-Town septage facility.

Plan 2--Centralized Wastewater Treatment and Disposal at the Tri-Town Site

As in Plan 1, wastewater would be collected in all areas of Orleans that are tributary to nitrogen-sensitive embayments, in proportion to the nitrogen control needs determined by MEP studies. As shown in Figure 6-5, collected wastewater would be pumped to the site of the existing Tri-Town Septage Treatment Facility, near the intersection of Route 6 and Route 6A. This plan uses available land at a site near the downtown area where wastewater activities already take place. Effluent would be disposed of using rapid infiltration beds, similar to those now used for disposal of treated septage.

Plan 2 would serve areas of Orleans that now generate an annual average wastewater flow of 371,000 gpd. The facility would be designed for a future peak flow of 1.21 mgd. With the construction of a new centralized wastewater treatment facility at this site, the aging Tri-Town Septage Treatment Facility could be abandoned, and septage handling equipment could be incorporated into the wastewater facility.

Plan 3--Centralized Wastewater Treatment and Disposal in or near South Orleans

Plan 3 is illustrated in Figure 6-7. As in Plans 1 and 2, wastewater would be collected in all areas of Orleans that are tributary to nitrogen-sensitive embayments, in proportion to the nitrogen control needs determined by MEP studies. Collected wastewater would be transported south-ward through gravity and pressure pipes to a site near the boundary of Orleans and Brewster, near the intersection of Route 39 and Freeman's Way. This plan would use vacant land near disturbed property where sand and gravel removal has occurred and where landscaping businesses now operate. Effluent would be disposed of in the cooler months using subsurface leaching systems that can be operated year-round. In the warmer months, effluent would be further treated to meet the DEP Reclaimed Water Guidelines, so it could be used to irrigate one or both of the Captains and Cape Cod National golf courses. This would reduce the golf courses' needs to pump groundwater for irrigation and use synthetic fertilizers.

Plan 3 would serve areas of Orleans that now generate an annual average wastewater flow of 386,000 gpd. The facility would be designed for a future peak flow of 1.28 mgd. While site investigations are preliminary, it may be possible for this plan to also serve the portions of Brewster tributary to Pleasant Bay.

The wastewater treatment plant would generate a liquid sludge that would be periodically removed from the treatment process. This liquid would be trucked to the Tri-Town site for co-disposal with the septage received at an upgraded Tri-Town septage facility.

6.5 NO ACTION PLAN

The three management plans selected for detailed evaluation all are intended to resolve identified wastewater needs in a comprehensive fashion. It is standard practice in wastewater management planning to also consider the alternative of taking no action to address needs, the so-called "No Action Plan". For Orleans, the No Action Plan entails the continued use of traditional on-site wastewater systems, within the purview of the state sanitary code, Title 5, and local supplemental regulations. This plan would not address the significant nutrient control needs faced by the town, and would allow continued degradation of freshwater ponds and coastal waters.

6.6 IMPORTANCE OF NITROGEN BALANCE

While the three plans provide a comparable degree of wastewater management to the town, there are subtle differences in the sewer service areas that are important to an understanding of the costs and benefits of the plans.

In Plan 2, wastewater would be collected from the watersheds of three nitrogen-sensitive embayments and transported to the Namskaket watershed where current watershed nitrogen loads are well below the nitrogen threshold for this marsh system. A high degree of wastewater treatment would be provided, converting most of the nitrogen to harmless nitrogen gas. Some nitrogen would remain in the facility effluent and would eventually find its way to the Namskaket and Little Namskaket marsh systems. The residual nitrogen load, together with the nitrogen load from other watershed activities, will still be well below the critical thresholds for those systems.

In contrast, Plans 1 and 3 involve recharge of effluent in the watersheds of sensitive embayments (both Nauset and Pleasant Bay for Plan 1 and Pleasant Bay alone for Plan 3). To account for the residual nitrogen in the recharged effluent that would remain in those watershed, the sewer service areas must be expanded over those in Plan 2 to eliminate more septic systems and offset the effluent nitrogen load. As a consequence, the sewer systems for Plans 1 and 3 must be more extensive than for Plan 2. There would be higher cost for collection, and the higher volumes collected would result in higher costs for treatment and disposal. In Plan 2 a total of 2,400 lots (47% of all developed properties in Orleans) would be connected to address current nitrogen control needs. By comparison, Plans 1 and 3 would connect 2,620 and 2,570 developed parcels respectively.

6.7 EXTENT OF SEWER SYSTEM

Figures 6-3, 6-5 and 6-7 depict, in green, preliminary sewer service areas. There are subtle differences in those areas that reflect the differing numbers of properties that would be connected to the public sewer, as detailed in Table 6-6. In each figure, the green-shaded areas represent the sewer service areas that would exist at the end of the planning period (in the year 2030). As indicated in Table 6-6, only about 85% of the developed parcels in those areas would be sewered initially. As currently-developed parcels are redeveloped and as vacant lots are built upon, more properties must be sewered to offset the increased nitrogen loads that otherwise would occur through existing septic systems. The collected wastewater flow, and the nitrogen it contains, would gradually increase in response to growth in watersheds of sensitive embayments. That increased flow would come both from geographic expansion of the initial sewer service area and from "infill" (new connections within previously sewered neighborhoods). The geographic extent of the proposed sewer service areas, and the specific parcels to be initially connected, would be determined as part to the preliminary design work after selection of the recommended wastewater plan.

TABLE 6-3
SUMMARY OF WASTEWATER PLAN #1

Summary:

Collection of wastewater from all 3 major watersheds to satisfy all identified needs, transport to 3 new decentralized wastewater treatment plants, with the balance taken to a new plant at the Tri-Town site, with effluent disposal by rapid infiltration at the Tri-Town site and by subsurface leaching at seven sites at or near the decentralized plants.

Wastewater Collection:

Collection by conventional gravity sewers supplemented by grinder pumps

From Cape Cod Bay watershed	69,000 gpd	(270 properties)
From Nauset watershed	204,000 gpd	(1,030 properties)
From Pleasant Bay watershed	273,000 gpd	(1,780 properties)
Overall	546,000 gpd	(3,080 properties, 58% of all wastewater)

Wastewater Treatment: (Total of four wastewater treatment facilities)

Three decentralized treatment plants (with short-term peak capacities of 320,000 gpd, 240,000 gpd and 110,000 gpd) using

- Primary treatment
- Biological secondary treatment and nitrogen removal (SBRs or equivalent)
- Standard ultraviolet disinfection
- Filtration

One new plant at Site 241 (730,000 gpd) using:

- Primary treatment
- Biological secondary treatment and nitrogen removal (SBRs or equivalent)
- Ultraviolet disinfection
- Filtration

Wastewater Disposal:

Rapid infiltration Site 241

Subsurface leaching at:

Site 111	Site 162	Site 321
Site 112	Site 173	Site 322
Site 121	Site 181	Site 323

Disposition of effluent by watershed (annual average):

Cape Cod Bay	291,000 gpd	(53%)
Nauset system	125,000 gpd	(23%)
Pleasant Bay	130,000 gpd	(24%)

Septage and Sludge Handling:

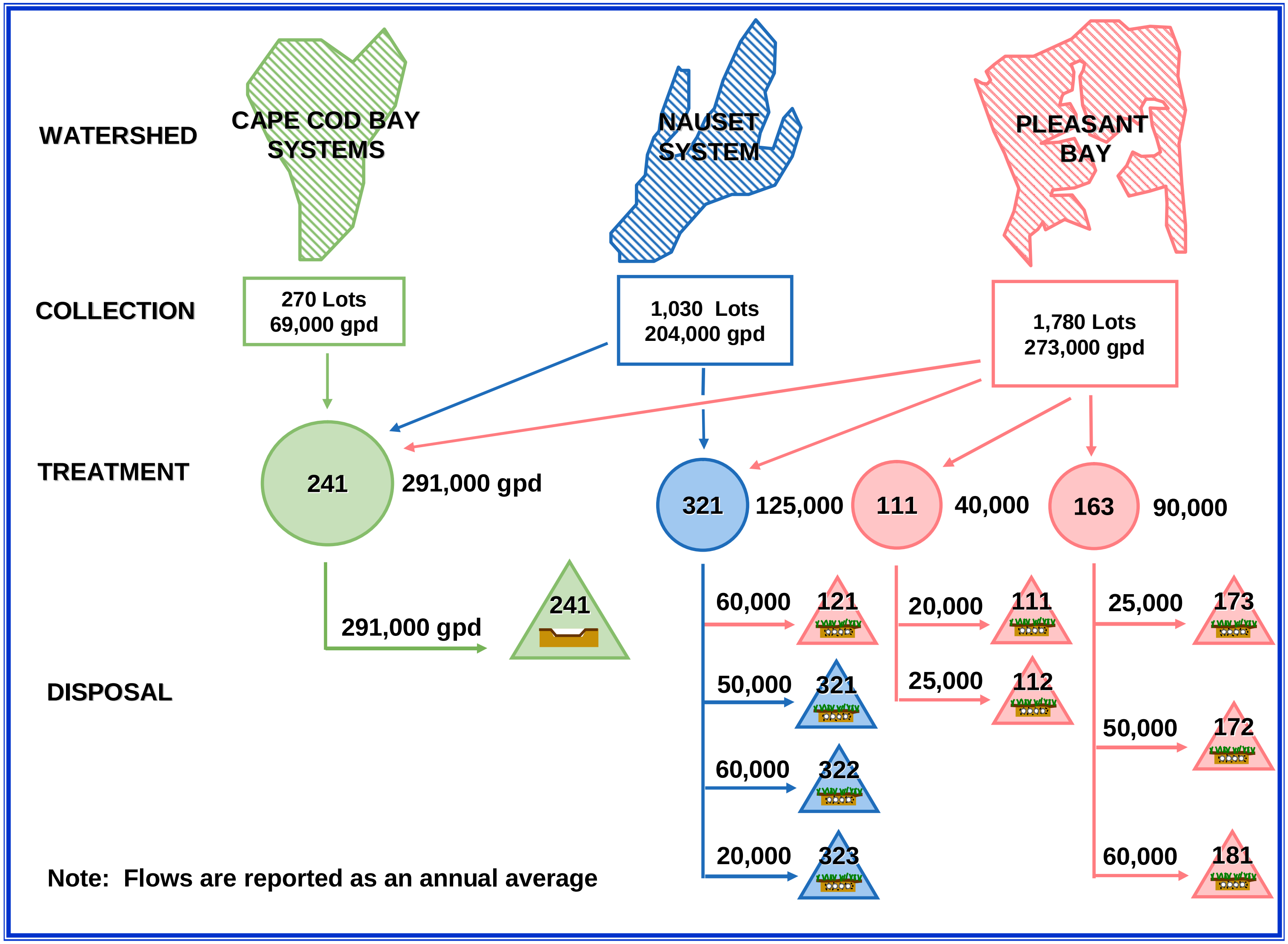
The treatment plant at the Tri-Town site would receive and dewater septage from all 3 District towns, as well as liquid sludge trucked from the 3 decentralized plants. Dewatered sludge would be trucked away for ultimate disposal out of town.

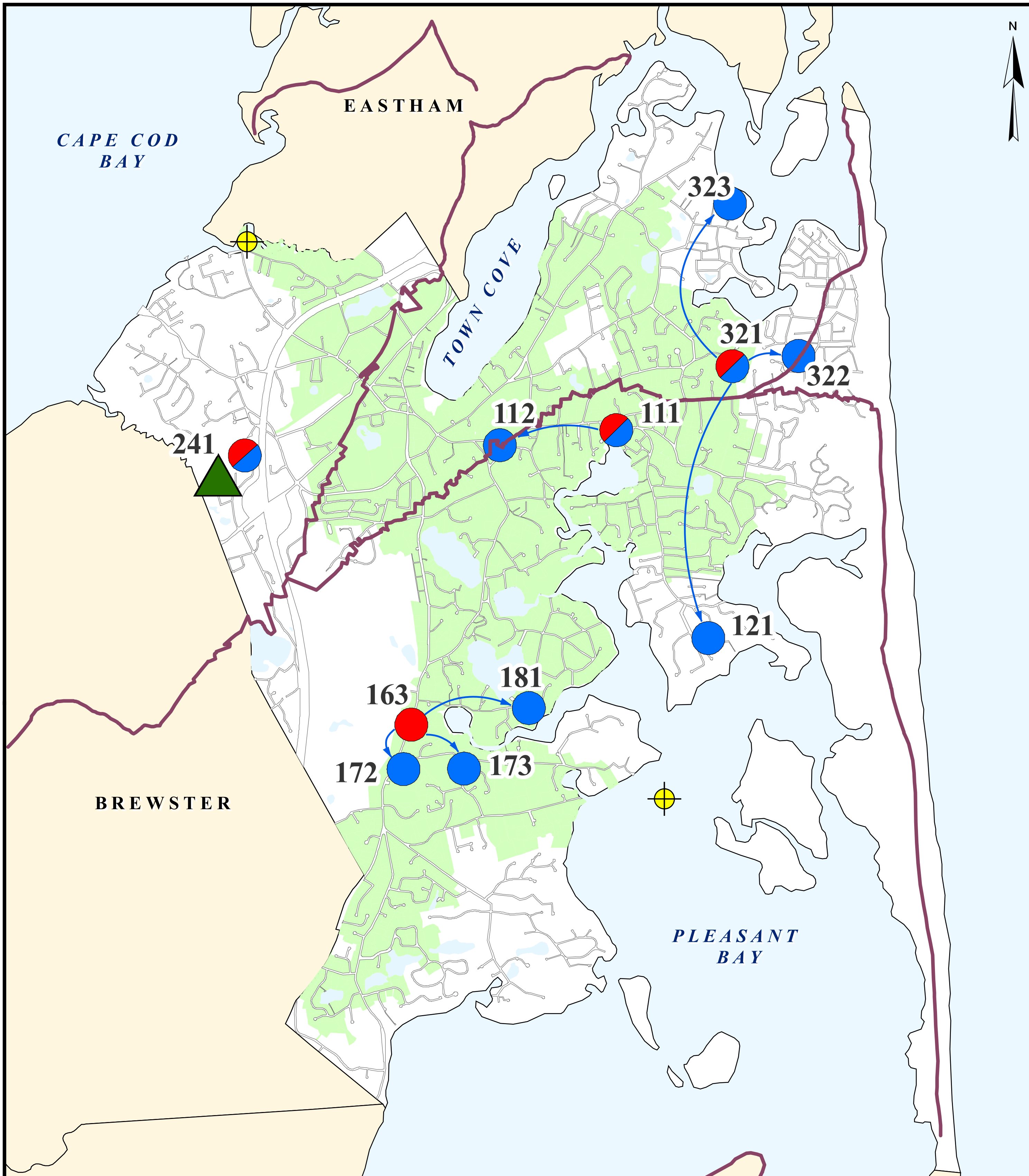
Land Acquisition Needs:

Purchase land at 3 treatment plant sites (all privately owned)

Purchase land or acquire easements at 9 sites for effluent disposal (8 privately owned)

FIGURE 6-2
WASTEWATER PLAN #1





Septage Treatment Facility

100 Site Number

Wastewater Treatment Site

Effluent Disposal Site

Sewer Service Area

Major Watershed Boundaries

Sentinel Stations

Source: Base data obtained from the Town of Orleans and MassGIS

0 4,000 8,000 Feet

Orleans CWMP

Wastewater Plan #1

PROJ NO: 10645G	DATE: Apr 2009	FIGURE:	6-3

WRIGHT-PIERCE Engineering a Better Environment

Thursday, September 11, 2008 2:28:52 PM W:\GIS_Development\Projects\10645B-Orleans\RecommendationPlan\Fig6-3.mxd

TABLE 6-4
SUMMARY OF WASTEWATER PLAN #2

Summary:

Collection of wastewater from all 3 major watersheds to satisfy all identified needs, transport to a new wastewater treatment plant at the Tri-Town site, with effluent disposal by rapid infiltration at the Tri-Town site and by subsurface leaching or rapid infiltration at one or two other nearby sites.

Wastewater Collection:

Collection by conventional gravity sewers supplemented by grinder pumps

From Cape Cod Bay watershed	69,000 gpd (270 properties)
From Nauset watershed	186,000 gpd (880 properties)
From Pleasant Bay watershed	249,000 gpd (1,680 properties)
Overall (current)	504,000 gpd (2,830 properties, 53% of all wastewater)

Wastewater Treatment:

A single treatment plant (with short-term peak capacity of 1.21 mgd) using:

- Primary treatment
- Biological secondary treatment and nitrogen removal (SBRs or equivalent)
- Standard ultraviolet disinfection
- Filtration

Wastewater Disposal:

Rapid infiltration Site 241 (the Tri-Town site), supplemented as necessary by

- subsurface leaching at Site 247 and
- rapid infiltration at Site 244

Disposition of effluent by watershed (annual average):

Cape Cod Bay	504,000 gpd	(100%)
Nauset system	0 gpd	(0%)
Pleasant Bay	0 gpd	(0%)

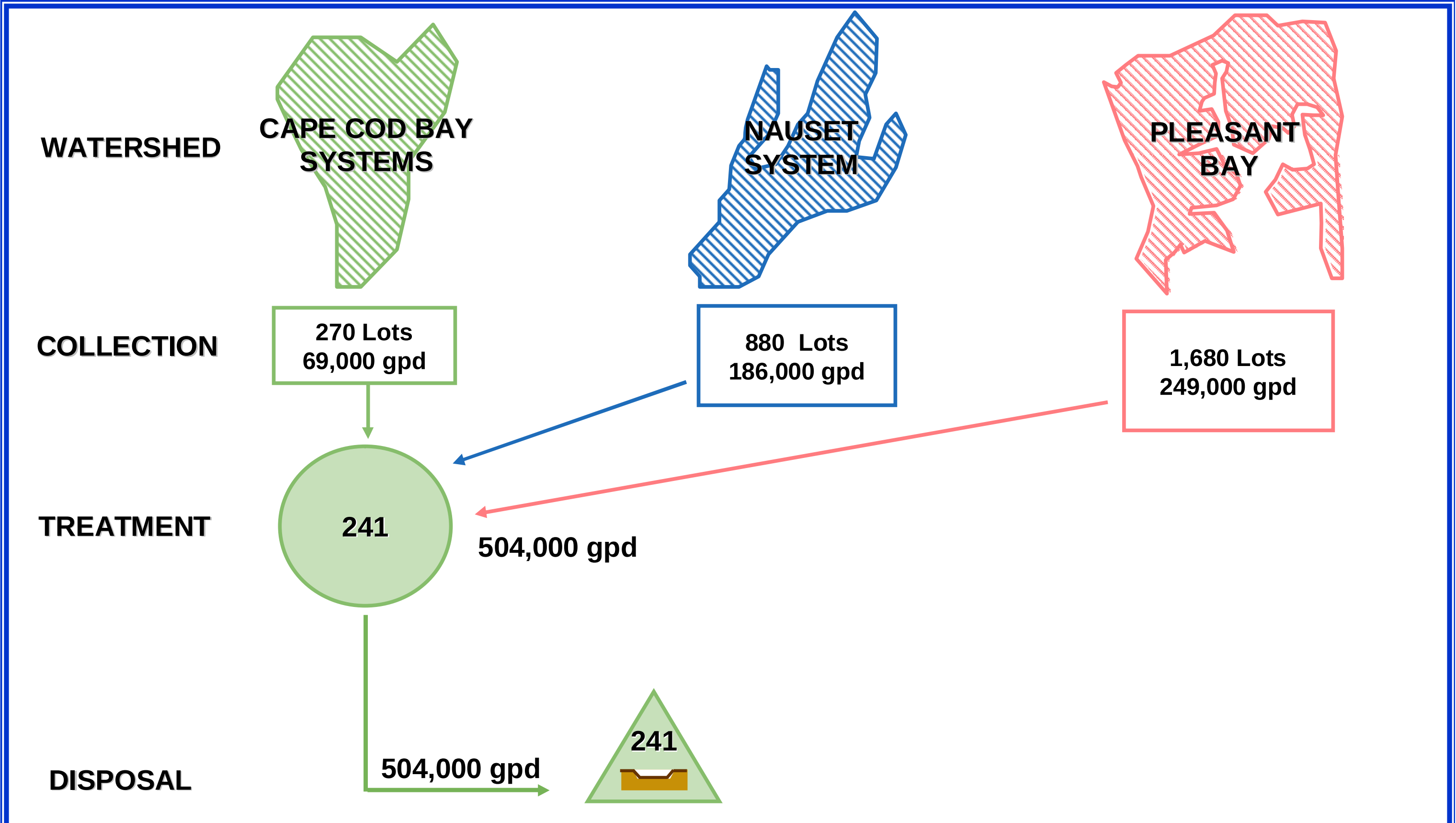
Septage and Sludge Handling:

The treatment plant at the Tri-Town site would receive and dewater septage from all 3 District towns. Dewatered sludge would be trucked away for ultimate disposal out of town.

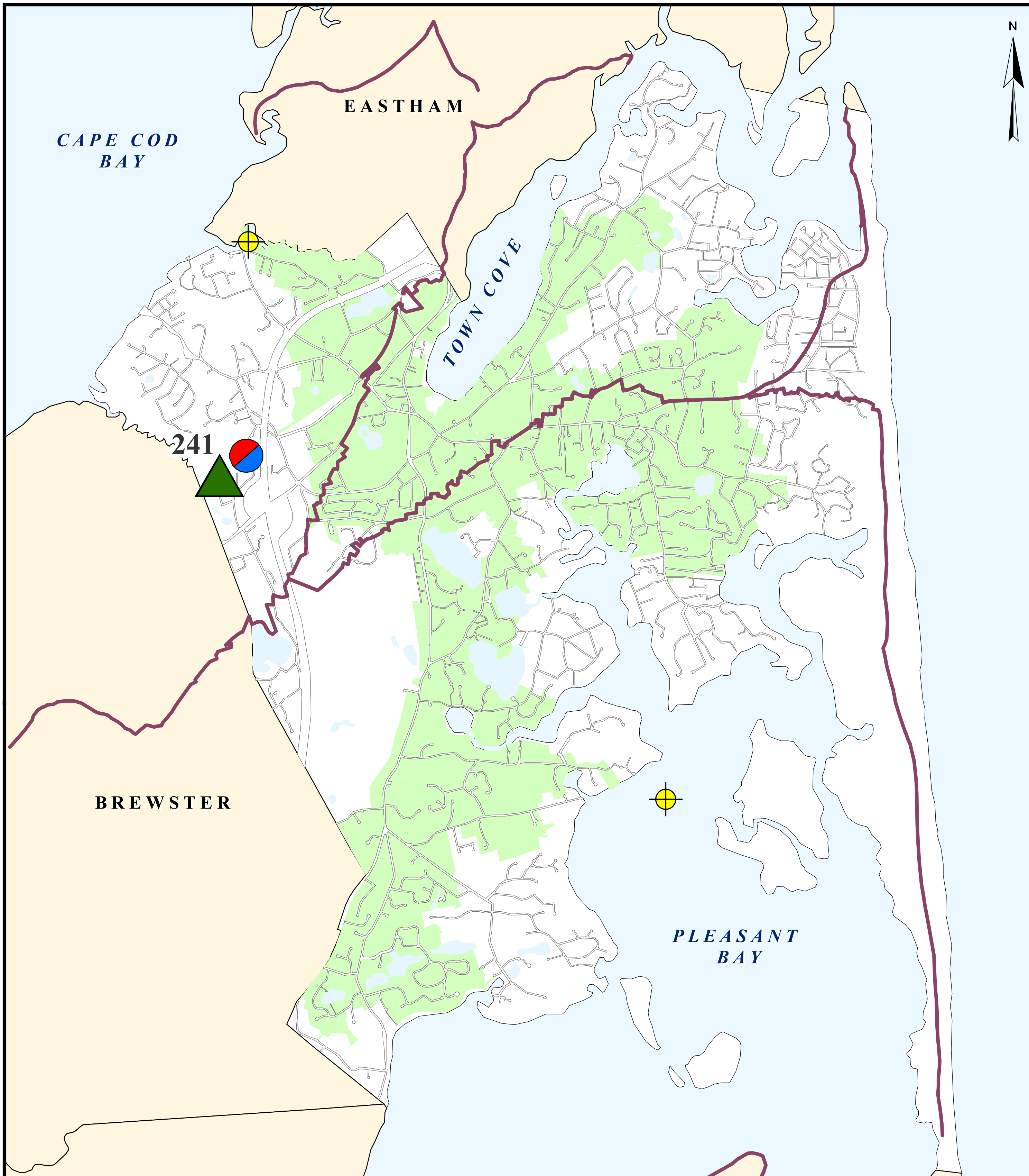
Land Acquisition Needs:

Purchase land or acquire easements at two sites for effluent disposal (1 privately owned)

FIGURE 6-4
WASTEWATER PLAN #2



Note: Flows are reported as an annual average



Septage Treatment Facility

100 Site Number

Wastewater Treatment Site

Effluent Disposal Site

Sewer Service Area

Major Watershed Boundaries

Sentinel Stations

Source: Base data obtained from the Town of Orleans and MassGIS

0 4,000 8,000 Feet

Orleans CWMP

Wastewater Plan #2

PROJ NO:	DATE:	FIGURE:
10645G	Apr 2009	6-5

WRIGHT-PIERCE
Engineering a Better Environment

TABLE 6-5
SUMMARY OF WASTEWATER PLAN #3

Summary:

Collection of wastewater from all 3 major watersheds to satisfy all identified needs, transport to a new wastewater treatment plant in South Orleans, with effluent disposal at one or two golf courses in Brewster/Harwich (spray irrigation in warm months, subsurface leaching during remainder of year).

Wastewater Collection:

Collection by conventional gravity sewers supplemented by grinder pumps

From Cape Cod Bay watershed	69,000 gpd (270 properties)
From Nauset watershed	186,000 gpd (880 properties)
From Pleasant Bay watershed	280,000 gpd (1,900 properties)
Overall	535,000 gpd (3,050 properties, 56% of all wastewater)

Wastewater Treatment:

A single treatment plant (with short-term peak capacity of 1.28 mgd) using:

- Primary treatment
- Biological secondary treatment and nitrogen removal (MBRs or equivalent)
- Redundancy features necessary to meet Reclaimed Water Guidelines
- Filtration
- High-intensity ultraviolet disinfection
- Sludge thickening for transport to Tri-Town

Wastewater Disposal:

Spray irrigation at Site 194 and/or Site 195 during warm months

Subsurface leaching at Site 193 and/or Site 194 during cold months

Disposition of effluent by watershed (annual average):

Cape Cod Bay	0 gpd	(0%)
Nauset system	0 gpd	(0%)
Pleasant Bay	535,000 gpd	(100%)

Septage and Sludge Handling:

The upgraded Tri-Town Septage Treatment Facility would receive and dewater septage from all 3 District towns, as well as liquid sludge trucked from the South Orleans centralized plant. Dewatered sludge would be trucked away for ultimate disposal out of town.

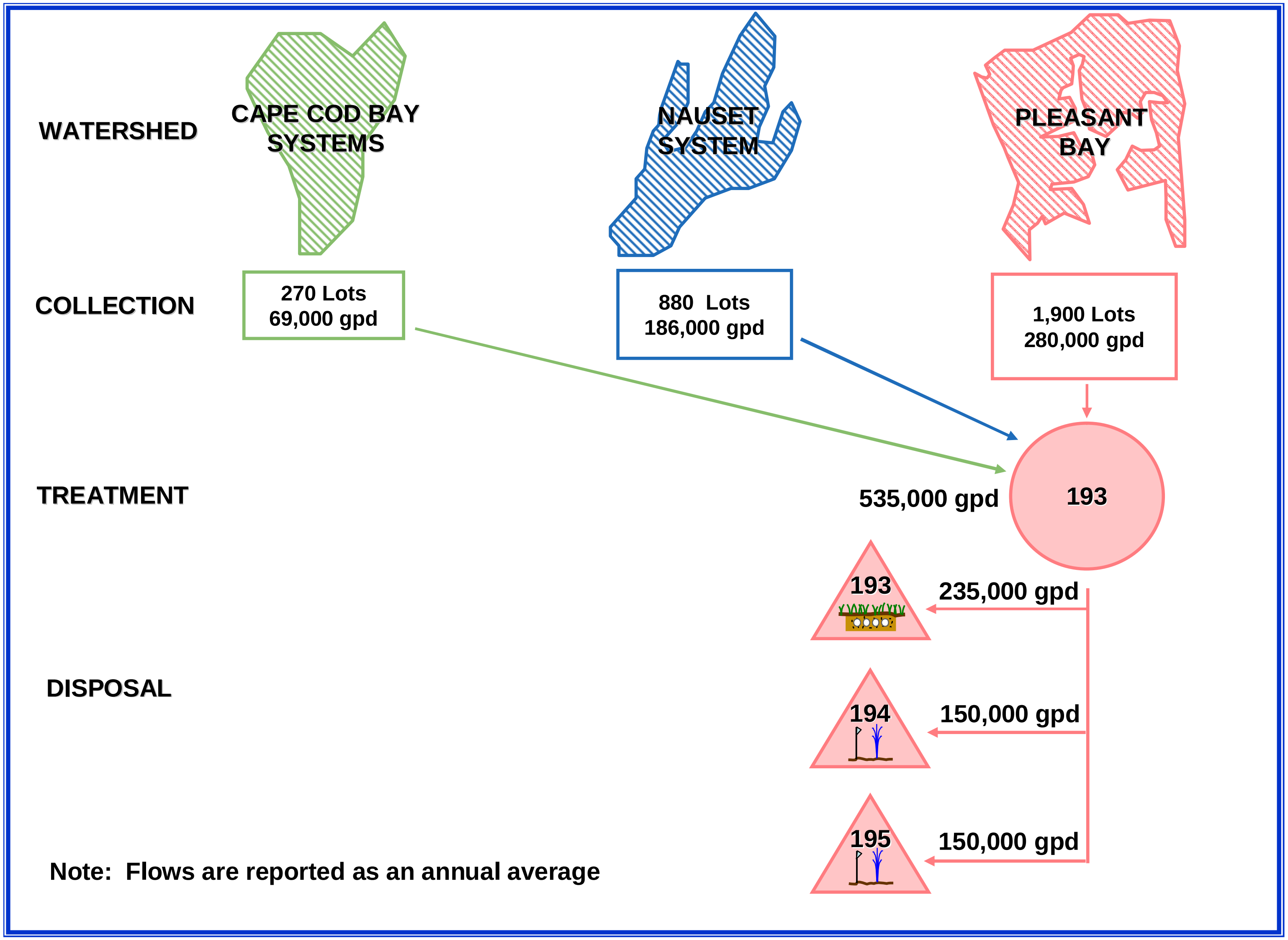
Land Acquisition Needs:

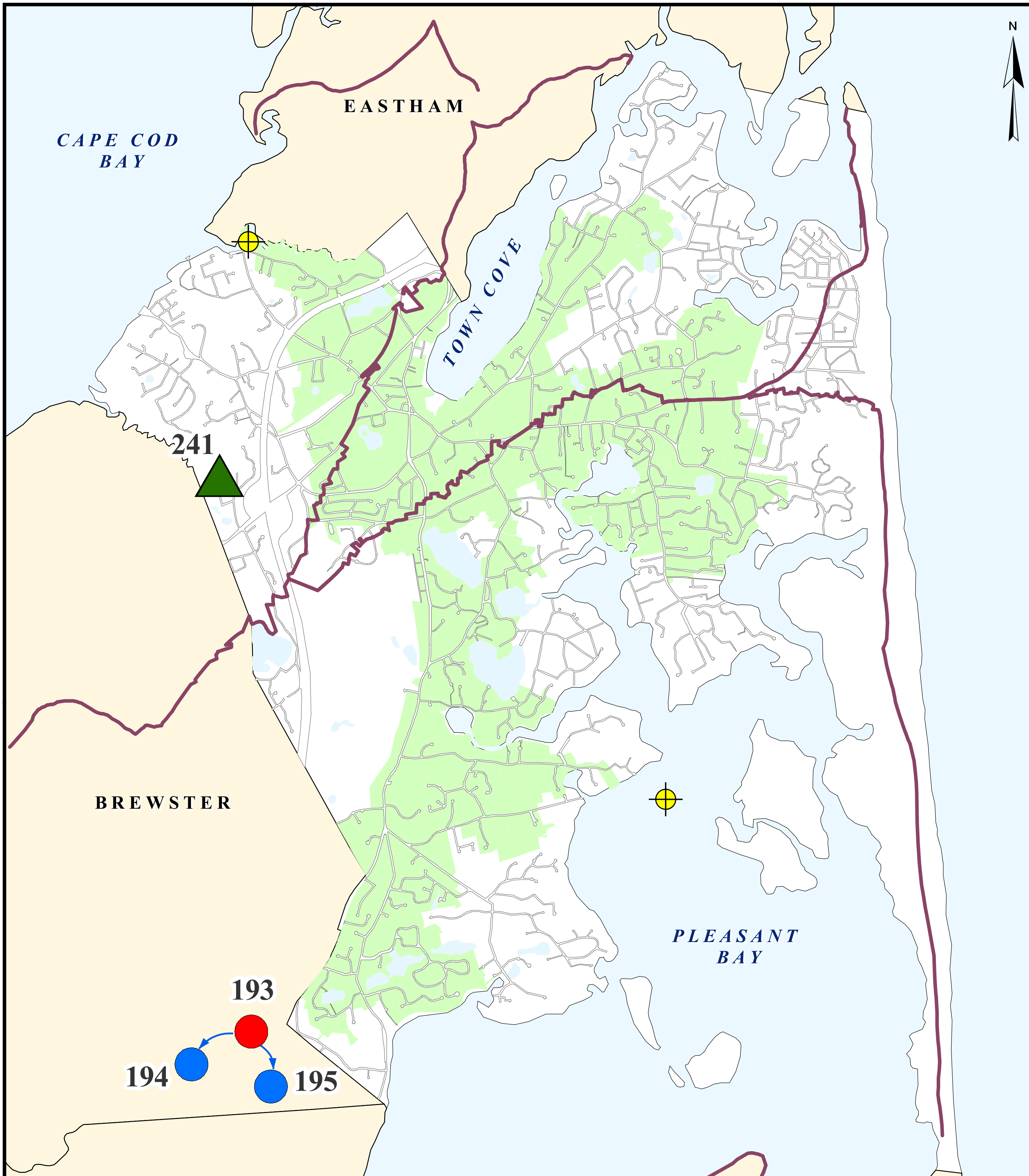
Purchase land for one treatment plant site (privately owned)

Purchase land or acquire easements at 2 sites for effluent disposal (1 public, 1 private)

Sign long-term contracts for golf course irrigation (1 public, 1 private)

FIGURE 6-6
WASTEWATER PLAN #3





Septage Treatment Facility

100 Site Number

Wastewater Treatment Site

Effluent Disposal Site

Sewer Service Area

Major Watershed Boundaries

Sentinel Stations

Source: Base data obtained from the Town of Orleans and MassGIS

0 4,000 8,000 Feet

Orleans CWMP

Wastewater Plan #3

PROJ NO:	DATE:	FIGURE:
10645G	Apr 2009	6-7

WRIGHT-PIERCE
Engineering a Better Environment

Thursday, September 11, 2008 2:38:54 PM W:\GIS_Development\Projects\10645B-Orleans\RecommendationPlan\Fig6-7.mxd

TABLE 6-6
COMPARISON OF WASTEWATER PLANS

	Plan 1 Decentralized (4 plants)	Plan 2 Centralized (Tri-Town)	Plan 3 Centralized (So. Orleans)
Wastewater Collection			
Properties served initially			
Cape Cod Bay watersheds	190	190	190
Nauset System watershed	920	780	780
Pleasant Bay watershed	1,510	1,430	1,600
Total	2,620	2,400	2,570
Initial annual avg wastewater flow, gpd	395,000	371,000	386,000
Percentage of properties served	48	44	47
Percentage of town-wide flow	51	48	50
Properties served at planning horizon			
Cape Cod Bay watersheds	270	270	270
Nauset System watershed	1,030	880	880
Pleasant Bay watershed	1,780	1,680	1,900
Total	3,080	2,830	3,050
Planning horizon annual avg wastewater flow, gpd	546,000	504,000	535,000
Percentage of properties served	57	52	56
Percentage of town-wide flow	58	53	56
Wastewater Treatment			
Number of plants	4	1	1
Location and capacity (mgd) of plants			
Cape Cod Bay watersheds	1 @ 0.73 mgd	1 @ 1.21 mgd	
Nauset System watershed	1 @ 0.32 mgd		
Pleasant Bay watershed	1 @ 0.24 mgd		1 @ 1.28 mgd
	1 @ 0.11 mgd		
Wastewater Disposal			
Number of sites			
Cape Cod Bay watersheds	1	1	0
Nauset System watershed	3	0	0
Pleasant Bay watershed	6	0	2
Total	10	1	2
Technology	rapid infiltration	rapid infiltration	spray irrigation
	subsurface leaching		subsurface leaching
Septage and Sludge Handling			
Septage receiving location	Tri-Town site	Tri-Town site	Tri-Town site
Liquid sludge dewatering	Tri-Town site	Tri-Town site	Tri-Town site
Dewatered sludge disposal	Out-of-town	Out-of-town	Out-of-town
Acquisition of Land or Easements			
Number of sites			
Treatment	3	0	1
Disposal	8	0	2
Total	11	0	3

SECTION 7

EVALUATION OF ALTERNATIVE PLANS

7.1 INTRODUCTION

Section 6 of this report describes the three wastewater management plans that have been considered in detail, and the No Action Plan which serves as a benchmark for comparison. This section of the report presents a detailed comparison of the plans in the following 20 categories:

- Transfer of water among watersheds
- Transfer of nitrogen among watersheds
- Extent of sewer system
- Need for land purchases and easements
- Capital costs
- Operation and maintenance costs
- Net present worth
- Impacts on user charges and tax rate
- Environmental impacts
- Energy consumption
- Suitability of treatment facility sites
- Truck traffic at Tri-Town site
- Expandability
- Flexibility for phasing
- Potential for water reuse
- Regulatory acceptability
- Ease in implementation
- Potential for impacting town growth rate
- Potential for public works facility at Tri-Town site
- Overall public acceptability

Most of these evaluative criteria were considered by the WMSC in narrowing the investigation from nine general plans to the three plans that were then considered in detail. With more information available on the three plans, these criteria were applied again with more specificity.

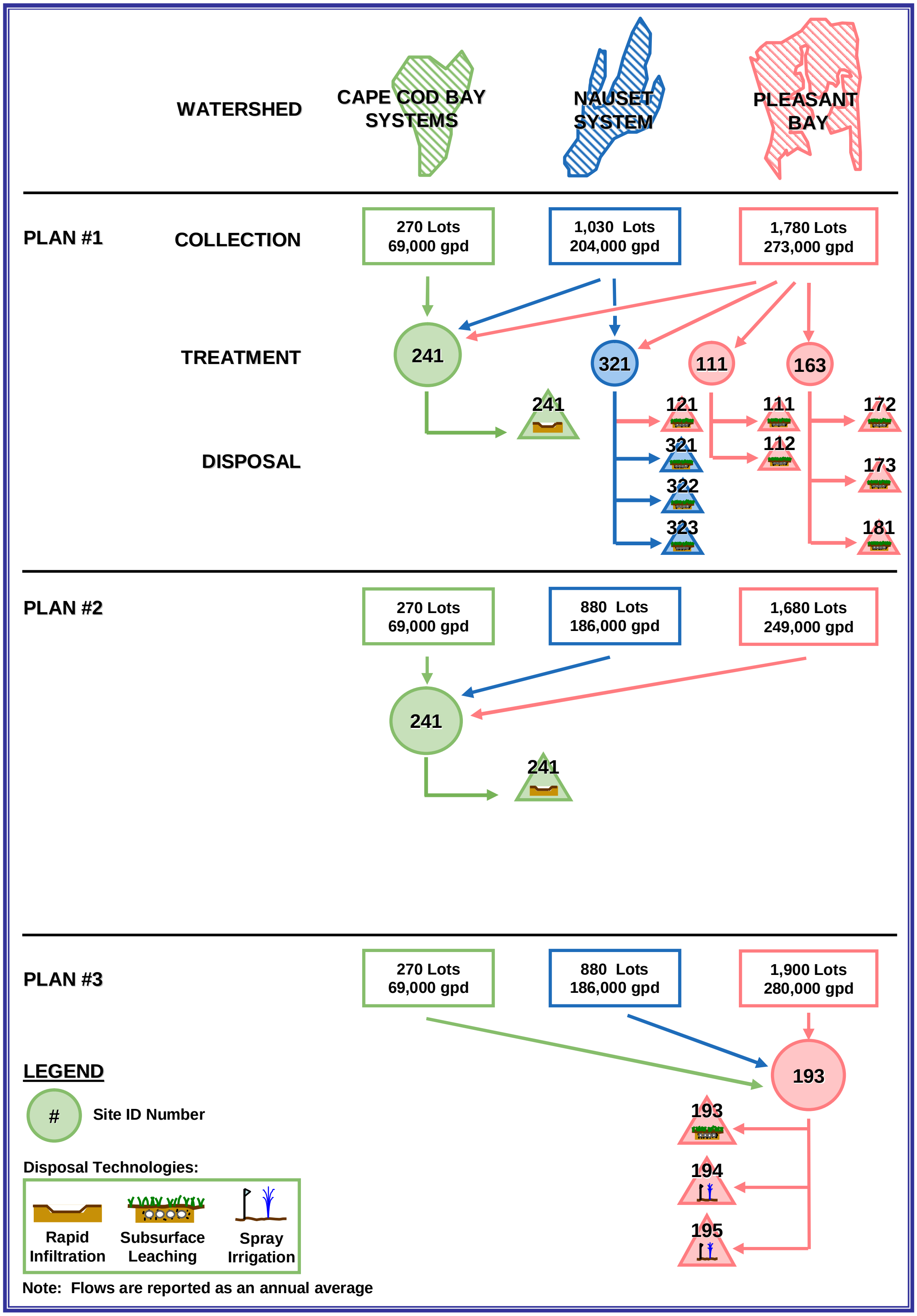
7.2 TRANSFER OF WATER AMONG WATERSHEDS

Over 95 percent of the homes and businesses in Orleans are served by the municipal water system, which withdraws water from the Pleasant Bay watershed and distributes it all across town. Wastewater that is produced in Orleans today receives rudimentary treatment (through on-site septic systems) and is recharged in the watershed where the wastewater is produced. Each of the public wastewater plans under consideration would eliminate a portion of the existing septic systems and convey the collected wastewater to one or more sites for treatment. Effluent would then be recharged at the treatment plant site or at nearby sites. Given this change from fully-dispersed discharges to more concentrated discharges, it is important to consider the overall disposition of wastewater by major watershed.

Figure 7-1 is a schematic representation of the three wastewater plans, constructed to illustrate the watershed location of each component. Facilities in the Cape Cod Bay watersheds are shown in green; those in the Nauset watershed are depicted in blue, and red is used to portray facilities in the Pleasant Bay watershed. The geographic diversity of the three plans is apparent from Figure 7-1. Treatment and disposal in the Cape Cod Bay watersheds would occur in Plans 1 and 2. Facilities are located in the Nauset watershed only in Plan 1. Plans 1 and 3 include facilities in the Pleasant Bay watershed. None of the plans includes facilities in the watershed directly tributary to the Atlantic Ocean.

Table 7-1 illustrates the disposition of wastewater by major watershed for all three plans. The first block of data in Table 7-1 presents estimates of the annual average recharge from wastewater disposal in the year 2030, assuming a continuation of current practices (the "No Action Plan"), that is, without public wastewater infrastructure. The term "wastewater recharge" is used to describe the liquid entering the groundwater from either septic systems that remain in

FIGURE 7-1
SCHEMATIC REPRESENTATION OF WASTEWATER MANAGEMENT PLANS



service, existing private wastewater plants, new public wastewater facilities, or the Tri-Town Septage Treatment Facility. In the No Action Plan, the vast majority of the recharge would be from private septic systems, about 930,000 gpd. Table 7-1 includes the projected discharge from the Tri-Town facility, treating septage from just the three District towns. Discharges from two private wastewater plants (Community of Jesus and Skaket Corner) are also included. In the absence of public sewers, the three major watersheds each receive nearly equal percentages of the total wastewater recharge: from 27% in the Cape Cod Bay watersheds to 39% in the Pleasant Bay watershed.

TABLE 7-1
DISPOSITION OF EFFLUENT

	Major Watershed				
Wastewater Recharge at Planning Horizon (gpd, annual average)	**Cape Cod Bay**	**Nauset System**	**Atlantic Ocean**	**Pleasant Bay**	**Total**
No Action Plan					
Total Wastewater Recharge	266,000	299,000	28,000	376,000	969,000
Distribution by Watershed, %	*27%*	*31%*	*3%*	*39%*	*100%*
Plan 1					
Total Wastewater Recharge	488,000	220,000	28,000	233,000	969,000
Distribution by Watershed, %	*50%*	*23%*	*3%*	*24%*	*100%*
Change from No Action	222,000	-79,000	0	-143,000	0
Plan 2					
Total Wastewater Recharge	701,000	113,000	28,000	127,000	969,000
Distribution by Watershed, %	*72%*	*12%*	*3%*	*13%*	*100%*
Change from No Action	435,000	-186,000	0	-249,000	0
Plan 3					
Total Wastewater Recharge	197,000	113,000	28,000	631,000	969,000
Distribution by Watershed, %	*20%*	*12%*	*3%*	*65%*	*100%*
Change from No Action	-69,000	-186,000	0	255,000	0
Non-Wastewater Recharge					
Annual Average, mgd	7.40	4.46	0.52	31.0	43.4
Change in Wastewater Recharge as % of Non-Wastewater Recharge					
Plan 1	3.0%	-1.8%	0.0%	-0.5%	
Plan 2	5.9%	-4.2%	0.0%	-0.8%	
Plan 3	-0.9%	-4.2%	0.0%	0.8%	

Plan 1

Table 7-1 shows how that distribution of wastewater recharge would change if the decentralized plan were implemented. There would be a net reduction of 79,000 gpd in the Nauset watershed and 143,000 gpd in the Pleasant Bay watershed. (Greater quantities of wastewater would be collected from these watersheds, and some would be disposed of there; these figures represent the net effect.) The Cape Cod Bay watershed would see an increase in wastewater recharge of 222,000 gpd, the net of wastewater collected there and the discharge at the Tri-Town site. This plan would shift the percentage distribution of wastewater recharge to about 50% in the Cape Cod Bay watersheds and 47% in Nauset and Pleasant Bay combined.

Plan 2

For the centralized plan involving a single facility at the Tri-Town site, wastewater recharge would be reduced by 186,000 gpd in the Nauset watershed and by 249,000 gpd in the Pleasant Bay watershed. The additional recharge of 435,000 gpd in the Cape Cod Bay watershed would result in 72% of the total wastewater recharge occurring in that watershed, an increase of 160% over the No Action option.

Plan 3

With a centralized facility in South Orleans, wastewater recharge would be decreased by 69,000 gpd in the Cape Cod Bay watersheds and by 186,000 gpd in the Nauset watershed, with a 255,000 gpd increase in Pleasant Bay. This is an increase of 68% over the No Action wastewater recharge in Pleasant Bay. In this plan, the Pleasant Bay watershed would receive 65% of the Town-wide wastewater recharge.

Comparison With Natural Recharge

All of the figures discussed above are related to wastewater recharge, from either septic systems that remain in service, existing private wastewater plants, new public wastewater facilities, or the Tri-Town septage facility. It is important to put those recharge quantities in perspective by also considering the recharge that occurs from precipitation on vegetated or paved surfaces. The data shown at the bottom of Table 7-1 under the heading of "Non-Wastewater Recharge" address this issue, by presenting the precipitation-related recharge for each watershed based on the land surface area (excluding ponds) and 30 inches of recharge per year. While the annual average wastewater recharge is projected to be 969,000 gpd in 2030, the precipitation recharge will be over 40 million gallons per day (mgd), also expressed as an annual average. Therefore, wastewater recharge would represent about 2% of the average precipitation recharge town-wide. Precipitation recharge will vary significantly year-to-year, and the typical annual variation in precipitation recharge is larger than the projected wastewater recharge.

Table 7-1 shows the distribution of the precipitation recharge by major watershed. It also compares the change in wastewater recharge for each plan with the precipitation recharge. The increased wastewater recharge in the Cape Cod Bay watersheds represents about 3% of the average precipitation recharge in Plan 1 and 6% in Plan 2. In Plan 3, the increase in wastewater recharge in the Pleasant Bay watershed would be about 1% of the precipitation recharge. The Nauset system would see a reduction in wastewater recharge in all plans that represents 2% to 4% of the average precipitation recharge there.

The land-based disposal of effluent from one or more wastewater treatment plants will increase groundwater levels in the vicinity of the disposal sites and increase the freshwater discharge at the downgradient end of the watershed such as the shore of the embayment or salt marsh. These impacts would be evaluated in detail as part of the groundwater discharge permitting required by DEP. Given the relatively small increases compared to natural recharge, especially compared with normal variability in precipitation, these impacts are expected to be very small.

The removal of septic system recharge from areas to be sewered will lower groundwater levels in those areas. As shown in Table 7-1, the decreases in recharge volumes are all less than about 4%, and are not significant given the annual variation in precipitation. It is also important to realize that water tables in most areas in Orleans are slightly higher than they were prior to the advent of the public water supply system, which removes water from the Pleasant Bay watershed and distributes all across town.

While there are subtle differences among the plans, none would cause any significant problems in terms of the overall water balance in any watershed. Localized impacts from effluent disposal would be assessed by site-specific groundwater modeling.

7.3 TRANSFER OF NITROGEN AMONG WATERSHEDS

The principal purposes of the public wastewater management systems considered here are to:

- collect the nitrogen that is impacting coastal waters,
- bring it to a wastewater treatment facility that can convert most of the nitrogen to harmless nitrogen gas; and
- recharge the effluent, and the residual nitrogen it contains, in locations that respect the nitrogen control needs of the various watersheds.

Table 7-2 presents data on the annual wastewater nitrogen loads (expressed in pounds of nitrogen per year) that are projected to occur at the end of the planning horizon under each of the wastewater plans. Like Table 7-1, Table 7-2 first presents data on the No Action Plan which includes septic systems loads, the effluent nitrogen load from the Tri-Town Septage Treatment Facility, and the effluent loads from the two private wastewater facilities in Orleans that are greater than 10,000 gpd in capacity. The remainder of Table 7-2 shows how the nitrogen loads would be reduced in each of the plans.

Table 7-2 shows that the projected town-wide nitrogen load from wastewater sources is about 100,000 pounds per year. In the absence of public sewers, the three major watersheds would each receive nearly equal percentages of the total nitrogen load: from 26% in the Cape Cod Bay watersheds to 40% in the Pleasant Bay watershed.

Table 7-2 also shows how the three wastewater plans would reduce the town-wide nitrogen load from wastewater sources to a range of 50,000 pounds per year (Plan 3) to 54,000 pounds per year (Plan 2). These figures indicate a 45% reduction from current loads and a 50% reduction from what the loads would become at the end of the planning horizon. The percentage reductions from current nitrogen loads all match the nitrogen removal needs established in MEP technical reports or projected needs estimated by MEP staff.

TABLE 7-2
DISPOSITION OF WASTEWATER NITROGEN

	Major Watershed				
Nitrogen Loads at Planning Horizon (lb/yr)	**Cape Cod Bay**	**Nauset System**	**Atlantic Ocean**	**Pleasant Bay**	**Total**
No Action Plan					
Total Nitrogen Load	26,640	31,860	2,980	40,060	101,540
Distribution by Watershed, %	*26*	*31*	*3*	*40*	
Plan 1					
Total Nitrogen Load	23,890	13,170	2,980	14,140	54,180
Distribution by Watershed, %	*44*	*24*	*6*	*26*	
Reduction from No Action Plan, %	-10	-59	0	-66	-47
Plan 2					
Total Nitrogen Load	25,110	12,040	2,980	13,530	53,660
Distribution by Watershed, %	*47*	*22*	*6*	*25*	
Reduction from No Action Plan, %	-6	-62	0	-66	-47
Plan 3					
Total Nitrogen Load	19,390	12,040	2,980	15,110	49,520
Distribution by Watershed, %	*39*	*22*	*6*	*28*	
Reduction from No Action Plan, %	-27	-62	0	-62	-51

With regard to nitrogen control, all three plans are equivalent. Indeed, they were formulated with that equality in mind. While Plan 2 removes the least amount of septic system nitrogen, that is not a flaw of this plan. The benefit of Plan 2 is the reduced need for nitrogen reduction due to the favorable location of the effluent nitrogen recharge.

7.4 EXTENT OF SEWER SYSTEM

As discussed in Section 4.4, the extent of the wastewater collection system in each plan is determined by the location of recharge of the residual nitrogen remaining after treatment. The extent of the sewers varies with the plan:

Plan 1	3,100 properties served	420,000 feet of collection pipe
Plan 2	2,800 properties served	390,000 feet of collection pipe
Plan 3	3,000 properties served	420,000 feet of collection pipe

The residual nitrogen in Plan 2 would be discharged in the watersheds of coastal systems that are not nitrogen limited and the added nitrogen does not cause the nitrogen thresholds to be exceeded. By contrast, the residual nitrogen discharged in Plans 1 and 3 would eventually reach nitrogen-sensitive embayments, requiring the elimination of more septic systems in those watersheds.

The less extensive sewer system associated with Plan 2 is a distinct advantage. Not only are the collection costs reduced compared with the other plans, but a smaller volume of collected wastewater translates to reduced treatment and disposal costs.

7.5 NEED FOR LAND PURCHASES AND EASEMENTS

Plan 1 requires the acquisition of numerous privately-owned parcels to accommodate the wastewater treatment facilities and associated effluent disposal systems. Plan 2 could be constructed entirely on the site of the Tri-Town Septage Treatment Facility, where the land is owned by the Town of Orleans. Plan 3 would require the Town of Orleans to acquire land or easements from property owners in Brewster, including the Town of Brewster. The extent of land purchase or easements is estimated as follows:

Plan 1	11 parcels	2007 assessed value: $13 million
Plan 2	none	none
Plan 3	3 parcels	value: not determined

Given the availability of Town-owned land at the Tri-Town site, Plan 2 has the distinct advantage of not requiring land purchases. This benefit is reflected in capital costs as well as in ease in implementation. Land for pump stations is not included above.

7.6 CAPITAL COSTS

The Town of Orleans will be faced with costs in two categories, regardless of the plan that is implemented. The first category, presented here, is "capital cost", the cost to design and build the needed facilities. The second category is "operation and maintenance (O&M) costs" which include the ongoing annual expenses to run the facilities.

Basis For Estimates

Key technical data were compiled for all three plans, based on conceptual designs. Next, typical "unit costs" were applied (dollars per foot of pipe, or dollars per pump station, for example) using recent experience from publicly-bid wastewater projects across New England. More generalized costs were also derived from a cost model that predicts treatment and disposal costs for a range of facility sizes. Once basic construction costs were estimated, allowances were added for contingencies, engineering and legal expenses, site investigation costs, and land costs. Then construction cost indices were used to adjust these estimates to current dollars, and then to project the costs into the future to the expected earliest bid date of January 2012. It was assumed that all the facilities would be built at one time. While that is not likely, it does provide the simplest basis for comparison and creates a platform for later phasing analyses. For each plan, costs were estimated in the standard categories of wastewater collection, transport-to-treatment, wastewater treatment, transport-to-disposal, effluent disposal and sludge/septage handling.

Estimates for Each Plan

Table 7-3 presents a summary of the cost estimates. Capital costs, expressed in mid 2008 dollars, are estimated to be:

Plan 1: $204 million
Plan 2: $145 million
Plan 3: $170 million

Plan 2 has the least cost by a significant margin. Plan 3 is about 17% more expensive and Plan 1 is about 40% higher.

For the centralized plans (Plans 2 and 3), collection and transport costs represent about two-thirds of the total, treatment about 20%, and land about 5%. For the decentralized plan (Plan 1), the costs for land and for effluent transport and disposal are more significant.

TABLE 7-3
SUMMARY OF CAPITAL COST ESTIMATES

	Capital Costs in Millions of Dollars		
Cost Category	**Plan 1 Decentralized (4 Plants)**	**Plan 2 Centralized (Tri-Town)**	**Plan 3 Centralized (So. Orleans)**
Collection	67.9	60.3	65.2
Transport to Treatment	45.6	42.1	46.2
Treatment	41.3	27.1	31.6
Transport to Disposal	10.8	0.4	2.1
Disposal	15.4	7.4	12.6
Septage/Sludge Handling	3.6	3.1	3.6
Land	19.3	4.8	8.4
Total--Jul 2008 dollars	**204**	**145**	**170**

Comparison of Costs--Plan 1 Versus Plan 2

It is instructive to consider the specific reasons why Plan 2 is expected to be the least expensive. The cost premiums for Plan 1 over Plan 2 are as follows:

Collection	+ $ 7.6 million
Transport to treatment	+ $ 3.5 million
Treatment	+ $14.2 million
Transport to disposal	+ $10.4 million
Disposal	+ $ 8.0 million
Septage/sludge handling	+ $ 0.5 million
Land	+ $14.5 million
Total	+ $58.7 million (+40%)

Collection costs are about 11% higher with Plan 1, which collects about 8% more wastewater. Despite the dispersed location of the facilities in the decentralized plan, there are higher transport costs to reach the plants due to the need to balance the flows by watershed. Similarly, the few disposal sites are all quite remote from the treatment plant locations, and there is little opportunity to dispose of effluent at the treatment plant sites. The much higher treatment costs reflect two factors: the cost per gallon treated is nearly twice as high as in Plans 2 and 3 due to "diseconomies of scale", and there is a slightly higher volume of wastewater to be treated. Disposal costs are similarly influenced by "diseconomies of scale". Next to treatment costs, the largest cost premium is for land; the sites that are available for Plan 1 are all prime real estate, while the Town already owns the land at the Tri-Town site.

Comparison of Costs--Plan 3 Versus Plan 2

It is also interesting to compare Plan 3 costs against those of Plan 2. The cost premiums for Plan 3 over Plan 2 are as follows:

Collection	+ $ 4.9 million
Transport to treatment	+ $ 4.1 million
Treatment	+ $ 4.5 million
Transport to disposal	+ $ 1.7 million
Disposal	+ $ 5.2 million
Septage/sludge handling	+ $ 0.5 million
Land	+ $ 3.6 million
Total	+$24.5 million (+17%)

The largest cost premium is associated with wastewater collection; costs are about 9% higher than Plan 2, which collects less wastewater. Transport costs are somewhat higher due to the long distance to South Orleans. The higher treatment costs reflect two factors: there is a slightly higher volume of wastewater (about 6%) to be treated, and this plan must meet the higher treatment requirements necessary to spray irrigate the effluent. There is a significant premium for disposal, because of the requirement to have traditional disposal back-up for any reuse plan. Further, it was assumed that subsurface disposal would be used for the back-up system, compared with the less expensive rapid infiltration system at the Tri-Town site. The cost premium for land is based on our assumptions on how much Brewster would charge for land it now owns and the cost of easements to use the two golf courses for irrigation.

Section 8 of the report presents cost estimates for adding a reuse component to Plans 1 and 2, in order to provide a more balanced comparison among the options. The capital cost for reuse facilities for either Plan 1 or Plan 2 would be approximately $7 million. If the capital cost were added to Plan 2, then Plan 3 would be only about $18 million more expensive than Plan 2, a 10% difference. Inclusion of reuse costs would not change the relative difference between Plans 1 and 2.

7.7 OPERATION AND MAINTENANCE COSTS

Estimates were prepared for the ongoing costs to operate, maintain and replace the wastewater facilities that would be built in each plan. These costs were estimated for the following types of expenses:

- Labor, including fringe benefits
- Electrical energy for powering pumps and treatment equipment
- Fuel for building heating and vehicular use
- Chemicals
- Disposal of dewatered sludge
- Laboratory testing and other permit compliance costs
- Administrative costs such as insurance
- Equipment maintenance and replacement

Based on current unit costs, the three plans are projected to have operation and maintenance requirements as follows:

Plan 1	$1.60 million per year
Plan 2	$1.35 million per year
Plan 3	$1.49 million per year

Plans 1 and 3 treat higher volumes of wastewater than Plan 2, a factor that adds to the operation and maintenance costs in many ways. Plan 1 has higher labor costs due to the need to staff multiple facilities and a higher laboratory cost for monitoring multiple facilities. There is also a cost premium for Plan 3 because it includes more treatment equipment to meet the Reclaimed Water Guidelines that apply to spray irrigation of effluent, and associated laboratory and administrative expenses.

The inclusion of a water reuse component in Plans 1 and 2 would add about $120,000 to their annual O&M costs.

7.8 NET PRESENT WORTH COSTS

A "present worth analysis" is a standard economic tool that allows the calculation of a single "cost" to represent the combination of capital costs and annual expenses for operation and maintenance. In essence, the "present worth" represents the amount of money that one would invest to be able to pay the capital costs at the beginning of the project and allow periodic withdrawals to pay the annual O&M expenses over a certain period at a given interest rate. For the purposes of this study, the present worth has been computed assuming a 4% interest rate and a 20-year planning period. The results are:

	Plan 1	Plan 2	Plan 3
Capital cost	$204 million	$145 million	$170 million
Present worth of O&M costs	$24 million	$20 million	$22 million
Total present worth	$228 million	$165 million	$193 million

Since Plan 2 has the lowest capital cost and the least O&M expense, it naturally follows that it has the lowest present worth. The inclusion of a water reuse component in Plans 1 and 2 would not change the ranking of the three plans with respect to net present worth.

7.9 IMPACTS OF USER CHARGES AND TAX RATE

Capital costs for municipal wastewater systems are traditionally recovered through increases in property taxes and the assessment of betterment charges against parcels served by the system. User fees are employed to cover O&M costs, and are typically charged in proportion to a property owner's use of the system, based on a wastewater flow rate as estimated from water billing.

The Town of Orleans has not yet reached any final decision about methods for recovering capital cost or sharing O&M expenses. Regardless of the system selected, however, it is likely that tax increases, betterment assessments and user fees will fall in the following order:

Plan 1: most
Plan 2: least
Plan 3: middle

The Town should establish a policy on how much of the capital costs of any of the plans would be recovered by property taxes and how much would be recovered by betterments. Setting that policy would allow projections to be made of the necessary tax increases and allow sample betterment charges to be estimated.

7.10 ENVIRONMENTAL IMPACTS

The three plans would have a range of environmental impacts related to both construction and long-term operation. There are no significant differences in the environmental impacts of the three plans. Section 8 of this report separately addresses these impacts.

7.11 ENERGY CONSUMPTION

In addition to the energy consumed in constructing the wastewater facilities, energy would be used in the day-to-day operations as follows:

- Electricity to run pumps in the collection and transport systems;
- Electricity to run equipment at the wastewater treatment plant;

- Fuel to heat the occupied buildings; and
- Fuel consumed by vehicles, including liquid sludge hauling.

In the final design of the recommended plan, every effort would be made to select energy-efficient processes and equipment, regardless of which plan is chosen. In this planning stage of the project, it is possible to predict which plans will have the least and the most energy consumption based on the conceptual elements of each plan. Table 7-4 summarizes that analysis, in the standard categories of wastewater facilities.

TABLE 7-4
EVALUATION OF ENERGY USAGE

Function	Plan 1 Decentralized (4 Plants)	Plan 2 Centralized (Tri-Town)	Plan 3 Centralized (So. Orleans)
Wastewater Collection	Slightly More	Least	Slightly More
Transport to Treatment	Slightly More	Least	Slightly More
Wastewater Treatment	Somewhat More	Least	Significantly More
Transport to Disposal	Significantly More	Least	Slightly More
Effluent Disposal	Same	Same	Same
Sludge Hauling	Somewhat More	Least	Significantly More

Wastewater Collection

The sewer systems for the three plans collect different volumes of wastewater, based on the nitrogen sensitivity of the coastal waters that ultimately receive the effluent nitrogen. Plan 1 collects about 8 percent more wastewater than Plan 2, and Plan 3 collects about 6 percent more than Plan 2. Since Plan 2 moves the lowest volume, it will have the least energy consumption for pumping within the collection system. Plans 1 and 3 would use slightly more energy in pumping.

Transport to Treatment

Additional pumping is required to move the collected wastewater to the treatment plant site. The energy consumption is a function of the volume conveyed and the elevation of the treatment plant site. Considering both factors, Plan 2 would have the least energy consumption, and Plans 1 and 3 would each have slightly more.

Wastewater Treatment

The amount of energy used in wastewater treatment is a function of the level of treatment provided and the volume treated. All plans would involve a high level of treatment, but meeting the Reclaimed Water Guidelines in Plan 3 would entail an energy premium. Plan 1 would use slightly more energy than Plan 2 because of the multiple treatment facilities involved.

Transport to Disposal

Plan 2 would use little or no energy for transport of effluent, since the disposal area is at the same site as the treatment plant. Plan 1 involves considerable distances from the decentralized treatment plants to their multiple disposal areas. Plan 3 would use less energy than Plan 1, but more than Plan 2.

Disposal

The only energy required in effluent disposal would be for golf course irrigation in Plan 3. Since the golf courses are now irrigated anyway, there would be no net increase. Therefore, the three plans are essentially equal.

Sludge Hauling

Energy is required to run trucks used in transport of sludge, the solid material removed during the treatment of septage and wastewater. Two types of trucking are involved; tanker trucks would haul liquid sludge from remote treatment facilities to Tri-Town for dewatering, and dump trucks that would take dewatered sludge out of town for ultimate disposal.

Data on the quantities of liquid sludge that would be transported for each plan are presented in detail later in Section 7.13 of the report. Plan 1 would entail 220 truck trips per year, compared with 460 trips for Plan 3 and none for Plan 2. Plan 3 would also have the longest hauling distance. The number of trucks leaving Orleans with dewatered sludge would be about the same for all three plans. Plan 2 is clearly the least energy intensive in this category, and Plan 3 is the most energy intensive.

Overall

For all six functions, Plan 2 would have the same or less energy consumption than the other two plans. Therefore the wastewater plan involving the centralized facility at the Tri-Town property would be the most energy efficient overall. Plan 1 would consume about the same amount of energy as Plan 3.

7.12 SUITABILITY OF TREATMENT FACILITY SITES

Among the three wastewater management options, there are five prospective sites for wastewater treatment plants, each with its own strengths and weaknesses as the location for such a facility. Table 7-5 summarizes important features of each of the sites. An ideal site would have the following characteristics:

- Publicly-owned, in an industrial setting, far from public water supply recharge areas;
- 20 acres or more in size to allow sufficient on-site wooded buffer zones;
- No homes or business within 500 feet and very few within 1000 feet;
- Ready access to state and major local roads; and
- Adequate depth to groundwater and no wetlands issues on site.

Given these criteria, two of the candidate sites stand out as most favorable: Sites 241 and 193. They are publicly-owned, of sufficient size to allow adequate buffer zones, and have limited nearby development. Site 241 is particularly attractive because of its close proximity to Route 6 and its great distance from water supply Zone IIs.

The remaining three sites (Site 111, Site 321 and Site 163) are less desirable because they are either quite small, located in residential areas with many nearby homes, require travel on minor local roads, or are located close to water supply Zone IIs.

Considering only the sites for wastewater treatment, this analysis shows the advantages of Plan 2, (which involves Site 241) and Plan 3 (Site 193). A significant disadvantage of Plan 1, the decentralized plan, is the less-than-optimum nature of the associated treatment facility sites.

TABLE 7-5
COMPARISON OF WASTEWATER TREATMENT SITES

	Plan 1			**Plans 1 & 2**	**Plan 3**
	Site 111	**Site 321**	**Site 163**	**Site 241**	**Site 193**
Watershed Location	Pleasant Bay	Nauset	Pleasant Bay	Namskaket	Pleasant Bay
Total Lot Area, acres	1.5	24	4.5	26	30
Portion of Lot Required	All	< 50%	About 50%	About 50%	< 50%
Current Ownership	Private	Private	Private	Town of Orleans	Town of Brewster
Number of Nearby Homes					
Or Businesses					
Within 100 feet	0	0	0	0	0
Within 250 feet	4	0	2	0	0
Within 500 feet	19	1	7	4	0
Within 750 feet	50	4	16	6	1
Zoning District	Rural Business	Residential	Residential	Gen. Business	Industrial
				Historic	
Close to Water Supply Zone IIs?	No	No	Yes	No	Yes
Availability of 3-phase Power	Yes ?	No ?	Yes ?	Yes	Yes ?
Depth to Groundwater, ft	30	85	65	30	> 50
Access Roadways	On Barley	2,300 feet	On Rt 28	2,300 feet	On Freemans
	Neck Rd.	off Beach Rd.		off Rt 6A	Way
Distance from Route 6, ft					
State road	1,200	1,200	9,200	1,000	7,700
Major local road	10,100	10,100	3,700		3,500
Minor local road	300	4,100		2,300	6,000
Private road		1,000			2,000
Total	11,600	16,400	12,900	3,300	19,200
On-Site Wetlands?	No	Yes	No	Yes	No

7.13 TRUCK TRAFFIC AT TRI-TOWN SITE

One important aspect of wastewater management is the proper handling of the sludges that are produced as a byproduct of treatment. Each of the three wastewater plans under consideration would rely on sludge dewatering facilities at the Tri-Town site, followed by out-of town disposal of the dewatered sludge. In Plan 1 (decentralized) and Plan 3 (centralized, South Orleans), liquid sludge would be trucked to the Tri-Town site from treatment facilities elsewhere in town. In Plan 2 (centralized, Tri-Town), the new wastewater facilities would include dewatering equipment for both septage and the liquid sludge produced there, so no liquid sludge transport would occur.

In each of the three wastewater plans, a large number of septic systems will be eliminated in Orleans, resulting in a reduction of septage requiring disposal. The plans would collect 48% to 51% of the total wastewater currently produced in Orleans, and 53% to 58% at the planning horizon. Comparable percentages would apply to the quantities of septage that would be eliminated by public sewering. It has been projected that the Tri-Town facility would receive about 14% less septage (1.7 to 1.8 million gallons per year) than in the No Action Plan at the planning horizon.

On one hand, the Tri-Town site would see fewer deliveries of septage. On the other hand, Plans 1 and 3 would involve deliveries of liquid sludge from other sites. The net effect is as follows at the end of the planning period:

	Plan 1	Plan 2	Plan 3
Liquid sludge deliveries per year	220	none	460
Change in septage deliveries per year	-850	-780	-830
Net	-630	-780	-370

In all plans, the reduction in septage deliveries more than offsets the increased truck traffic related to liquid sludge handling. Plan 2 has the greatest reduction in truck traffic because there would be no liquid sludge deliveries.

7.14 EXPANDABILITY

This evaluation of wastewater management options is based on both current wastewater flows and those expected at the end of a 20-year planning period (2030). While this is a prudent basis for planning, it is important to also consider scenarios where it might be necessary to collect greater quantities of wastewater or provide more capacity for treatment and disposal. Those scenarios include:

- Land use changes or market forces may generate more rapid development toward build-out than is now expected;
- Greater nitrogen removal could be required for estuary protection than is now expected, due to possible "under-prediction" in the embayment modeling, natural changes in flushing rates (for example, movement in the North Beach "breach"), or yet incomplete MEP studies that later show current nitrogen removal "placeholders" to be too low.
- Wastewater treatment capacity might be provided to neighboring towns to take advantage of the economies of scale that occur in regional systems.
- Political, environmental or economic factors might cause the Town to elect to extend the sewer system beyond that assumed in this evaluation, including town-wide sewering.

If more capacity for wastewater collection, treatment and disposal is needed, which of the three plans under consideration is most easily expanded?

In Plan 1, three of the four decentralized facilities are not easily expanded due to limited treatment plant site area or limited nearby effluent disposal capacity. The wastewater facilities that would be built at the Tri-Town site in Plan 1 would not use all of the space available there, and space would remain that would allow as much as 75% increase in overall wastewater flows.

Plan 2 relies solely on the Tri-Town site for both treatment and disposal. An early estimate of the site's capacity for effluent disposal indicates the potential for that site to accept a 40% increase over the wastewater flows expected at the planning horizon.

(For both Plan 1 and Plan 2, the capacity of the Tri-Town site for effluent disposal has not been definitively determined, and these estimates of potential expansion should be treated with some caution.)

There is insufficient information available on the capacity of the treatment and disposal sites included in Plan 3 to be able to predict potential expansion capacity. Nonetheless, there appears to be more capability for expansion than in Plan 2.

Based on the above discussion, the three plans can be rated as follows with respect to their ability to be expanded for possible future flow increases:

Plan 1	significant expansion possible
Plan 2	some expansion possible
Plan 3	some potential for expansion, but not yet quantified

The analysis discussed above is based on the apparent physical characteristics of the treatment and disposal sites included in each plan. Plan 3 has an added potential for expansion in that its implementation would require close coordination with the Town of Brewster. That joint effort could form the basis for developing a future regional facility.

A more detailed evaluation of regionalization is presented in Section 9 of this report. Later in this Section 7 is a discussion of the potential to use a portion of the Tri-Town site for a public works facility.

7.15 FLEXIBILITY FOR PHASING

In light of the magnitude of the expense and potential disruption of the construction of an extensive wastewater project in Orleans, it would be prudent to develop any of the three plans in segments over time. By implementing the project in phases, the Town can spread out the capital costs and institute "mid-course corrections" as more information is available on nitrogen control needs, as neighboring towns make progress on their wastewater management plans, and as growth rates result in increased nitrogen control needs.

Any of the three plans can be implemented in phases. However, there are some practical limitations related to the geography of the treatment and disposal sites.

Because Plan 1 involves four treatment plant sites and 10 effluent disposal locations, it is the most amenable to phased development. One of the reasons the WMSC included this decentralized plan for further consideration is its ability to be implemented in segments with focus on the "headwaters" sub-embayments of Pleasant Bay, such as Meetinghouse Pond and Areys Pond. The first phase of Plan 1 could include the decentralized facilities needed to address Meetinghouse Pond nitrogen control needs, and the second phase could include analogous facilities for the Areys Pond watershed. If those two watersheds are deemed to be most important, Plan 1 would allow the lowest cost approach to achieving those goals as soon as possible.

Plan 2 involves treatment and disposal at the Tri-Town site, located in the northwest corner of Orleans. Since any collected wastewater would require transport to that location, this plan requires the sewering of nearby areas first. If providing wastewater collection to the downtown area is a high priority, this plan could easily accommodate that goal. Conversely, providing collection services to the Meetinghouse Pond and Areys Pond watersheds would require that trunk lines be built through the northerly portions of town first, in order to access the Tri-Town site.

Similar conclusions can be drawn about Plan 3. It involves treatment and disposal at a site in the far southerly area of Orleans/Brewster. Since any collected wastewater would require transport to that location, this plan requires the sewering of nearby areas first. If providing wastewater collection service to the watershed of Pleasant Bay proper (or to the areas upgradient of the ponds in South Orleans) were a high priority, this plan could easily accommodate that goal. Conversely, providing collection services to the Meetinghouse Pond watersheds or to the downtown area would require that trunk lines be built through the southerly and central portions of town first, in order to access the Plan 3 treatment facility site.

Given these geographic realities, the three plans can be rated as follows:

Plan 1	most flexible
Plan 2	less flexible
Plan 3	less flexible

Because of the fact that more wastewater is generated in the north and central parts of Orleans, that are closer to the Tri-Town site than the South Orleans site, Plan 2 has a slight advantage over Plan 3.

7.16 POTENTIAL FOR WATER REUSE

As demand rises for potable water, the ability to reuse effluent for irrigation and other purposes will become more and more important. Under current regulations, the added treatment needed to produce reuse-quality water imposes a cost premium on this practice. That premium must be weighed against the many benefits of reuse, and that balancing of costs and benefits may change in the future. Thus it is pertinent to look at each of the three wastewater plans in terms of their ability to allow current or future effluent reuse.

Plan 3 is the most amenable to effluent reuse. This practice is a fundamental part of this plan, which was structured to include significant spray irrigation of one or two golf courses located just south of Orleans's southern border. In that the facilities to produce reuse-quality water are built into this plan, it is also readily modified to provide more reuse for other potential activities such as private lawn watering.

Water reuse is not part of either Plans 1 or 2, but could be added in the future if demand warranted. Facilities at the Tri-Town site would be most amenable to such future modifications, because more space exists at that site, and reuse opportunities in the public sector are nearby. Since Plans 1 and 2 both involve facilities at the Tri-Town site, neither of these two plans has an advantage over the other in this regard.

A more detailed evaluation of reuse opportunities and costs is presented in Section 10 of this report.

7.17 REGULATORY ACCEPTABILITY

Once the Town decides on a single wastewater plan, it must proceed to gain the approval of county, state and federal entities related to a number of issues. While the three plans involve mostly conventional technology, there are some differences that may impact regulatory acceptability.

The three plans are comparable with respect to the following concerns:

- All plans are technically feasible and include features that have been employed elsewhere in Massachusetts;
- All plans will fully comply with nitrogen-based TMDLs, as currently exist or as projected based on ongoing MEP work;
- The plans are equal with respect to compliance with Title 5, in that their collection systems serve the same number of parcels with sanitary needs; and
- None of the plans includes significant construction activities within the designated Areas of Critical Environmental Concern.

All of the plans involve groundwater discharges that are regulated under 310 CMR 5. A permit would be needed for each disposal site, so Plan 1 has the disadvantage of much more permitting work and related engineering and hydrogeologic evaluations. Plan 3 requires a groundwater discharge permit for a year-round disposal area with enough capacity to fully back up the summer spray irrigation operation. Sufficient detail on the Plan 3 site is not available to gauge the difficulty of permitting that groundwater discharge. Plan 2 involves the Tri-Town site which already has a groundwater discharge permit. A new permit would be needed, but some background information is already in hand that would make this permitting effort somewhat easier.

In addition to a groundwater discharge permit, Plan 3 must comply with the DEP Reclaimed Water Guidelines related to spray irrigation of the golf courses. In that those regulations are evolving, and experience with golf course irrigation in Massachusetts is limited, there may be somewhat more permitting effort associated with Plan 3.

Publicly-owned wastewater treatment plants must go through the DEP site assignment process, as required by Section 6 of Chapter 83 of the Massachusetts General Laws. The essence of this state requirement is to formally notify all abutters of the proposed project, conduct a public hearing to review the project design, and place a record in the Registry of Deeds to alert all future purchasers of nearby properties of the permanent wastewater-related nature of activities on the site. The Tri-Town property is already site-assigned, but all other sites would be subject to this requirement. Given the fact that Plan 1 involves eleven sites and the other plans include just one or three each, Plan 1 requires somewhat more permitting effort in this regard.

In light of all of these factors, the three plans are rated as follows:

Plan 1	more permitting effort than Plan 2
Plan 2	most readily permitted
Plan 3	more permitting effort than Plan 2

7.18 EASE IN IMPLEMENTATION

Any municipal wastewater system faces some hurdles for smooth implementation, especially with a fairly extensive sewer system, purchase of private land, and possible sharing of facilities in adjacent towns.

Plan 2 is clearly the easiest to implement because it involves a site owned by the Town of Orleans that has historically been in wastewater-related uses and is in the watershed of a coastal waterbody that is not nitrogen limited.

Plan 1 would be more difficult to implement because it involves three treatment plants in residential neighborhoods on land that would be required from private owners.

Plan 3 also involves land acquisition issues. The treatment plant site is publicly owned, but the owner is the Town of Brewster, not the Town of Orleans. One of the golf courses is owned by the Town of Brewster and one is privately owned. Plan 3 would be considered the most difficult to implement primarily because there are property acquisition issues, technical maters related to golf course irrigation and fertilization, and the need for inter-municipal coordination. In the simplest case, the Town of Brewster could be viewed as a land-owner comparable to the owners of private sites. However, Brewster should consider the benefits of a joint facility as part of Plan 3, and that requires a fair degree of wastewater planning that has not yet begun in Brewster.

For all of these reasons, the plans should be rated in the following order, with respect to ease in implementation:

Plan 1	more difficult
Plan 2	easiest
Plan 3	most difficult

All three plans involve coordination between the Town and the Tri-Town District. In Plans 1 and 3, the Tri-Town Septage Facility would be upgraded. In Plan 2 it would be demolished and its functions included in the new wastewater facility located at that site. The necessary coordination with the District adds complexity to the implementation of any of the plans. That coordination may be most difficult in Plan 2, due to the need to restructure existing inter-municipal agreements and deal with the salvage value of jointly-funded existing facilities.

7.19 POTENTIAL FOR IMPACTING TOWN GROWTH RATE

One of the most frequently-stated reasons in opposition to municipal sewerage is the fear that sewers will unleash unwanted growth. The potential for unwanted growth exists in two areas: either sewer service allows an otherwise undevelopable lot to be built upon, or existing development, which is now constrained by effluent disposal area, can then be expanded once a sewer connection is available.

The Town of Orleans is considering bylaws and regulations that would protect against both potential mechanisms for unwanted growth.

First, special legislation has been introduced to the state legislature that would allow Orleans to implement a "checkerboard" sewer system. In such a system, the Town would select in advance those lots that will be connected to the public sewer and which ones will not be allowed to connect. In essence this new bylaw would give the Town the ability to reject a request for sewer service for any property that need not be sewered.

Second, the Board of Health has drafted a nutrient control regulation that would help limit redevelopment of properties. This regulation will impose restriction on the amount of additional nitrogen load from a given property and it could be expanded to limit wastewater flow from sewered lots so there would be no increase over that allowed under Title 5.

The Planning Board is also considering zoning bylaws to prevent growth impacts associated with any of the wastewater plans.

These tools can be adapted to limit any unintended growth related to a public sewer system. They can be applied regardless of the wastewater plan that is selected. Therefore there is no real difference among the plans in this regard.

7.20 POTENTIAL FOR SITING A PUBLIC WORKS FACILITY AT THE TRI-TOWN SITE

Located at the far northern corner of the Tri-Town site is an abandoned composting building. That building is situated within a 5.5-acre parcel where the Town of Orleans has obtained permission from Brewster and Eastham to implement other uses. The Town of Orleans is beginning to plan for a new public works facility, and has considered using that portion of the

Tri-Town site where the composting building is located. One of the three wastewater plans would require that land and two would not.

With Plan 2, current site layouts and predicted soil permeability indicate that nearly all of the Tri-Town site would be needed for either wastewater treatment or effluent disposal. While it is conceivable that further soil explorations could reveal better soils than currently predicted, it is unlikely that the effluent disposal area could be reduced enough to allow another use of the full 5.5-acre parcel where the compost building is located.

With Plan 1, a portion of the collected wastewater flow would be treated and disposed of elsewhere. This would result in much more unused space at the Tri-Town site, compared with Plan 2. The design of the effluent disposal system would probably allow another use of the area around the composting building, with the caveat that confirming soil explorations are needed.

Plan 3 involves centralized treatment and disposal facilities in South Orleans and the upgrading of the Tri-Town plant for septage and sludge handling. This plan could definitely accommodate another use in the vicinity of the compost building.

In summary, the plans provide the following possibilities for use of the area near the existing composting building:

Plan 1	likely
Plan 2	not likely
Plan 3	most likely

The reuse of the compost shed itself may be easier than alternate uses of the 5.5 acres on which it sits. The shed could be used for truck storage and wash down up until the point where its smaller footprint is needed for a future phase of effluent disposal in Plans 1 or 2.

Earlier in this Section 5 is a discussion of expansion capabilities of each plan, which must be considered when evaluating other potential uses of the Tri-Town site.

7.21 OVERALL PUBLIC ACCEPTABILITY

One of the most important features of any public-works-type project is its acceptability to the general public. The public may be concerned about some or all of the factors discussed in this section of the report. The intention of this evaluation is to provide objective information to the Town staff and officials, and to the general public, so that all can become familiar with the issues that interest them, and the Town can move toward a consensus as to the best plan for Orleans.

The WMSC conducted two public meetings at which this evaluation was discussed (both on May 22, 2008), which were followed by a series of weekly workshops in July and August of 2008. The public feedback obtained during those meetings and workshops is summarized in Section 11 of this report and detailed in Appendix C.

7.22 SUMMARY OF EVALUATION

Twenty criteria have been selected for evaluation of the three wastewater options. The evaluation is summarized in Table 7-6. One criterion, public acceptability, is discussed in Section 11. Of the 19 other criteria evaluated to date, the plans are essentially equal in four cases, and Plan 2 appears to be superior with respect to 10 factors.

TABLE 7-6

SUMMARY OF EVALUATIVE CRITERIA

Evaluative Criteria	Plan 1 Decentralized (4 Plants)	Plan 2 Centralized (Tri-Town)	Plan 3 Centralized (So. Orleans)
7.2 Transfer of Water Among Watersheds	No Significant Impacts		
7.3 Transfer of Nitrogen Among Watersheds	No Significant Impacts		
7.4 Extent of Sewer System	Largest	**Smallest**	Middle
7.5 Need for Land Purchases and Easements	Greatest	**Least**	Middle
7.6 Capital Cost	Highest	**Lowest**	Middle
7.7 Operation & Maintenance Cost	Highest	**Lowest**	Middle
7.8 Net Present Worth	Highest	**Lowest**	Middle
7.9 Impact on Taxes and User Fees	Highest	**Lowest**	Middle
7.10 Environmental Impacts	No Significant Differences		
7.11 Energy Consumption	More	**Lowest**	More
7.12 Suitability of Treatment Facility Sites	Less Suitable	**Most Suitable**	**Most Suitable**
7.13 Truck Traffic at Tri-Town Site	Middle	**Least**	Most
7.14 Expandability	**Best**	Least	Middle
7.15 Flexibility for Phasing	**Most Flexible**	Less Flexible	Less Flexible
7.16 Potential for Water Reuse	Less	Less	**Best**
7.17 Regulatory Acceptability	Somewhat Less	**Highest**	Somewhat Less
7.18 Ease in Implementation	More Difficult	**Easiest**	Most Difficult
7.19 Potential for Impacting Town Growth Rate	No Significant Differences		
7.20 Potential for Public Works at Tri-Town	Likely	Not Likely	**Most Likely**
7.21 Overall Public Acceptability	Determined through public meetings and workshops between May and August 2008; see Section 11.		

The principal advantages and disadvantage of the three plans are summarized below.

Plan 1: Decentralized (4 Plants)

Advantages

- Allows least expensive early implementation of solutions for headwaters sub-embayments (Meetinghouse Pond and Areys Pond)
- Most amenable to phasing
- Reduces local impacts of larger centralized options

Disadvantages

- Has the highest cost to build and operate
- Requires acquisition of 11 sites that are now privately owned
- More sites means more potential for neighbor impacts and/or disputes
- Requires more permitting (groundwater discharge permits, site assignment, etc.)
- Some disposal of wastewater in sensitive watersheds means greater extent of sewering compared with Plan 2
- Requires liquid sludge hauling from decentralized facilities to Tri-Town

Plan 2: Centralized (Tri-Town)

Advantages

- Treatment facility site is already in wastewater-related use in an largely industrial area of Orleans
- Treatment facility site is already in Town ownership
- Site is close to downtown (largest concentration of wastewater to be collected)
- All effluent is disposed in the watershed to Namskaket Marsh, which has less nitrogen sensitivity than other embayments in Orleans. This translates to a smaller sewer system compared with Plans 1 and 3
- Has the lowest cost to build and operate
- Uses the least amount of energy of all plans
- Produces better effluent quality than Plan 1 due to size of plant
- Amenable to regionalization with Eastham and Brewster
- Most readily permitted plan

Disadvantages

- Concentrates all wastewater at one location, increasing chances of odor/noise impacts at one location
- Full use of the Tri-Town site precludes co-siting of a public works facility

Plan 3: Centralized (South Orleans)

Advantages

- Recycling of water and nutrients at golf courses is the most environmentally-acceptable disposal option
- Produces better effluent quality than Plan 1 due to size of facility, and better effluent quality than Plan 2 due to compliance with Reclaimed Water Guidelines
- Allows reduction in groundwater withdrawals and commercial fertilizer use at golf courses
- Tri-Town Septage Treatment Facility stays in operation for septage and liquid sludge, and sufficient land is available for possible public works facility
- Amenable to regionalization with Brewster, Harwich and Chatham

Disadvantages

- Treatment facility sites in So. Orleans are all small; may require site in Brewster
- Concentrates all wastewater at one location, increasing chances of odor/noise impacts at one location
- All effluent is disposed in Pleasant Bay watershed, which means larger sewer system compared with Plans 1 and 2
- More expensive than Plan 2 to build and operate
- Requires cooperation of Town of Brewster and thus may be more difficult to implement
- Requires more effluent disposal capacity that Plans 1 and 2 due to need for winter back-up for spray irrigation
- Requires highest level of wastewater treatment of all plans, and meeting reuse standards involves some new technology
- Requires liquid sludge hauling to Tri-Town

SECTION 8
EVALUATION OF ENVIRONMENTAL IMPACTS

8.1 INTRODUCTION

All three of the wastewater plans that were considered have the same fundamental goal: improving the environment in Orleans, specifically water quality in ponds and coastal waters. Compared to the No Action Plan, Plans 1, 2 and 3 are vastly superior in an environmental sense. The purpose of this section of the report is to contrast the three plans within the framework of a standard set of environmental review parameters. Impacts are considered for both initial project construction and long-term project operation.

This section of the report is presented in the format of an Environmental Impact Report which will be filed with the Massachusetts Environmental Policy Act (MEPA) unit of the Executive Office of Energy and Environmental Affairs (EOEEA).

8.2 PROJECT DESCRIPTION

Orleans wastewater management planning activities are described in detail in the previous sections of this report and in three prior reports: the draft Needs Assessment Report (February 2007), the draft Alternatives Screening Report (December 2007), and the draft Alternatives Evaluation Report (May 2008).

8.3 ALTERNATIVES TO THE PROJECT

The Town is considering three wastewater plans to address its documented needs. These plans have many common features, but are distinctly different with respect to the location of wastewater treatment and disposal facilities and the ultimate receiving waters for effluent-impacted groundwaters. Also considered for comparison purposes is the No Action Plan, which involves the continued reliance on private on-lot wastewater disposal systems.

8.4 EXISTING ENVIRONMENT

The existing environment in Orleans is described in detail in Section 2 of this report. That section describes land use and demographics, environmentally sensitive areas, soils, groundwater and water use.

8.5 ASSESSMENT OF IMPACTS

Impacts of the three wastewater plans under consideration, and the No Action Plan, fall in the general categories of "direct", "indirect" and "cumulative". The direct impacts are those that occur as a direct result of either the construction of the proposed wastewater facilities, or their ongoing operation. Indirect impacts are those land use or demographic changes that eventually occur as a result of implementation of one of the wastewater plans, or as a consequence of taking no action. Cumulative effects result from the incremental impact of the proposed project when added to other past, present or future actions, regardless of who undertakes those other actions.

This section of the report identifies direct, indirect and cumulative impacts for a wide range of environmental issues. Direct impacts are discussed as either "short-term" (generally related to project construction) or "long-term" (generally related to ongoing operation of the constructed facilities).

8.5.1 Surface Water Quality

No significant short-term impacts on surface water quality are expected with any of the three wastewater plans. There is the possibility of erosion and sedimentation problems during the construction of sewers or the facilities for treatment and disposal, but those impacts can be closely controlled by requiring appropriate construction techniques and with close contractor oversight. Since the extent of sewers is approximately the same in each plan, and the impacts are small, the three plans can be considered equivalent in this regard.

There are major long-term benefits for surface water quality associated with all of the three wastewater plans, and major detriments to the No Action Plan. The driving forces behind this project are the current and expected future overloading of coastal waters from wastewater-related nitrogen, and analogous phosphorus loading problems in selected freshwater ponds. The plans under consideration will all allow compliance with nitrogen-based TMDLs and reduce phosphorus loadings where important to pond quality.

Pleasant Bay and Cape Cod Bay are considered Outstanding Resource Waters (ORW). These two bays and their tributaries, and the Nauset system, will all benefit from reduction in nitrogen loads. The implementation of a public sewerage system, in any of the three plans, will result in reductions in wastewater nitrogen loads equaling or exceeding the following percentages, as contained in published or expected TMDLs:

Pleasant Bay	58%
Nauset system	55%
Rock Harbor	70%

In Plan 2, the residual nitrogen remaining after treatment at the Tri-Town site will increase the nitrogen loading to Namskaket Marsh and Little Namskaket Marsh, but only to 38% and 84% of their respective nitrogen thresholds.

Significant indirect long-term benefits will accrue to any of the three wastewater plans. The water quality improvements will allow improved swimming, fishing and boating activities; better environmental health with respect to eelgrass and bottom fauna; and preservation of tourism and property values.

8.5.2 Groundwater Quality

No short-term impacts on groundwater quality are expected with any of the three plans.

The elimination of septic systems that will occur in any of the three plans will result in long-term improvements in groundwater quality. It is that improvement in groundwater quality that will eventually lead to better surface water quality, as groundwater moves from inland areas to coastal discharge areas, or toward ponds from tributary areas. All of the plans serve roughly the same areas of Orleans, so they provide equal benefits with respect to enhanced protection of private drinking water wells that exist in some areas. Similarly, all plans provide for some sewering in the Zone II of public water supply well #7. The elimination of some of the wastewater nitrogen in the Zone II area is not expected to have an appreciable impact on drinking water quality, since the nitrogen loading is quite small, even with the No Action Plan. However, septic systems do allow some other contaminants to reach the groundwater, and their elimination will provide general benefits beyond the nitrogen issue.

8.5.3 Wetlands

There are no mapped wetlands at the treatment or disposal sites in Plans 2 and 3, and the wetlands that exist at one of the sites in Plan 1 can be avoided. It is likely that the routes of sewer lines or the location of pumping stations will encroach on the 100-foot buffers of regulated wetlands. That may create the potential for wetland impacts, but standard mitigation measures, under the purview of the Conservation Commission, will limit that potential to very low levels. Thus, no significant short-term wetland impacts are expected.

Over the long term, effluent-impacted groundwater will emerge in the Namskaket Marsh and Little Namskaket Marsh systems as a result of effluent disposal at the Tri-Town site in Plans 1 and 2. At the other sites associated with Plans 1 and 3, effluent-impacted groundwater will emerge in Pleasant Bay or the Nauset system and will not pass through wetlands. Studies by the Massachusetts Estuaries Project have estimated the thresholds for nitrogen-related impacts on Namskaket and Little Namskaket Marshes, and Plans 1 and 2 keep the nitrogen loading below those thresholds. Impacts unrelated to nitrogen are not expected. While the Tri-Town site is different from the other sites in Plans 1 and 3 with respect to the contact of effluent-impacted groundwater with wetlands, there is not appreciable difference among the plans with respect to long-term wetland impacts.

8.5.4 Floodplains

None of the candidate treatment facility sites or effluent disposal areas is located in floodplains. There may be the need to locate a few pumping stations in floodplains, but those structures would be small, they would be flood-proofed, and they would pose little impact on potential floods. Therefore, none of the plans is expected to have any significant short-term or long-term impacts on floodplains.

8.5.5 Coastal Resources

Coastal resources include beaches and other swimming areas, commercial and recreational shellfishing areas, and marine/estuarine habitat. Some of these areas are within the two Areas of Critical Environmental Concern (ACEC) in Orleans (the Pleasant Bay ACEC and the Cape Cod ACEC).

There will be little if any construction in the ACECs, or in areas close to these coastal resources, that result in any significant direct short-term impact. In some cases, individual homes (or small clusters of homes) will be served by near-shore grinder pump stations. These pump stations can be installed quickly with little environmental impact provided proper mitigating measures are undertaken. These grinder pumps will be used in any of the three wastewater plans; no one plan would be expected to have significantly more impact than another.

All of the three wastewater plans provide added protection for these resources, primarily through improved water quality. Conversely, the No Action Plan allows current water quality degradation to continue and worsen. In any of the three plans, when effluent-impacted groundwater eventually emerges in coastal waters, it would do so sufficiently offshore, and in sufficiently well-mixed areas, to pose no significant threat to any of these coastal resources. The emergence of effluent-impacted groundwater would occur many years after the initiation of treatment and disposal activities.

8.5.6 Open Space and Recreation

None of the wastewater plans will have any direct short-term or long-term impacts on designated open space in Orleans. There will be some clearing of land to build wastewater treatment and disposal facilities, but only on parcels now in public or private use, unrestricted with respect to open space.

It is the intention of the Town of Orleans to adopt regulations and bylaws that allow the selected wastewater plan to be "growth-neutral"; see the Community Growth and Land Use section below. Therefore, there will be no indirect impacts on open space associated with any of the three wastewater plans.

8.5.7 Rare and Endangered Species

For any of the three plans, the construction of sewers and pump stations will occur largely within the rights-of-way of public roads, so any short- or long-term impacts on plant and animal habitat would be minimal at most. No cross-country sewer routes are now expected, but if cross-country routes are later found necessary for certain stretches of the sewer system, the avoidance of important habitat would be one of the principal criteria in that selection. Additional site-specific review may be warranted during the design phase of the project.

All of the treatment plant sites have been reviewed against available mapping of habitat for rare and endangered species. According to the 13th edition of the *Massachusetts Natural Heritage Atlas (October 1, 2008)*, only the Tri-Town site appears to be located within a Priority Habitat of Rare Species and an Estimated Habitat of Rare Wildlife. Preliminary review by the Natural Heritage and Endangered Species Program (NHESP) of the Massachusetts Division of Fisheries & Wildlife has determined that the Tri-Town site is within Priority Habitat of four species protected under the Massachusetts Endangered Species Act (MESA): the Eastern Box Turtle, the Diamond-backed Terrapin, Salt Reedgrass and Mitchell's Sedge. The NHESP preliminary review found that the proposed construction on the Tri-Town site has the potential to impact only one of those species, the Eastern Box Turtle. At the request of NHESP, the Town arranged for a formal assessment of box turtle habitat. That assessment, conducted by LEC Environmental, is presented in Appendix H.

The box turtle habitat assessment considered four possible layouts of wastewater treatment and disposal facilities, and estimated the extent of disruption for each alternative. That disruption would range from 4.6 acres to 6.5 acres during construction, and 0.5 acres to 1.6 acres would be restored after construction is complete. The Town is evaluating the four alternative layouts with respect to several factors including the degree of box turtle habitat disruption. More discussion on minimizing the impacts to turtle habitat with respect to the four alternative site layouts is provided in Section 11.4.7. After receiving comments during the MEPA review, the Town will select one of the alternatives. The Town will implement appropriate mitigating measures approved by NHESP or will initiate necessary permitting requirements under MESA (e.g., obtain a Conservation and Management Permit), which may include off-site land protection.

8.5.8 Archaeological and Historic Resources

The construction of sewers and pump stations will occur largely within the rights of way of public roads, so there will be no direct short-term impacts on historic and archaeological sites and resources. Each of the candidate treatment plant sites has been reviewed against available mapping of such resources. Significant archaeological resources were discovered at the Tri-Town site prior to construction of the Septage Treatment Facility there. These resources were removed from the site prior to construction. Coordination with the Massachusetts Historical Commission (MHC) has determined that any remaining archaeological resources are unlikely to exist within the area of the proposed new facilities for wastewater treatment and disposal at the Tri-Town . No constraints on other treatment facility sites have been identified.

Areas north and west of Route 6A in Orleans are within the Old Kings Highway Regional Historic District. A portion of this District is included in the proposed sewer service area for all wastewater plans, primarily for protection of Rock Harbor. None of the structures in the District would be impacted by the project, since construction will occur primarily in public road rights-of-way. Any above-grade structure built as part of the project (treatment plant buildings at the Tri-Town site or pump stations located elsewhere in the District) would be designed with architectural features consistent with District standards.

It is the intention of the Town to review the designs of its wastewater facilities with MHC to ensure that historical and archaeological resources are appropriately identified and protected.

8.5.9 Traffic

One of the most significant direct short-term impacts of the proposed project would be traffic congestion resulting from construction activities in public roadways. The vast majority of the 75 to 80 miles of sewer lines will be installed in roadways or roadway shoulders. The Town will schedule this work for the October-to-May period when traffic is generally less intense, and will segment the work to avoid disruption of lengthy stretches of principal roads at any one time. Plan 2 involves the least amount of collection system, so it would have the least short-term impact on traffic; however the difference among the three plans is small.

There will also be long-term traffic impacts as well, but at a much lower level. These include the vehicles accessing any of the treatment plant sites for normal operation, and the deliveries of septage and liquid sludge to the Tri-Town site. Section 7.13 of this report presents data on annual truck trips for each of the plans. These activities are relatively limited in scope and will not cause major traffic congestion. However, in Plan 1, the decentralized treatment plant sites are located in residential neighborhoods, and even a small number of additional vehicular trips may be noticeable to the neighbors. All plans result in fewer septage deliveries to the Tri-Town site, and Plan 2 offers the most advantage when liquid sludge deliveries are also included.

8.5.10 Air Quality

Construction vehicles can be the source of added air emissions and represent a direct short-term impact. Dust from construction sites is another common source of air quality concern. There should be no appreciable difference among the three wastewater plans, because each involves the same general level of construction activity.

Direct long-term impacts include potential odor releases at treatment plants and pump stations and air emissions from vehicles accessing any of the treatment plant sites for normal operation. None of these sources of air emissions is considered significant, since all can be subject to routine emissions control.

8.5.11 Noise

Much like air quality, noise impacts can occur both during construction and as a result of routine operation.

As a direct short-term impact, construction noise is unavoidable. Noise controls on construction equipment are available and are required, but are rarely capable of allowing noise-free construction. None of the three wastewater plans has any particular advantage in this regard.

Pumps, blowers, standby generators, ventilation systems and other equipment emit noise at treatment plants and pump stations. All can be fitted with noise control devices that are largely successful in avoiding nuisance noise conditions. The use of earthen berms and vegetated buffers can help limit off-site noise impacts. This may be most difficult to accomplish in Plan 1 which includes some small treatment plant sites in residential neighborhoods.

8.5.12 Energy

Energy use during construction is an unavoidable occurrence. Section 7.11 of this report evaluates each of the three wastewater plans with respect to their energy consumption during normal operations, and demonstrates that Plan 2 would use the least amount of energy on an annual basis.

8.5.13 Generation of Solid Waste

Any of the three wastewater plants would generate solid waste in the form of grit, screenings, and dewatered sludge. Since the quantities of wastewater treated are all within 10% of one another, so too would the quantities of these solid wastes. Solid waste generation is not a significant issue for this project, and the three plans are essentially the same in that regard.

8.5.14 Public Health

Section 3 of this report, the needs assessment, identifies those few properties in Orleans that might benefit from public sewers in a sanitary sense. Those properties are few enough in number, and the issues are benign enough, that public health is not a significant issue even in the No Action Plan.

8.5.15 Community Growth and Land Use

In many communities, the construction of public sewers allows unintended growth that can represent a significant indirect impact of the project. As detailed in Section 7.19 of this report, Orleans is undertaking steps to mitigate this impact or eliminate it altogether. The Town intends that this wastewater project will be "growth neutral"; that is, it will neither restrict growth nor will it promote more growth than allowed under current zoning bylaws. Two tools are being developed. One will give the Town the ability to deny sewer connections to property owners that need not tie into the system to allow TMDL compliance. The second tool is a nutrient control regulation that could be adapted to restrict redevelopment to the level of wastewater flow that exists today. Given this approach by the Town, no significant indirect impacts are expected related to community growth or development of land beyond what would occur in the No Action Plan.

8.6 REGULATORY STANDARDS AND REQUIREMENTS

There are a number of regulatory programs and permitting requirements that apply to all three of the wastewater plans under consideration. These include:

- DEP approval of the CWMP.
- DEP Groundwater Discharge Permitting under 314 CMR 5.0. A groundwater discharge permit is required for each treatment facility and its associated effluent disposal sites.
- Compliance with the federal Clean Water Act through nitrogen-based TMDLs as implement by DEP.
- The DEP Reclaimed Water Permit Program (314 CMR 20.0) applies to the proposed golf course irrigation in Plan 3 and any supplement effluent reuse that might be incorporated into Plans 1 or 2.
- DEP Plan Review is required for any of the treatment plants, once final plans and specifications have been prepared.
- DEP Site Assignment under MGL Chapter 83 Section 6 is required for any publicly-owned wastewater site.
- DEP Sewer Extension Permits will be needed for system expansion after completion of the first phase.
- Compliance with the Massachusetts Wetlands Protection Act and local supplemental bylaws is necessary for all proposed work activities located within protectable Wetland Resource Areas and/or their associated Buffer Zones.
- The project must be reviewed under the requirements of the Massachusetts Environmental Policy Act (MEPA) which will require both an Environmental Notification Form and an Environmental Impact Report.

- The project must comply with the Cape Cod Commission's Regional Policy Plan and undergo review as a Development of Regional Impact (DRI).
- Review must be conducted under the Massachusetts Natural Heritage and Endangered Species Program, pursuant to the Massachusetts Endangered Species Act.
- Review must be conducted under the program of the Massachusetts Historical Commission.
- All activities must be consistent with the two Areas of Critical Environmental Concern.
- Any facilities constructed in the southeastern corner of Brewster must comport with its District of Critical Planning Concern.
- Compliance with the regulations of the Old Kings Highway Regional Historic District is required for above-grade structures located in the District (all areas of Orleans north and west of Route 6A).
- The Town must issue building permits for treatment facilities and pumping stations after compliance with the State Building Code is demonstrated.
- Permits are required from MassHighway for all construction work in state roads.

Compliance with these programs must be demonstrated at various stages of project development.

8.7 MITIGATION MEASURES

There are many mitigation measures that will be employed should any of the three wastewater plans be implemented. These include:

- Restricting sewer construction work to the period of October to May to avoid periods of high traffic;
- Segmenting sewer work on public streets to avoid protracted closures;
- Designing sewer lines and pump station to avoid floodplains and to minimize encroachment on the buffers of wetlands and other protected resource areas;
- Restricting work hours on construction sites near residential areas;
- Requiring contractors to implement dust control measures;
- Erosion and siltation controls at all construction sites as part of site-specific stormwater management plans;
- Compliance with all terms of Orders of Conditions for work in wetland buffers;
- Installation of odor and noise control systems on operating equipment and facilities;
- Implementation of policies that restrict potential odor-generating activities to times of the day with the least impact;

- Compliance with applicable standards for construction activities near historic structures;
- Facility siting to avoid, minimize, and mitigate impacts to habitat of rare and endangered species, including compliance with all NHESP conditions;
- Facility site design to include vegetated berms and to maximize natural buffers;
- Selection of wastewater treatment equipment to minimize energy use and maximize nitrogen removal; and
- Adoption of bylaws and regulations to ensure a "growth neutral" program.

8.8 THE "NO ACTION" ALTERNATIVE

It is very important to envision Orleans and its environment in the scenario where none of the documented wastewater management needs are formally addressed; that is under the "no action" alternative.

In some ways, the "no action" alternative has manageable impacts. The needs assessment has determined that very few properties in Orleans have on-site septic systems that would be expected to create serious unhealthful or nuisance conditions. The continuation of current on-site disposal practices poses no significant risk to the water supply. By definition, wastewater needs associated with convenience and aesthetic factors do not pose substantive risks to the town if they are not addressed with off-site solutions. The Town intends to develop a growth-neutral wastewater management plan that neither restricts nor promotes growth different than allowed under current bylaws and regulations. Therefore, failure to implement wastewater management solutions should not impact economic growth. With respect to 40B housing, failure to provide off-site wastewater management capacity could restrict the options for affordable housing developers and conceivably create an impetus to locate such projects in less densely developed areas of town.

All of the above-noted impacts are relatively minor in comparison with the likely negative effects on pond and estuary quality. With respect to surface water protection, failure to address excessive nitrogen loading to estuarine waters will allow the currently observed degradation to continue and worsen. The degradation that has already occurred and been documented in Pleasant Bay, Rock Harbor and the Nauset system could led to sharply reduced fishing and swimming, and the eventual decline in property values. Given the great importance of coastal water quality in the Town's character and economy (of great value to both year-round and seasonal residents), lack of actions to control nitrogen loading could have very serious long-term impacts on the very resources that define the Town. With the issuance of nitrogen-based TMDLs, an enforcement mechanism will be in place that could be used by DEP to require nitrogen control. Orleans' failure to act in that setting will expose the Town to serious legal penalties and associated financial impacts. For some of Orleans' freshwater ponds, failure to remove phosphorus sources will appreciably accelerate water quality degradation.

The "no action" alternative is explicitly contrary to the Orleans Comprehensive Plan. The Comprehensive Plan, as adopted on December of 1995 and amended in October 2006, sets forth the following explicit goals:

- To preserve and improve the ecological integrity of fresh and marine waters.
- To maintain coastal water quality that allows fishing, shellfishing, and/or swimming in all three estuaries, and to protect those coastal ecosystems which support shellfish and finfish habitat.

Inaction related to the documented needs to protect ponds and estuaries is directly contrary to these important Comprehensive Plan goals.

With respect to protection of surface waters, the ramifications of "no action" would be severe. These impacts include:

- degradation of fisheries;
- impairment of water clarity and associated deterioration to swimming and other water contact sports;
- reduced opportunities for recreational and commercial shellfishing;
- floating algal mats and associated odor and visual impact;
- reduction in property values; and
- negative impact on the tourism economy

In that the impacted resources are part of the very fabric of life in Orleans, these documented needs for surface water protection warrant serious concerted attention.

SECTION 9
POTENTIAL FOR REGIONALIZATION

9.1 INTRODUCTION

Regional wastewater facilities may offer cost savings, particularly for small towns that are faced with relatively high costs for wastewater treatment, or have limited land for local disposal facilities.

The principal reason for regional cost savings is "economies of scale"; that is, the cost to treat a gallon of wastewater decreases with increasing plant size. As flows increase at a wastewater treatment facility, some costs (such as chemicals or sludge disposal) increase in direct proportion to the flow. Other costs, such as labor, do not increase in proportion to flow. If two or more towns participate in a regional facility, they can share those "fixed costs" and save money over separate individual plants.

Transport costs are the principal factor offsetting these economies of scale. Any town must weigh the cost to build a pipeline to a regional facility against the costs savings attributable to joint treatment.

Towns the size of Orleans and its neighbors are prime candidates for regionalization. This section of the report identifies several regionalization opportunities and outlines the upcoming analysis that will determine potential cost savings and evaluate advantages and disadvantages of the viable options.

9.2 REGIONALIZATION OPTIONS

Orleans and Eastham share the watersheds of the Nauset System, Rock Harbor and Boat Meadow. Both Towns have responsibility for controlling nitrogen to meet the needs as documented in published MEP studies or as projected by MEP staff.

The watershed of Pleasant Bay includes lands in Orleans, Brewster, Harwich and Chatham, and all four of these towns have responsibility to comply with nitrogen-based TMDLs adopted by EPA and DEP in 2007.

Orleans and Brewster also share the watershed of Namskaket Marsh. Draft MEP reports indicate that nitrogen loads to that system are well below thresholds, so no nitrogen control needs exist in that watershed.

Given this sharing of watersheds, there are two logical regionalization opportunities, as follows:

A. A regional wastewater treatment and disposal facility in or near South Orleans shared by Orleans and Brewster. This option is a simple expansion of Plan 3. It could also serve easterly areas in Harwich and the northern neighborhoods of Chatham.

B. A regional wastewater treatment and disposal facility in the northerly part of Orleans to serve both Orleans and Eastham. This option could be an expansion of either Plan 1 or Plan 2 at the Tri-Town site.

These hypothetical regional wastewater facilities would receive wastewater generated both in Orleans and in the neighboring towns. Some degree of public sewers would be needed in Eastham and Brewster to allow elimination of septic systems in those two towns proportional to the nitrogen control needs in the respective watersheds.

These options involve the installation of public sewers in Brewster and Eastham, and the associated pipelines to transport the collected wastewater to the regional treatment facility. It is also possible for Orleans to remove Brewster's and Eastham's shares of the watershed nitrogen loads by expanding the proposed Orleans sewer system. In essence, Orleans could eliminate more Orleans septic systems to offset Brewster and Eastham nitrogen loads, and have those two Towns pay for that expansion. If Options A or B, as described above, make economic sense, then it would be prudent to see if an expansion of the wastewater system in Orleans could be accomplished for lower cost. If costs are less, and the Towns can agree on an appropriate cost sharing formula, then regionalization could occur without the construction of public wastewater facilities in either Brewster or Eastham. This approach has been termed "nutrient trading".

9.3 EVALUATION OF OPTIONS

As an adjunct to the Orleans CWMP, these regionalization options will be evaluated to see if they make economic, environmental and political sense. As the Town of Orleans considers the Recommended Plan described in Section 11 of this report, a parallel study of regionalization opportunities is taking place, including the following steps:

- Estimating wastewater flows in the portions of Eastham and Brewster that are tributary to coastal systems with nitrogen control needs;
- Identifying prospective sites in Brewster and Eastham where these Towns could address their needs on their own;
- Estimating costs for both local and regional solutions;
- Developing cost-sharing formulas; and
- Evaluating non-financial issues.

This evaluation should be completed by mid 2009, and will be incorporated into the final CWMP.

SECTION 10
POTENTIAL FOR WATER REUSE

10.1 INTRODUCTION

Any wastewater treatment facility built in Orleans would provide a high level of wastewater treatment, removing most contaminants to very low levels and providing thorough disinfection. Such high levels of treatment are required under the DEP Groundwater Discharge Permit program and are necessary to accomplish the goals of this project. By providing an even higher level of treatment, the Town could also produce an effluent suitable for reuse in a number of settings. Reusing highly treated water would lessen the demand on the public water system, since potable water is now used for irrigation and other functions. Reuse also allows the controlled recycling of the nutrients remaining after treatment.

This section of the report identifies options for reuse, discusses the level of treatment needed, presents costs for selected reuse opportunities, and discusses regulatory and other non-cost factors.

10.2 REUSE OPTIONS

The options that are available are dictated by the DEP's Reclaimed Water Guidelines, which currently allow four types of reuse:

- Spray irrigation of golf courses,
- Reuse at landscape nurseries,
- Artificial aquifer recharge, and
- Toilet flushing

DEP's guidelines are undergoing revision, and more uses may be allowed under the new guidelines, perhaps including private lawn irrigation.

Section 5 of this report, which describes the identification and screening of alternatives, concluded that the following reuse options have the most promise:

- Toilet flushing at public buildings,
- Lawn irrigation at public sites,

- Irrigation of ballfields,
- Irrigation of golf courses, and
- Use of reclaimed water in concrete production.

Reuse options are considered to be viable as supplements to Plans 1 and 2, and reuse in the form of golf course irrigation is an important aspect of Plan 3. To form a uniform basis of comparison, a goal has been established to reuse a total of 10 to 15 million gallons of water each month over the period of June 15 to September 15. If that goal can be reached, then the effluent disposal facilities in each plan would see sharply reduced summer peak flows, and a month-to-month variation in effluent volume more typical of a largely year-round community.

The reuse facilities that would be feasible parts of the three plans are described below, starting with Plan 3.

Plan 3

This wastewater management plan was formulated in part around the concept of irrigation golf courses in Brewster and Harwich that are close to the southern border of Orleans. Plan 3 would include a year-round subsurface disposal system, either at the treatment plant site or under the parking lots at one or both golf courses. This system is needed to allow effluent disposal during cold weather, and as a back-up system to the irrigation that would occur in summer months. The treatment plant would have the facilities to produce an effluent that meets the Reclaimed Water Guidelines and those facilities would be operated during the irrigation season. The cost estimates presented in Section 7 of this report include all of these facilities.

The irrigation needs of the golf courses would be discussed with course managers to see how much reused water they could accommodate. Initial calculations indicate that the 54 holes that comprise the Captains and Cape Cod National courses could use all of the 10 to 15 million gallon reuse goal discussed above. Therefore, it has been assumed that any "supplemental" reuse facilities would not be needed in this plan to reach that goal. Should discussions with course managers result in lower irrigation needs, then this plan could be supplemented with effluent pipelines and irrigation facilities to serve a local tree farm and landscaping operations, and (if allowed under the new Reclaimed Water Guidelines) irrigation of private lawns.

Plan 2

Plan 2 includes a year-round rapid infiltration system at the site of the Tri-Town Septage Treatment Facility, which would provide both the primary means of disposal and the standby system for any summer reuse. One of the advantages of Plan 2 is the location of the treatment facility with respect to potential reuse sites. For the purposes of this evaluation, it has been assumed that the Town would build a reclaimed water pipeline from the Tri-Town site to serve a number of reuse customers in the most developed part of Orleans. As shown in Figure 10-1, that pipeline would run from Site 241 along Old Colony Road to Main Street, down Main Street to Route 28, south along Route 28 to Eldredge Parkway, along Eldredge Parkway to Route 6A and then back to the Tri-Town site. Reclaimed water would be provided to the following uses:

- Toilet flushing in public buildings to include the Highway Garage, the Snow Library, the police and fire stations, and the public toilets on Main Street and at Eldredge Field;
- Lawn irrigation at those same public facilities, as well as at town parks; and
- Irrigation of the ballfields at the Elementary and Middle Schools.

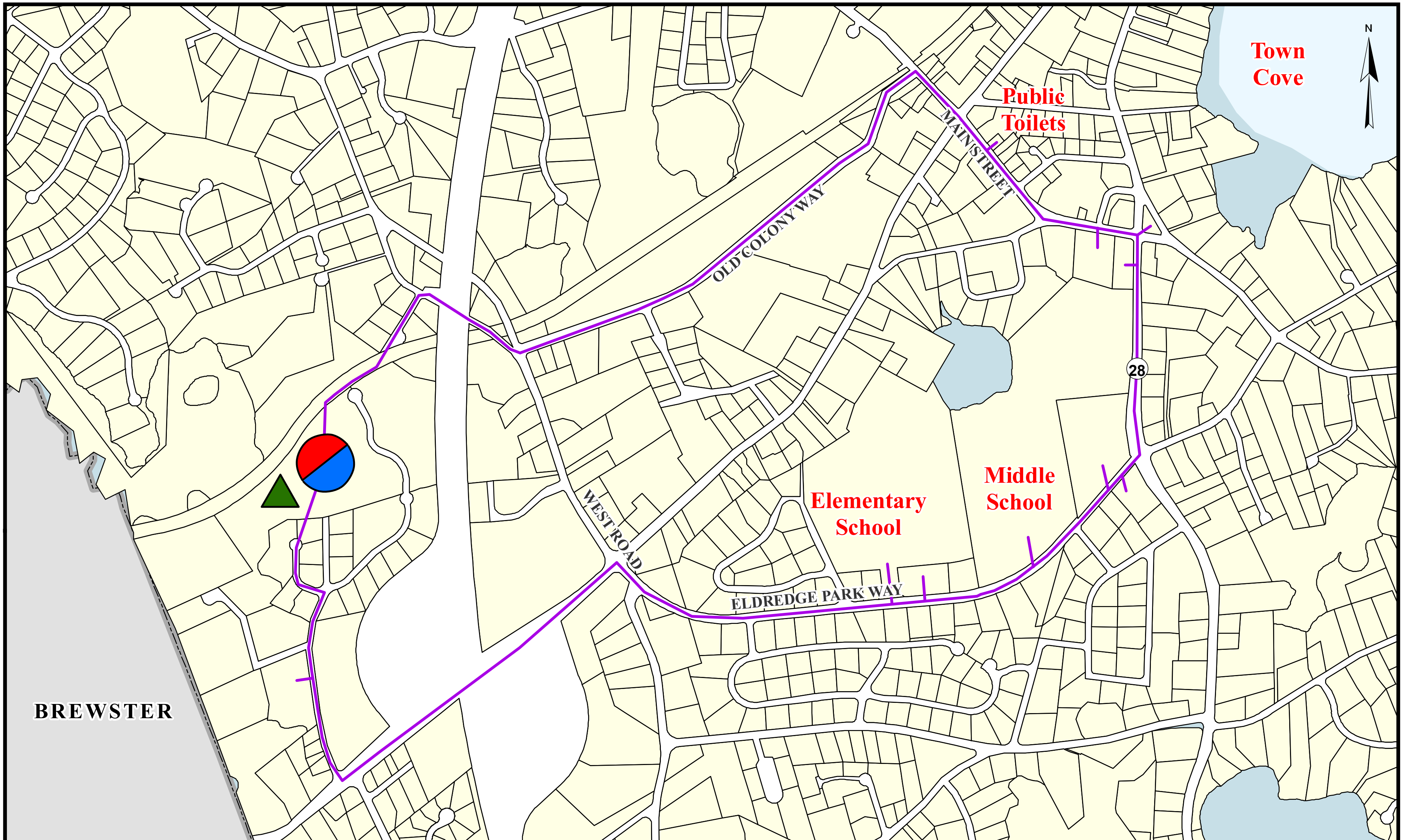
These uses could consume the full 10- to 15-million-gallon-per-month reuse goal. One additional outlet could be toilet flushing at downtown restaurants, if allowed under the new Reclaimed Water Guidelines.

The wastewater treatment facility at the Tri-Town site would be equipped with additional facilities needed to achieve the higher effluent quality, which would be sized for the goal of up to 15 million gallons per month.

Plan 1

In this decentralized plan, any of the four wastewater treatment facilities could produce the higher-quality water needed for reuse. The facility at the Tri-Town site would be the favored location, given its location near potential reuse customers. The reuse opportunities near the other

Tuesday, September 23, 2008 9:53:07 AM W:\GIS_Development\Projects\10645B-Orleans\RecommendationPlan\Fig10-1.mxd



Septage Treatment Facility

Effluent Disposal Stie

Wastewater Treatment Site

Proposed Routing of Reclaimed Water Pipeline

Source: GIS data obtained from the Town of Orleans and MassGIS.

0 470 940 1,410 1,880 Feet

Orleans CWMP

Possible Reclaimed Water Pipeline

PROJ NO: 10645G DATE: Apr 2009 FIGURE: 10-1

WRIGHT-PIERCE Engineering a Better Environment three facility sites are limited primarily to private lawn watering, which would require more cost to serve than the reuse pipeline described for Plan 2. Therefore, the reuse program for Plan 1 would be the same as for Plan 2.

10.3 LEVEL OF TREATMENT

The treatment standards for reclaimed water are similar to those for the standard groundwater discharge permit in some ways, and more stringent in others. With respect to BOD and nitrogen removal, the effluent limits would be the same. To enable reuse, a higher degree of suspended solids removal is required, along with a higher level of disinfection.

There are two approaches to producing reuse-quality effluent. In the first case, the treatment facility would include additional facilities for suspended solids removal following the SBR system, the biological aerated filter or the oxidation ditch needed to meet the basic requirements for a groundwater discharge permit (see Appendix B for description of these technologies). Those add-on systems would include a membrane system for high level solids removal, and enhancements to the disinfection system. In the second case, the Town could build a membrane bioreactor (MBR) to meet the basic requirements, which would not require all of the add-on systems for reuse. In the first case, the add-on equipment could be installed any time in the future that the Town chooses to proceed with a reuse program. In the second case, the Town would install the MBR as part of the initial construction, and be faced with only minor upgrading to allow reuse. If reuse is to be part of the adopted plan, it would be wise to install the MBR initially. If reuse is to be implemented later, or may not be implemented at all, it would be prudent to pursue the first option. For cost estimating purposes, it has been assumed that the add-on approach is used.

In addition to effluent quality requirements for reclaimed water, the treatment facilities would be designed for a higher level of reliability and more frequent effluent monitoring would be required. A higher level of regulatory scrutiny would also be expected.

10.4 COST ESTIMATES

Estimates of capital costs were prepared for reuse facilities, using the same basis as the cost estimates reported in Section 7.6. The reuse program that is assumed for Plans 1 and 2 would add approximately $7 million to the capital costs for those plans. That represents about 5% of the costs for Plan 2 and 4% of the costs for Plan 1. Operation and maintenance costs would increase with a reuse program, primarily for energy, monitoring and administrative expenses. That increase is projected to be about $120,000 per year, which represents about 8 to 9% of the O&M costs for the basic options. On a present worth basis, the reuse program would add about $9 million to Plans 1 and 2, an increase of 4 to 5%.

Section 7 shows how the project costs are the least for Plan 2 and the most for Plan 1. To some extent, the comparison of Plan 3 with the other plans, as previously reported, does not account for the added benefits of reuse that are implicit in that plan. This analysis of the costs to add a reuse program to Plans 1 and 2 indicates that Plan 2 would still be the least expensive, once the reuse costs are included. The capital cost of Plan 2 would be $18 million less than Plan 3 (instead of the reported $25 million with a Plan 2 reuse program).

These capital cost estimates assume that a reuse program would be implemented after initial development of the overall project. Should reuse be included from the beginning, its cost would be 10 to 20% less. The savings include the ability to install the reclaimed water line at the same time as the sewer system is built.

10.5 REGULATORY ISSUES

A formal municipal reuse program, serving multiple private customers, is a rarity in Massachusetts. Therefore, the Town should recognize that such a program would require time and effort in coordination with DEP to address all of the relatively new aspects of reuse. The revised regulations for reclaimed water should be in force in 2009, and changes from the current programs may affect the description and costs presented here.

To be effective, a reuse program must include contracts between the water supplier (the Town) and the customers. In the options described above, the customers include the Town itself, the school district, golf course owners, and (perhaps) downtown restaurant owners. These customers are listed in the approximate order to complexity with respect to legal and administrative matters.

10.6 OTHER NON-COST FACTORS

Water reuse entails costs that would only partially be offset by any revenues from the possible sale of water. If water reuse is to be implemented, it would be on the strength of non-cost factors.

Some of the advantages of a reuse program include:

- Reduced demand on the municipal water supply system;
- Reduced reliance on commercial fertilizers to the extent that nitrogen and phosphorus in the reclaimed water can offset current uses on irrigated surfaces;
- For irrigation, a higher quality recharge to the groundwater (in terms of both nutrients and a wide range of other contaminants that would be present in low concentrations); compared with other effluent disposal options.
- Reduced use of the year-round effluent disposal systems, extending their useful life; and
- Elimination of existing private irrigation wells and pumping systems whose maintenance and replacement can be costly.

Among the disadvantages of a reuse program are:

- A higher level of oversight needed to ensure that reclaimed water is not used for inappropriate purposes;
- The legal and administrative aspects related to customer agreements and liability control; and
- Possible reduced revenue for the municipal water system.

There are two subjective advantages of a reuse program that warrant discussion, related to TMDL compliance and effluent disposal capacity.

Irrigation of vegetated surfaces is a key part of the reuse programs evaluated here. That contact between high quality effluent and growing vegetation will remove nitrogen and phosphorus and will provide better protection of ponds and coastal waters than either a subsurface leaching system or a rapid infiltration system. It is possible that DEP might allow some credit toward compliance with the nitrogen-based TMDLs if a successful reuse program is implemented. The Town should not presume that it can reduce its expenditures for nitrogen control as a direct result, but a well-documented program might allow cost savings in the future.

DEP requires a traditional effluent disposal system as a back-up to any reuse program to address the possibility that irrigation is not possible during some unusually wet year, or that effluent quality is not achieved for a protracted period. That requirement is a prudent one. However, a successful reuse program, that is demonstrated to be effective over a range of weather conditions and over a number of years of operation of the required treatment technology, should allow DEP to reduce its 100% standby requirement to some smaller percentage of capacity. If the Town were required to provide only two-thirds back-up, for example, then costs would be reduced for later phases of construction of the traditional effluent disposal systems.

Plan 2 is based on the premise that follow-up soils explorations at the Tri-Town site will confirm early projections of that site's effluent disposal capacity. On one hand, those future explorations might show that more capacity exists than has been estimated, and there would be room at that site for other municipal uses, such as a public works facility. On the other hand, less favorable results would require the Town to seek a nearby supplemental site, particularly if regionalization options are implemented or full town sewering is needed or desired. If the reclaimed water pipeline were added to Plan 2, it would be a relatively easy matter to also construct a subsurface leaching system below the ballfields at the elementary and middle schools. In that scenario, the transport facilities would already exist (to convey reclaimed water to the schools for irrigation). Thus the reuse option establishes a system that could facilitate a future supplemental effluent disposal system, should it be needed.

SECTION 11

RECOMMENDED PLAN

11.1 INTRODUCTION

The previous ten sections of this report describe:

- the documentation of wastewater management needs;
- the identification and evaluation of available solutions for those needs; and
- the detailed evaluation of three distinct wastewater and nutrient management plans.

All of that evaluation and planning leads up to the identification of a single comprehensive plan which is described in this chapter.

11.2 DEVELOPMENT OF RECOMMENDED PLAN

11.2.1 Activities of the WMSC

The WMSC has met regularly during the development of the CWMP, generally twice per month. At those meetings, the Committee has reviewed numerous technical letters from its consultant, made interim decisions as the planning has progressed, and methodically narrowed its search for the best wastewater management plan.

Section 7 of this report summarizes the three wastewater plans that the Committee has evaluated in detail. Those plans all address the Total Daily Nitrogen Loads (TMDLs) that are in place or expected to be adopted to reduce watershed nitrogen loads under the federal Clean Water Act. Those plans are:

- **Plan 1:** Decentralized wastewater treatment at four sites and effluent disposal at eleven sites:
- **Plan 2:** Centralized treatment and disposal at the site of the existing Tri-Town Septage Treatment Facility; and

- **Plan 3:** Centralized treatment and disposal at sites in South Orleans and/or Brewster with summer spray irrigation of Brewster golf courses.

During the period of May to August 2008, those three plans were analyzed with respect to a number of cost, environmental and technical factors, and were the subject of significant public review.

11.2.2 Public Consultation Process

The entire wastewater planning process has benefited from an aggressive program of public consultation, led by both the WMSC and the Citizens Advisory Committee (CAC). That effort is summarized in Appendix C. Public consultation has taken many forms, including:

- Regular meetings of the WMSC that are televised and open to the public;
- Well-attended public meetings on each of three interim reports, at which the public raised many thoughtful concerns and insightful points;
- Periodic WMSC progress reports to the Board of Selectmen, which are televised; and
- A series of weekly workshops held Tuesdays evenings from July 7 to August 19, 2008. Six of the workshops were focused on individual neighborhoods in Orleans, and the last was open to the entire town. A total of 414 people attended.

The workshops included a series of posters describing the project, an overview by members of the WMSC and CAC, and the opportunity for the public to make comments verbally and in writing through a survey form. The posters were available for review at any time that Town Hall was open, and "walk-ins" could complete the same survey form available at the workshops.

The WMSC compiled a listing of all pertinent questions and comments raised at the workshops and then tabulated the survey results. Questionnaires were received from 41% of the 414 attendees. Appendix C contains a summary of the survey results. The principal findings are as follows:

- Plan 2 was the most favorable plan to 70% of the respondents, with its lower cost the most often-cited supporting factor.
- Plan 1 was the least favored plan to 73% of the respondents. The most commonly cited drawbacks were the high cost and the need to acquire many private parcels of land.
- The effluent reuse aspect of Plan 3 was cited as a desirable feature, but offset by the uncertainties associated with dealing with a neighboring town which has yet to start its wastewater planning process.
- Many people suggested that town-wide sewers should be part of the selected plan, based on the concern that future more stringent environmental regulations may eventually force the Town in that direction, and the perceived fairness of providing comparable service to all residents.

11.2.3 Plan Selection

Based on its intensive deliberation over the three plans, the overall outreach program, and the specific broad-based input from the citizens attending the workshops, the WMSC voted to proceed with a program centered on Plan 2, supplemented with a number of features from Plans 1 and 3. Those supplemental features include the use of selected local treatment systems to allow early nitrogen control in headwaters embayments of Pleasant Bay (where the greatest need exists for nitrogen control), effluent reuse to allow recycling of the water and nutrients, and planning for town-wide sewers. Plan 2, with these supplemental features, is termed the "Recommended Plan".

The Recommended Plan was presented to the public at a well-attended public meeting on October 2, 2008. Public endorsement of the plan occurred at a Special Town Meeting on October 27, 2008. Over 800 people attended that meeting and approximately 70% supported the Recommended Plan.

11.3 OVERVIEW OF RECOMMENDED PLAN

From the outset of the CWMP process, the WMSC has recognized that a wastewater plan for Orleans must address a number of important issues:

- It must primarily address the significant problem of nitrogen overloading of coastal waters, as well as phosphorus loading threats to freshwater ponds.
- While traditional wastewater collection, treatment and disposal must form the central core of a wastewater plan, every effort should be made to reduce costs by maximizing the benefits of non-structural and non-traditional nutrient management techniques including such programs as control of lawn fertilization, stormwater management, and land use regulations.
- The nitrogen control needs estimated by the Massachusetts Estuaries Project, and implemented as TMDLs by DEP, are still in progress. The TMDLs are based on one likely nitrogen control scenario involving nitrogen load reductions across one or more sub-watersheds. Others scenarios may be possible and desirable.
- The estuarine environment is ever-changing, as evidenced by the April 2007 breach in North Beach.
- The DEP will be undertaking a review of the technical basis for the nitrogen control requirements that will include a process for the Town to obtain the underlying models to investigate other control scenarios.
- The magnitude of the costs of nitrogen control dictate that both structural and non-structural steps be implemented in segments over time.
- Regionalization may be beneficial in terms of reducing project costs, and Orleans neighbors are not as far along as Orleans in the wastewater planning process.

Based on these realities, the Orleans WMSC has embraced the concept of "adaptive management". This approach to environmental protection recognizes the need to proceed with nutrient control programs at the same time that the full nature and extent of problem are being better determined. "Mid-course corrections" are used to adjust the plan to reflect information that becomes available in the future. Accordingly, the Orleans CWMP has the following components:

1. Structural elements that will be constructed in segments within an overall plan;
2. Non-structural elements that will be implemented in a way that first documents their effectiveness and then allows their full application with predictable results and regulatory support, with the overall goal of reducing the cost of the structural elements;
3. Monitoring of surface waters to document the decline of water-column nutrient concentrations and the restoration of key habitats; and
4. Periodic re-assessment of progress toward cleaner waters and healthier habitats that leads to the refinement of the structural and non-structural elements.

The structural and non-nonstructural components of the Recommended Plan are discussed in the immediately following separate sections of this chapter. Monitoring and periodic reassessment are discussed in Section 11.6 entitled "TMDL Compliance Plan", where steps are outlined for the Town to make appropriate "mid-course corrections".

11.4 STRUCTURAL ELEMENTS OF RECOMMENDED PLAN

The structural aspects of the Recommended Plan include facilities for wastewater collection, wastewater treatment, effluent disposal and reuse, septage handling, and sludge disposal.

11.4.1 Wastewater Collection System

Wastewater will be collected from selected properties in the nitrogen-sensitive watersheds using traditional gravity sewer systems supplemented by sections of low-pressure sewer and grinder pumps where necessary to overcome steep terrain and difficult-to-access properties. Wastewater will be transported by conventional pump stations and force mains.

The physical extent of the collection system will primarily address nitrogen control needs, and will also allow the elimination of septic systems upgradient of most major freshwater ponds.

Figure 11-1 shows an initial assessment of those areas of Orleans where septic systems would be eliminated to meet nitrogen and phosphorus control needs. This sewer service area is based on the goal of collecting as much wastewater nitrogen as necessary with the least amount of infrastructure.

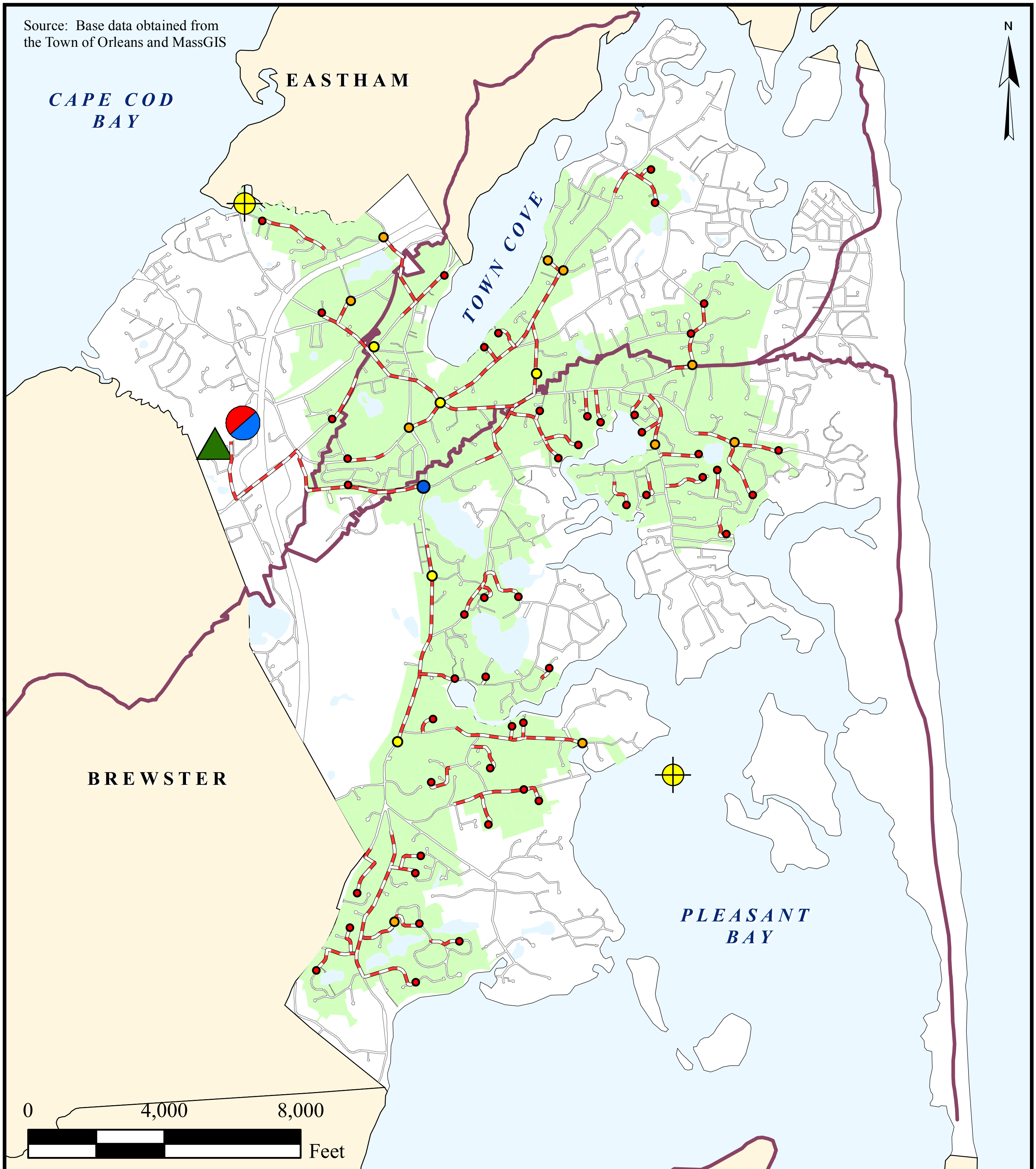
The design of the collection system will reflect the possible eventual full sewering of Orleans should the Town later decide to take this step. Major trunk lines and pump stations will be designed for later expansion to handle the larger wastewater flows, without actually investing capital funds at this time. Enlarged versions of Figure 11-1 are included as Figures D-4, D-5, and D-6 in Appendix D.

For convenience, the sewered areas shown in Figure 11-1 will be termed the "core" sewer service area, and the remainder of town will be termed the "extended" area. This distinction between the "Core Program" (intended to address documented needs, mostly nitrogen and phosphorus control) and the "Extended Program" (to enable full town sewering) will be carried forward to all aspects of the Recommended Plan.

The Core Program will serve about 2,800 properties with 390,000 feet of sewer pipe and generate an annual average flow of 640,000 gallons per day. The Extended Program, if needed or desired, would result in 1,140,000 gallons per day from about 5,300 properties served by 630,000 feet of sewer pipe.

11.4.2 Wastewater Treatment System

Collected wastewater will be transported to the site of the Tri-Town Septage Treatment Facility, near the intersection of Route 6 and Route 6A, where it will be treated to a high level that reflects the requirements of the DEP Groundwater Discharge Permit program. That high level of treatment includes the reduction of effluent total nitrogen to less than 10 mg/l and the removal of the vast majority of pathogenic organisms.



Sewers in all road rights-of-way
Sewers and Force Mains in Road
Pumping Stations
Small
Medium
Large
Transport to Treatment

Sentinel Stations
Major Watershed Boundaries
Septage Treatment Facility
Wastewater Treatment Site
Effluent Disposal Site

Orleans CWMP
Location of Collection System Infrastructure and Treatment Facility

PROJ NO: 10645G	DATE: Apr 2009	FIGURE:
WRIGHT-PIERCE Engineering a Better Environment		11-1

Friday, April 24, 2009 12:38:48 PM W:\GIS_Development\Projects\10645B-Orleans\10645G\April 2009 Draft Report\Fig11-1.mxd

The treatment process will include the following steps:

- Screening and grit removal;
- Primary settling to remove suspended solids;
- Biological treatment to remove BOD, suspended solids and nitrogen;
- Secondary settling to remove the bacterial cultures created in the biological process; and
- Disinfection using ultraviolet light.

A control building will be provided to house offices, laboratory, electrical and mechanical spaces, and sludge dewatering equipment.

Figure 11-2 depicts the proposed layout of new wastewater facilities at the Tri-Town site as well as the existing septage facility there. Table 11-1 presents a summary of design data for wastewater collection, treatment and disposal. Appendix D contains more detail on treatment process selection and sizing.

In concert with the Town's intent to implement wastewater solutions in segments, the treatment facilities will be built in phases. The first phase will provide capacity for treating one half of the wastewater to be collected in the Core Program. The site layout will also accommodate both the second half of the Core Program treatment capacity and the full treatment capacity needed for the Extended Program.

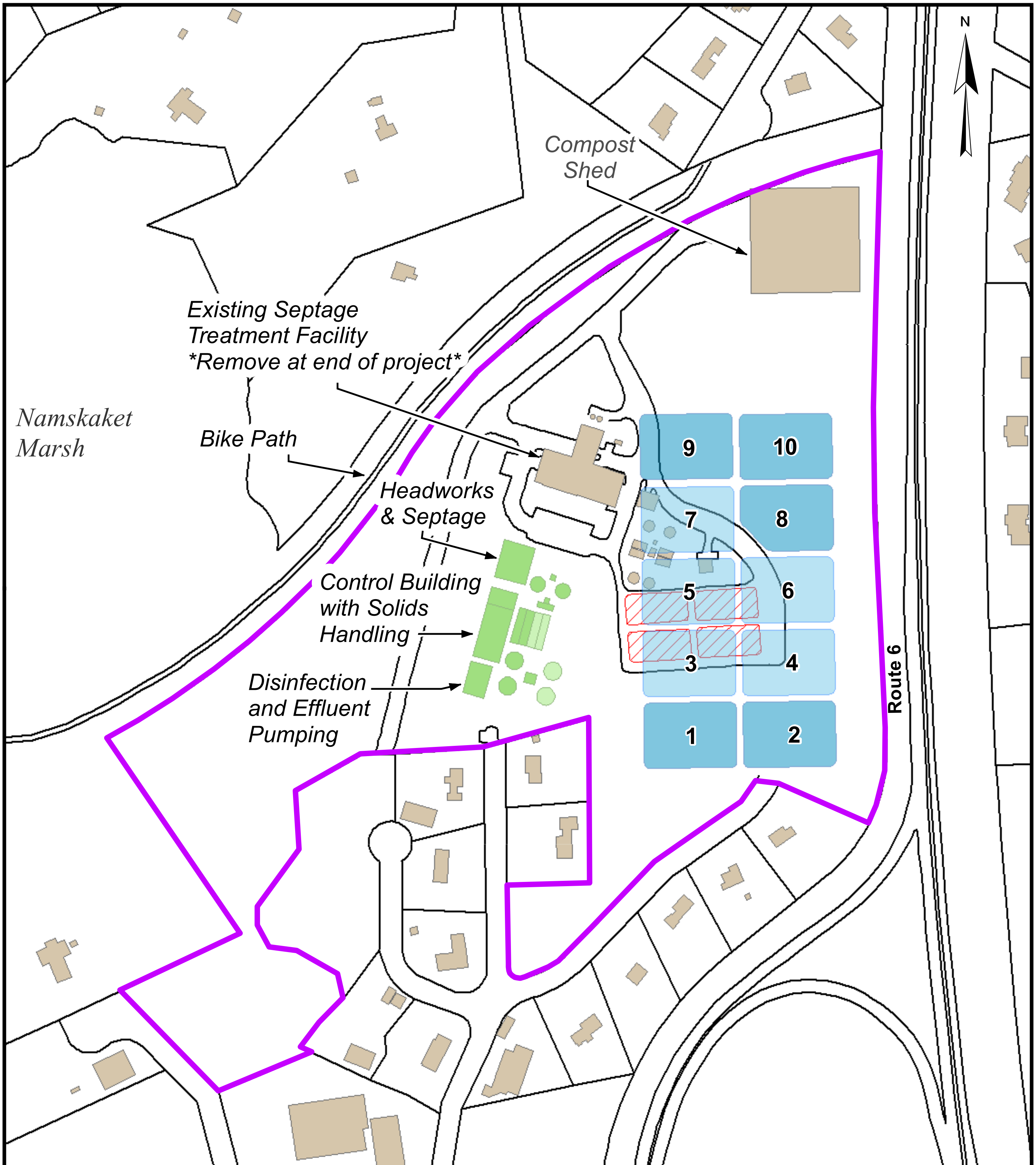
11.4.3 System for Effluent Disposal and Reuse

Effluent disposal will be accomplished through rapid infiltration, using a series of open basins located on the easterly and northerly portions of the site. Recharged effluent will mix with native groundwater and will flow away from the site toward Cape Cod Bay. The design of the rapid infiltration basins will be based, in part, on soil and groundwater studies conducted in 2007 2008 and 2009. Those studies are summarized later in this chapter.

As with the treatment system, the rapid infiltration system will be constructed in segments. Based on currently available soils and groundwater data, the rapid infiltration basins have been

Orleans CWMP

Layout of Proposed Wastewater Treatment and Disposal Facilities at Tri-Town Site



Proposed Disposal Basins
- Phase 1
- Phase 4/5

Proposed Wastewater Treatment Plant
- Phase 1
- Phase 4

- Tri-Town Property Line
- Existing Buildings
- Existing Disposal Basins

0 125 250 375 500 Feet

PROJ NO: 10645G DATE: Apr 2009 FIGURE: 11-2

WRIGHT-PIERCE
Engineering a Better Environment

TABLE 11-1

WASTEWATER SYSTEM DESIGN DATA FOR CORE PROGRAM

Component	Wastewater System Design Data for Core Program	
Wastewater Collection	Properties Served	
	Pleasant Bay watershed	1,680
	Nauset watershed	880
	Rock Harbor watershed	270
	Total	2,830
	Length of Sewers, feet	390,000
	Number of Pump Stations	
	Wetwell/drywell	6
	Submersible	56
	Grinder pumps	78
Wastewater Treatment	Design flow, gallons per day (including Infiltration and Inflow)	
	Annual average	640,000
	Maximum month	1,090,000
	Maximum 2-day	1,440,000
	Major Treatment Process	Biological Nitrogen Removal
	Effluent quality	
	BOD/TSS, mg/l	30
	Total nitrogen, mg/l	10
	Fecal coliform, col/100ml	200
Effluent Disposal	Method	Rapid Infiltration
	Loading rate, gal/day/square foot	7.7
	Number of basins	
	Total	10
	In use	8
Septage Handling	Participating Towns	
	Tri-Town District	Orleans, Brewster and Eastham
	Others	Based on market
	Design flows, gallons per day	
	Annual average	31,000
	Maximum month	50,000
Sludge Handling	Major Treatment Processes:	Decanting, Dewatering
	Disposal:	Contract Handling Off Site

sized on a composite loading rate of 7.7 gallons per day per square foot of infiltrative area. Further testing is needed to confirm this rate, but there appears to be capacity at the Tri-Town site for all of the effluent from the Core Program and some of the effluent from the Extended Program. Full town sewering, if needed or desired, will require one or more of the following:

- An additional effluent disposal site (or sites);
- The implementation of innovative vertical disposal systems (e.g., wicks) at this site;
- The implementation of an effluent reuse program.

Opportunities for effluent reuse are discussed in Section 10.

11.4.4 Facilities for Septage Handling

Septage disposal will be a continuing need in Orleans unless full town sewering is accomplished. While it is possible for the septage disposal function to be accomplished by the Tri-Town District, it will be more cost effective for the Town of Orleans to build a modern septage receiving station as part of the new wastewater facilities. Those facilities could be sized either for the Town of Orleans alone, for the three towns of the District (Orleans, Brewster and Eastham) or to also include other nearby towns. The septage that is received at the site will be pretreated to remove grit and coarse solids, stored and equalized, and then blended with the incoming wastewater for joint treatment.

11.4.5 Facilities of Sludge Handling

The solids that remain after wastewater and septage treatment will be decanted and dewatered, and trucked off-Cape for suitable reuse or disposal. The Town of Orleans should rely on private haulers for transport of dewatered sludge, and for the grit and screenings removed in the facility's headworks and in the septage receiving station. Wastewater solids will increase as the sewer system expands, offsetting the parallel reduction in Orleans septage solids.

11.4.6 Local Wastewater Management Systems

While the majority of nutrient removal will occur at new wastewater facilities at the Tri-Town site, the WMSC has chosen to incorporate five local "cluster systems" to provide more focused and rapid removal of nitrogen and phosphorus in certain areas.

Three small-scale systems will be built to provide interim nitrogen removal in the watersheds of Pah Wah Pond, Lonnies Pond and Arey's Pond. These coastal ponds, termed "headwaters" embayments in Pleasant Bay, have some of the highest nitrogen control requirements. Each of these cluster systems will be sized to handle about 9,000 to 10,000 gallons of wastewater per day and provide nitrogen removal to about 15 mg/l. This nitrogen removal will allow faster estuary protection than traditional sewering which will not reach these areas until later phases of the Core Program. Once the centralized wastewater system reaches these areas, the cluster treatment and disposal systems will be abandoned, and the collection systems will be incorporated into the centralized system. Cluster systems were considered for Meetinghouse Pond, where complete removal of nitrogen is required by the TMDLs, but this sub-watershed can be served in the early phases of the central sewer system. One or more additional cluster systems will be considered upon release of the MEP report on the Nauset system, including one near Mill Pond.

By eliminating septic systems upgradient of freshwater ponds as part of the overall nitrogen control program, the phosphorus that enters the groundwater can be eliminated, providing some protection to these ponds for phosphorus enrichment. Investment in public infrastructure accomplishes two purposes in these situations. The municipal sewer system will not pass near Bakers Pond, however, so the Recommended Plan includes a cluster septic system to serve 15 developed upgradient properties. The purpose of this cluster system is to transport wastewater downgradient of the pond; phosphorus "removal" is actually "relocation" in this case because the cluster system will not include treatment processes that remove phosphorus from the wastewater.

Studies are underway to select specific sites for these local systems. Prior to the completion of the final CWMP, sites will be identified and preliminary design data will be developed. Close coordination with DEP is needed to ensure that these systems are appropriately permitted and recognized as elements of the overall plan for TMDL compliance.

The cost to design and construct the structural elements of the Core Program are presented in Section 11.11.

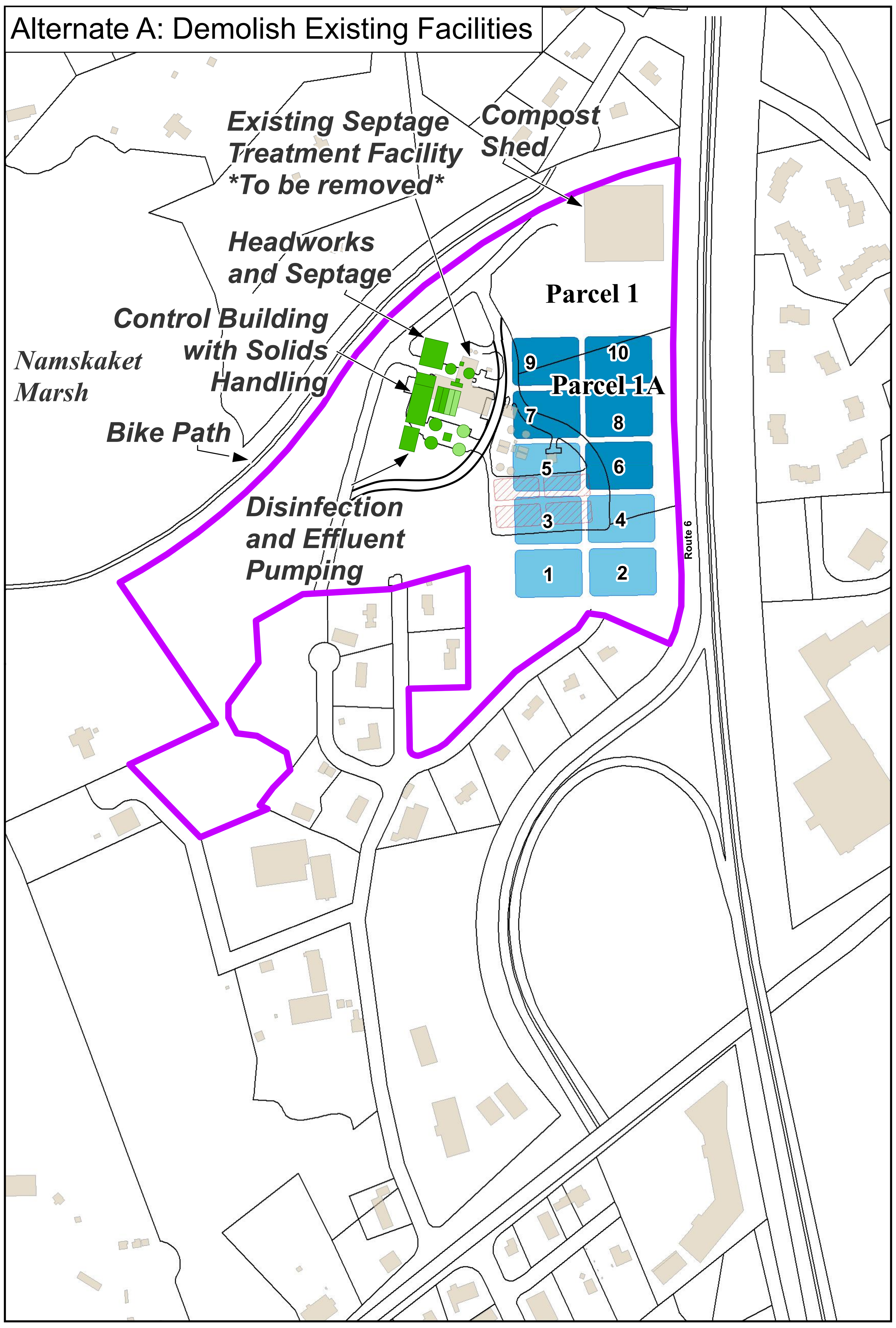
11.4.7 Alternative Layouts for Tri-Town Site

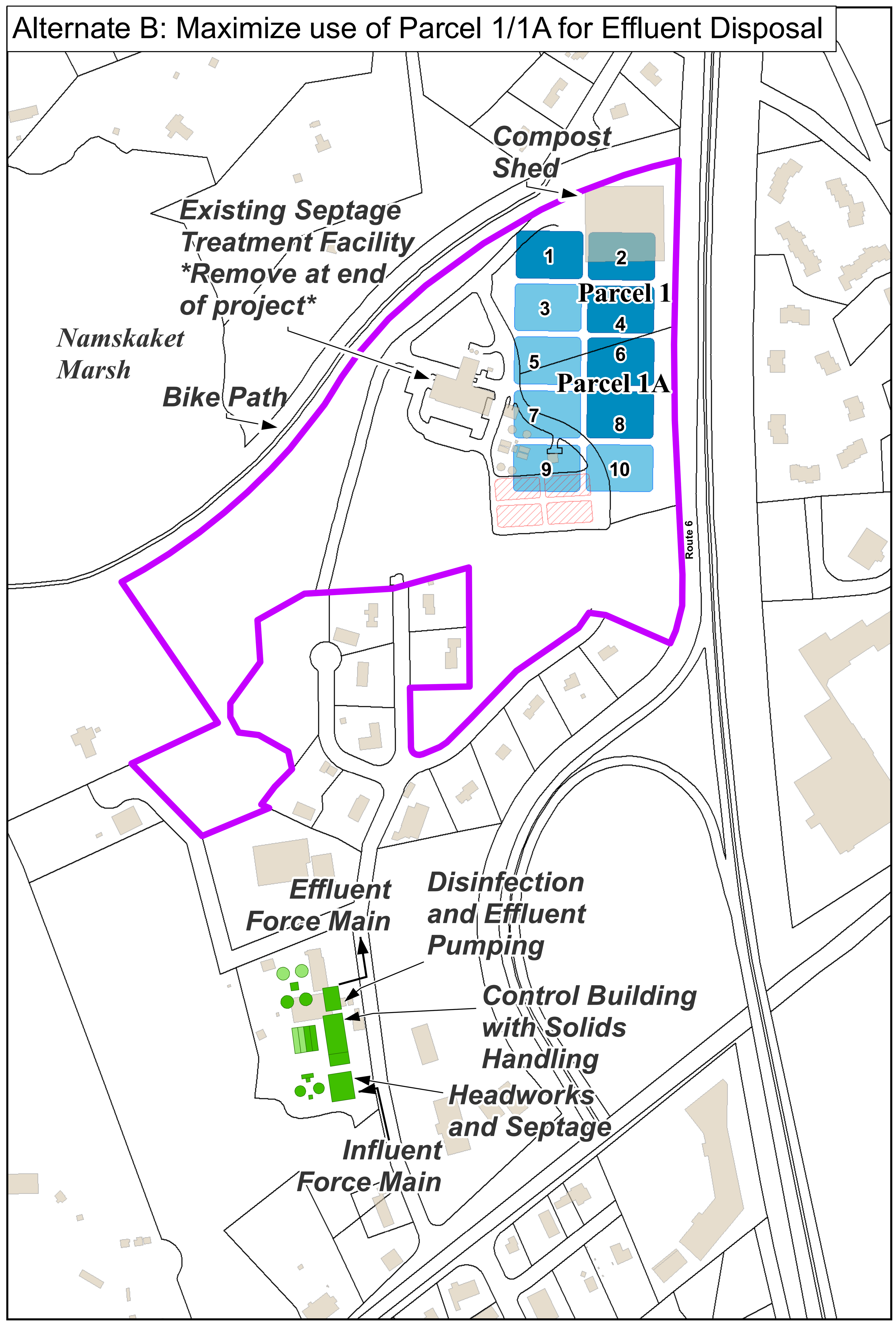
The configuration of new structures and infiltration basins shown in Figure 11-2 was designed to allow minimal impact on the existing facilities for septage treatment and disposal. This is the preferred layout because it would allow the exiting Tri-Town operations to continue unimpeded during construction of Phase 1 and perhaps until the construction of Phase 4 facilities. Three alternatives to this layout have also been developed and evaluated, as shown in Figure 11-3. These alternative layouts all have different advantages and disadvantages with respect to available land for effluent disposal, degree of buffering from nearby land uses, impacts on rare species habitat, and flexibility dealing with the existing septage handling operations. A thorough evaluation of these alternatives will be conducted and completed prior to the finalization of the Comprehensive Wastewater Management Plan.

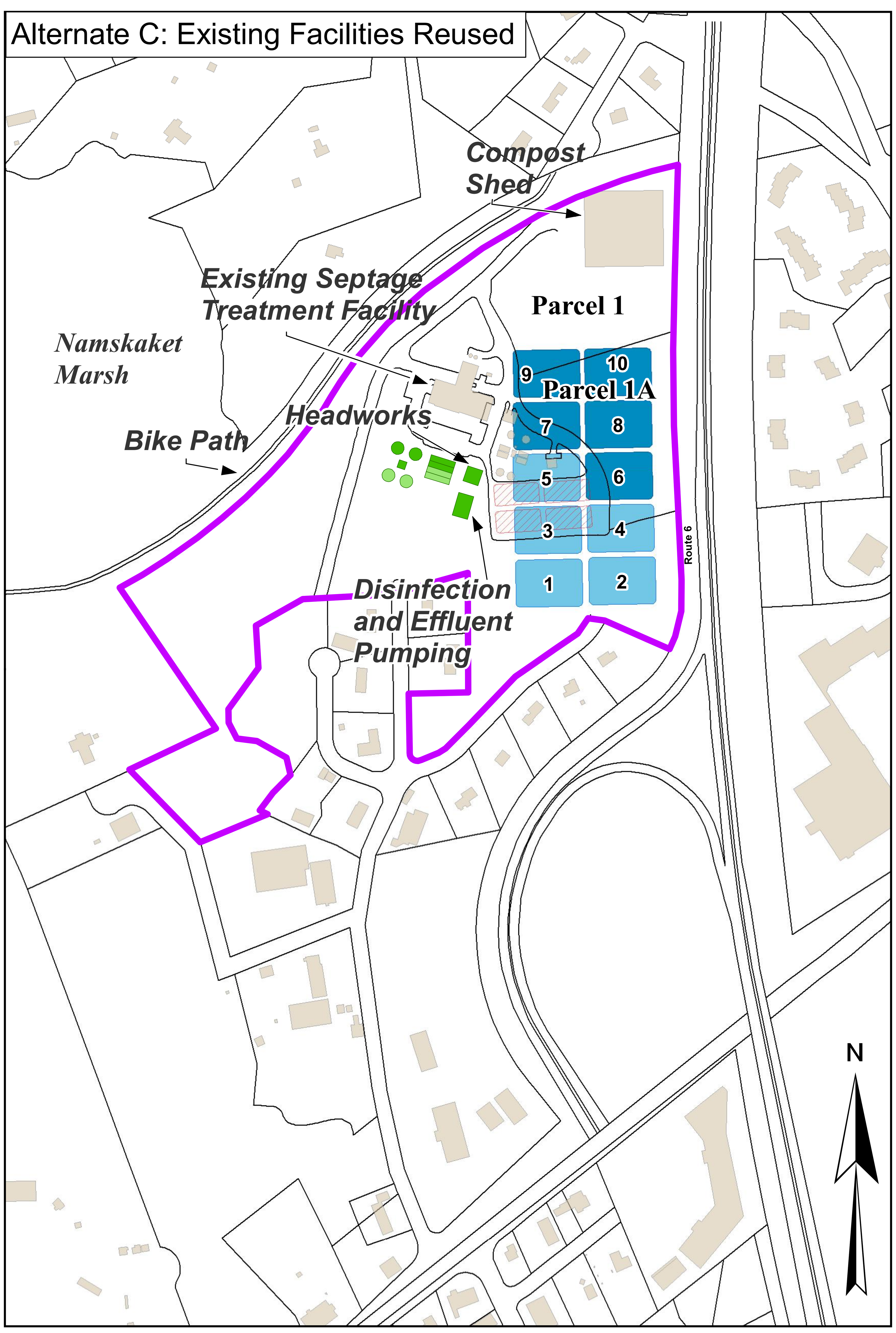
With respect to minimizing impacts to rare species habitat, a fifth layout was discussed with Natural Heritage at a meeting in their office on April 23. This fifth alternative, while not depicted graphically, can be described as combining portions of Alternative B (effluent disposal would be sited as far north as possible without requiring the removal of the compost shed) and Alternative C (maximizing reuse of septage facility infrastructure for wastewater treatment). This alternative will be considered in future evaluation.

11.5 NON-STRUCTURAL ELEMENTS OF RECOMMENDED PLAN

The nitrogen control needs estimated in the MEP technical reports and set forth as TMDLs by DEP equal or exceed 50% for all nitrogen-sensitive embayments impacted by Orleans. These







Tri-Town Property Line

Existing Buildings

Existing Disposal Beds

Proposed Wastewater Treatment Plant

Phase 1

Phase 4

Proposed Disposal Basins

Phase 1

Phase 4/5

0 100 200 400 600 800 Feet

Orleans CWMP

Proposed Wastewater Treatment and Disposal Facilities Alternate Layouts

PROJ NO: 10645G	DATE: Apr 2009	FIGURE: 11-3

WRIGHT-PIERCE

Engineering a Better Environment

nitrogen removal percentages are high enough to require municipal sewering. Such structural solutions are expensive and should be supplemented by the non-structural elements discussed below. While these non-structural elements cannot alone solve the nitrogen problem, and most are not recognized by DEP as fully proven techniques, they can serve as cost-effective supplements to the structural plan. They may allow cost reductions by making later phases of sewer expansion unnecessary. These non-structural elements are discussed in detail in Section 5 and Appendix B.

11.5.1 Fertilizer Control Program

For the Orleans-impacted estuaries studied by the Massachusetts Estuaries Project, about 7% to 10% of the watershed nitrogen load is associated with leaching of fertilizers applied to individual lawns and gardens, town parks and golf courses. If that fertilizer leaching could be avoided, then Orleans would need to eliminate fewer septic systems through its structural program. Fertilizer runoff is also a significant factor in the degradation of freshwater ponds.

The control of fertilizer nutrients will require a multi-pronged approach involving public education, policies on Town park and ball field fertilization, enhancement of subdivision regulations related to allowable lawn area and vegetation type, more controls on private lawn-care companies, and perhaps limitations on the amount or type of fertilizers that can be purchased locally. This multi-faceted program should be developed and implemented as soon as practical, so that its effectiveness can be demonstrated before the later phases of the structural program are initiated. A regional approach is likely to be required. This program must address the identified challenges of fertilizer control, including the import of fertilizer from outside the region, the widespread love of green lawns, the economic burden on certain businesses and the difficulty documenting actual application practices.

11.5.2 Stormwater Management

For the Orleans-impacted estuaries studied by the Massachusetts Estuaries Project, about 8% to 10% of the watershed nitrogen load is associated with stormwater disposal. The Town must improve its stormwater management practices and techniques to comply with its permit under the National Pollutant Discharge Elimination System (NPDES). (It holds a Small MS4 General Permit under that program.) If these improvements can be implemented in the next few years, and the nitrogen removal effectiveness can be documented, then later phases of the structural program can be scaled back accordingly. Stormwater disposal is a significant contributor of phosphorus to freshwater ponds, and town actions on this front will improve pond water quality as well. The Orleans Board of Selectmen has already identified stormwater management as a high priority task, and regular investments on infrastructure have already begun.

11.5.3 Water Conservation Program

Water conservation is a desirable goal because it reduces the Town's impact on groundwater supplies and indirectly saves energy. While water conservation does not reduce the nitrogen load in wastewater, it will reduce wastewater flows and decrease the costs of certain flow-dependent aspects of the structural program. Most important is the impact on effluent disposal facilities. Water conservation will reduce the cost of rapid infiltration, and can help forestall the need for a second effluent disposal location if the Town elects to provide town-wide sewers. The water conservation efforts of the Water Department should serve as the basis for this program and the Town should build on its recent successes. In light of the benefits to the wastewater system, the overall cost savings should be apportioned to both water and wastewater functions, to reflect the loss in Water Department revenues that water conservation can cause.

11.5.4 Flow and Load Reduction Initiative

In addition to water conservation, the Town should adopt a formal program to promote a reduction in wastewater flows and nitrogen loads.

The Board of Health now strictly enforces the Title 5 requirement to provide larger septic tanks and more leaching capacity for homes with garbage grinders. That program should be extended to include a Town ban on garbage grinders in all homes and a public education program should be initiated to emphasize the benefits to both sewered and unsewered properties. The reduction in nitrogen concentration in the wastewater reaching the new treatment facilities may allow later phases to be somewhat smaller than otherwise. Reducing nitrogen loads from unsewered homes in nitrogen-sensitive watersheds will forestall the need for sewer extensions. As with all these non-structural elements, it will be crucial to set forth a methodology for confirming the nitrogen load reductions that actually occur.

Composting and urine-diverting toilets separate a high-nitrogen waste stream from the rest of the domestic wastewater. If a low-cost reuse or disposal method can be found for the separated urine or compost, then cost savings will accrue to the overall program. Such disposal methods are not now readily available, so the trade-off is between the costs of the municipal wastewater collection system and the cost of trucking the urine or compost to the wastewater treatment plant. To help establish the cost-effectiveness and public acceptability of composting and urine-diverting toilets, the Town should set up a pilot program of about 10 homes that would voluntarily install these systems and allow their wastewater to be sampled and their costs to be formally documented. If that test program could be successfully completed in the early years of the project, then its application to specific neighborhoods could lessen the cost of the structural program.

11.5.5 Enhancement of Embayment Flushing Rates

In certain embayments impacted by Orleans, the Massachusetts Estuaries Project has identified the opportunity to reduce the extent of necessary sewering by altering the hydrodynamics of the natural system. By increasing the flushing rate, the assimilative capacity of the embayment can be increased. In cases where the downstream water body is less nitrogen sensitive, this may be a low-cost measure with manageable side effects.

The benefits of this approach appear to be sufficient for it to be investigated in detail. That investigation would include a confirmation of the flushing rate changes, a detailed analysis of all costs (including dredge spoil disposal), and a frank assessment of the permitting hurdles. DEP has indicated a reluctance to allow a town credit for this technique, in that it may entail periodic destruction of some or all of the habitat that the nitrogen control program is intended to benefit. Further, there may be significant regulatory prohibitions related to new dredging projects in Areas of Critical Environmental Concern. In light of the fact that Rock Harbor and the inlets to Areys, Lonnies and Pah Wah Ponds have been historically dredged, these embayments should receive the first priority in the investigation. Studies should consider dredging both as a short-term measure (while structural elements of the Core Program are being implemented) and as a routine part of an on-going nonstructural plan.

11.5.6 Land Use Controls

Unsewered development in nitrogen-sensitive watersheds is the fundamental driving force behind the nitrogen loading problem. The costs of solving that problem can be reduced if the growth rate over the 20-year planning period is reduced below the 22% increase that has been the basis of planning to date. Further, an important funding mechanism now in place is only available for wastewater plans that are "growth neutral"; that is, plans that allow no more growth than would have occurred anyway under wastewater and zoning rules in place at the time of CWMP approval by DEP.

Two important land use controls should be pursued by the Town. The first is a regulation or bylaw that restricts development on sewered properties to that level that is allowed under Title 5 and current zoning.

The second measure is an accelerated program of acquisition of open space in nitrogen-sensitive watersheds. When one considers the full cost of extending the sewer system to capture future nitrogen loads, it may be cost effective to apply those funds to land acquisition. In some cases, it may be prudent to acquire land so that the nitrogen load from future development can be avoided, as well as to avoid other non-nitrogen impacts such as traffic.

The Orleans Board of Health has formulated a nutrient loading regulation that is intended to slow the rate of growth of nitrogen loads in unsewered areas and offset the growth that has already occurred since the start of the CWMP process and will occur prior to the first phase of the wastewater facilities. Of the 22% growth factor included in the planning process to date, the nutrient loading regulation would offset about 2 to 5 percentage points. It should be adopted as soon as possible, and seriously considered as a continuing tool for managing nitrogen control even after the wastewater facilities are constructed.

Other land use tools are available to slow the growth of wastewater flow (the important issue in sewered areas) and the nitrogen load from septic systems (the operative factor in unsewered areas). Such measures should be held in abeyance until trends in growth can be better discerned.

With all these non-structural elements, it will be crucial to set forth a methodology for confirming the nitrogen load reductions that actually occur so that regulatory approval can be obtained for reductions in the structural program. DEP officials have instructed the Town to focus its efforts on the structural aspects of this program and not delay progress to evaluate non-structural elements. Nevertheless, well-documented demonstrations of nitrogen removal through non-structural measures may help reduce the cost of later phases of the project.

Capital costs for evaluating non-structural elements of the Core Plan are presented in Section 11.11.

11.6 TMDL COMPLIANCE PLAN

For many U.S. communities, compliance with surface water quality standards is demonstrated by measuring the flow and contaminant concentrations in the discharge from a single municipal wastewater treatment plant, and comparing the results with a single discharge permit. The situation is much more complex on Cape Cod, where the nitrogen loads from a series of activities must be considered and compared with the TMDLs. The regulatory framework for demonstrating compliance is just evolving. DEP has made it clear that the ultimate compliance point is the restoration of habitat (eelgrass or bottom fauna), and that a town is not in compliance with the federal Clean Water Act until watershed nitrogen loads have been reduced to the point where that habitat is restored. The difficult regulatory issue is the travel time of nitrogen in the groundwater and the uncertainties associated with estimating how a reduction in watershed load will impact water-column nitrogen concentrations and how that reduction will lead to habitat restoration. Complicating the issue is the fact that the watersheds of most impacted embayments span multiple towns which may be proceeding with nitrogen control on different schedules and at different paces.

It is understood from discussions with DEP staff that achievement of the nitrogen load reductions implicit in the TMDLs is the only substantive mechanism for compliance over the short term. The threshold nitrogen loads that comprise the TMDLs are the only practical measure of progress, even though long-term monitoring may show that somewhat higher or somewhat lower nitrogen loads may lead to habitat restoration. (Elsewhere in this report, the nitrogen load reductions resulting from the Core Program have been shown to be consistent with published or expected TMDLs, and the added load from effluent disposal at the Tri-Town site has been shown not to exceed thresholds in the Namskaket and Little Namskaket systems.)

It is recommended that the Town of Orleans address this regulatory uncertainty through the phased implementation of a DEP-approved CWMP that includes multiple checkpoints and opportunities for "mid course corrections" based on a number of factors. The Town should be protected against enforcement action by state and federal entities under the Clean Water Act (including consent orders and fines) if:

1. DEP approves the CWMP;
2. The Town proceeds with the phased program outlined in the CWMP;

3. The Town complies with the groundwater discharge permit for the wastewater treatment facility;
4. The Town reports to DEP regularly on the information it will collect to document its progress implementing the plan, including monitoring of embayment water quality and habitat condition; and
5. The full implementation of the Core Program, or logical variations of it, results in whatever improved water quality is necessary to restore critical habitat.

To insure that the Town and DEP agree that the CWMP is being properly implemented, it is recommended that the Town submit an annual report to DEP that documents the following:

- The status of all of its activities called for in the CWMP;
- Spreadsheet-based estimates of the watershed nitrogen loads for all nitrogen-sensitive embayments;
- The results of the water quality monitoring program conducted during the year;
- The results of habitat assessments (may not be done every year);
- Documentation of the capital expenditures expected over the following 5 years, from the Town's Capital Improvement Plan;
- Progress made on non-structural elements of the CWMP; and
- Proposed changes in implementation (such as acceleration or delay of upcoming segments of the plan).

Since water use records form the basis for septic nitrogen loads, the Town should update the analysis reported in the Needs Assessment every five years and include the results in the next annual report to DEP. Similarly, the build-out projections should be updated every five years.

Any significant change from the program contained in the approved CWMP would be submitted to DEP as a formal CWMP amendment after appropriate citizen input and Town Meeting actions. The approved CWMP and approved amendments will document the Town's adaptive management approach.

Prior to the completion of the wastewater planning process, the Town must work with the MEP to model the nitrogen reductions associated with the Recommended Plan to confirm that such reductions will allow TMDL compliance. Such modeling is expected to be a relatively straightforward effort for the Cape Cod Bay and Pleasant Bay portions of the Core Program, because the proposed extent of sewers is closely linked to the percent nitrogen reduction recommended in the TMDL sub-watershed by sub-watershed. We would expect the Nauset System portion to be straight-forward as well, however the TMDL is not available for this watershed. Similar efforts would be needed for any multi-town programs that may be recommended in the Regionalization Study.

11.7 PHASING OF FACILITIES CONSTRUCTION

It is recommended that the Town implement the structural and non-structural aspects of this wastewater plan as part of a phased program. The Core Program, aimed at nitrogen and phosphorus control, should be implemented in six steps. Upon completion of the Core Program, and if conditions warrant, an additional four phases could be implemented to effect the Extended Program of town-wide sewers.

The reasons for phased implementation of Orleans' wastewater plan include:

- The very high cost of building all needed facilities over a short time period.
- The potential benefit of adjusting Orleans' program to accommodate wastewater from neighboring towns whose planning is several years behind Orleans' program;
- Uncertainties in the degree and rate of habitat restoration associated with reductions in watershed nitrogen loads.
- Differing degrees of urgency with respect to declining water quality in various sub-embayments;

- Uncertainties in forecasting the location and rate of town growth;
- The need to synchronize watershed load reductions with other towns sharing a given watershed;
- The need to avoid wholesale disruption of large areas of town during sewer construction; and
- The benefits of demonstrating at full scale the potential capabilities of the Tri-Town soils to accept wastewater at higher rates than currently predicted.

It also should be recognized that phasing has some disadvantages, including:

- The added cost and complexity of segmented construction;
- The risk of missing out on favorable financing that will not be available after 2019.
- The risk that the public bidding process will yield different manufacturers of key treatment equipment from one phase to the next.

While these disadvantages should be considered, they are of less importance than the issues discussed above.

Table 11-2 summarizes a possible phasing plan. It shows the six phases, the structural elements that should be included in each phase, and the activities that should be completed prior to the start of each phase. Phase 1 is the most intensive of the six phases, and includes the construction of one half of the needed capacity for wastewater treatment and disposal, and all of the septage handling capabilities. The remainder of the treatment and disposal capacity would be built in Phases 4 and 5. All of the phases include sewer construction, as the wastewater collection system is gradually expanded to reduce watershed nutrient loads consistent with the available capacity for treatment and disposal.

TABLE 11-2
PRELIMINARY PHASING PLAN FOR CORE PROGRAM

Phase	Construction Elements, % of Core Program	Actions and Decisions to be Considered Before Start of Next Phase
		Completion and validation of MEP studies
		Acceptance of TMDL Compliance Plan by DEP
		Resolution of real estate issues with Tri-Town District
		Preliminary design of all facilities
		Final design of Phase 1 facilities
1	50% Treatment	
	50% Disposal	
	20% Collection	
	100% Septage	
	100% Land	
		Final design of Phase 2 facilities
		Viability of flushing enhancements
2	15% Collection	
	100% Local Systems	
	(cluster systems)	Final design of Phase 3 facilities
		Viability of flow/load reduction measures
3	15% Collection	
		Final design of Phase 4 facilities
		Results of fertilizer reduction program
		Results of stormwater management program
		Viability of So. Orleans regional facility and commitment from Brewster
		Viability of Nauset regionalization and commitment from Eastham
4	50% Treatment	
	25% Disposal	
	15% Collection	
		Final design of Phase 5 facilities
		Results of full-scale rapid infiltration testing
5	20% Collection	
	25% Disposal	
		Final design of Phase 6 facilities
		Results of all efforts to reduce non-structural program
6	15% Collection	

Note: 1) Annual reports to DEP will document results of water quality monitoring and estimates of reductions in watershed nitrogen loads, both of which will be formally assessed prior to the initiation of each phase.

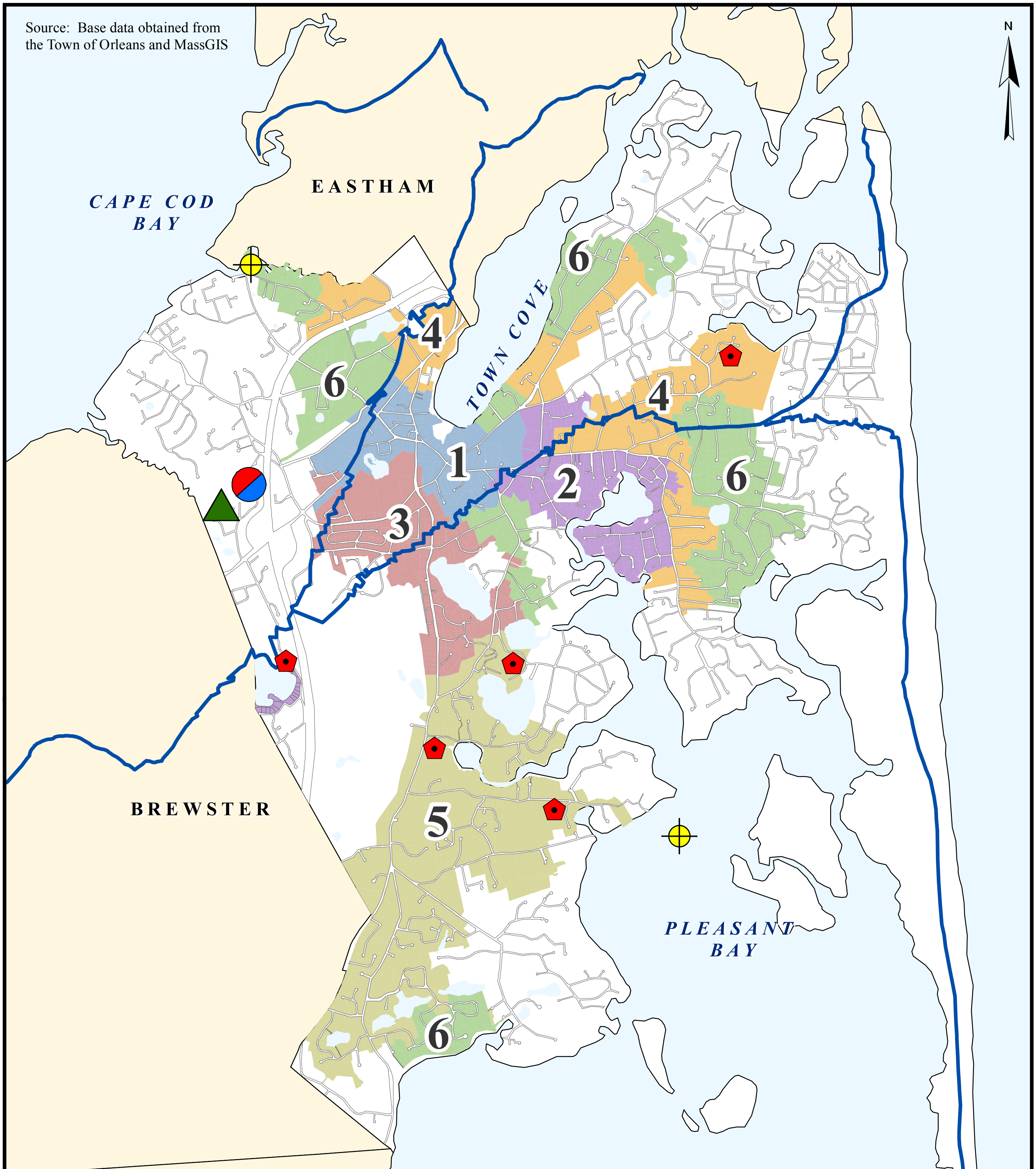
2) Progress by Eastham and Brewster (toward nitrogen removal in watersheds shared by Orleans) should be monitored throughout the Core Program.

Figure 11-4 depicts the geographic location of the six sewer phases. The first five phases reflect the sometimes competing goals of: a) logical geographic expansion, and b) the desire to reach the most threatened embayments as soon as possible. The inclusion of cluster systems for Lonnies Pond, Arey's Pond, Pah Wah Pond and Mill Pond will help to bridge the gap between these competing priorities. The sixth phase will include extensions of the sewer system throughout the remainder of the areas defined in the Core Plan.

The possible phasing plan shown in Figure 11-4 would focus first on the downtown area, where the most nitrogen can be collected with the least amount of infrastructure. Phase 2 would start to address nitrogen control needs at Meetinghouse Pond and The River, and continue the extension of the collection system in an easterly direction. Progression from phase to phase is dictated by the geography of Orleans, the need to build a logical core of the sewer system, and the location of the most stressed coastal waters.

Table 11-3 shows how the watershed nitrogen and phosphorus loads will be reduced in each phase of the Core Program. Phase 1 will provide some nitrogen removal in the Rock Harbor, and Town Cove watersheds, while providing enough wastewater flow for effective treatment. Substantial removal of nitrogen will be accomplished by Phase 2 for the Meetinghouse Pond watershed, the one with the highest nitrogen control needs. More than 80% of the required nitrogen removal will occur by Phase 4 for the Nauset system, by Phase 5 for Pleasant Bay and by Phase 6 for Rock Harbor. Four of the six high priority ponds will be served by Phase 4. The inclusion of clusters systems in the Pleasant Bay watershed accelerates the progress toward TMDL compliance by about 10 percentage points in Phases 2, 3 and 4.

The reader is cautioned that the sewer phasing depicted in Figure 11-4 is but one of many possible approaches. Other options should be considered during the finalization of the CWMP, based on further technical studies, financial analyses and public input. The Town is encouraged to undertake a healthy debate over the speed with which TMDL compliance will be reached and the prioritization of expenditures by watershed.



Wastewater Treatment Site

Effluent Disposal Site

Septage Treatment Facility

Sentinel Stations

Cluster Systems

Service Area Phasing

1	4	5
2	3	6

0 4,000 8,000 Feet

Orleans CWMP

Possible Sewer Phasing Plan

PROJ NO: 10645G DATE: Apr 2009 FIGURE: 11-4

WRIGHT-PIERCE
Engineering a Better Environment

Friday, April 24, 2009 7:56:12 AMW:\GIS_Development\Projects\10645B-Orleans\10645G\April 2009 Draft Report\Fig11-4.mxd

TABLE 11-3
NUTRIENT LOAD REDUCTION BY PHASE

	Percentage of Required[a] Nitrogen Removal			
Phase	**Pleasant Bay**	**Nauset System**	**Rock Harbor**	**Ponds [b]**
1	<1	30	34	
2	24[c]	32	34	Bakers*, Reubens
3	31[c]	52	39	Crystal*, Boland's*
4	44[c]	86	49	Ice House*
5	80	86	49	Pilgrim*, Shoal*, Uncle Seths, Twinings
6	100	100	100	Cedar*, Uncle Harveys

Notes: (a) "Required" is based on Pleasant Bay TMDLs, Rock Harbor MEP technical report and preliminary Nauset estimates.
(b) * Denotes the first and second priority ponds identified in Table 3-4.
(c) Cluster systems represent about 10 percentage points in Phases 2, 3 and 4.

Phases 1 and 2 of the Core Program are critical early building blocks of this program and should be implemented as soon as is practical. For initial discussion purposes, it is expected that all six phases of the Core Program will be built over 15 to 20 years, and that the Extended Program would require another 15 to 20 years. Detailed financial planning will be needed to determine if the Town can practically meet those broad preliminary goals. To initiate that financial planning, the following schedule is proposed:

Construction of Phase 1	2013 to 2015
Construction of Phase 2	2016 to 2018
Construction of Phase 3	2019 to 2021
Construction of Phase 4	2022 to 2024
Construction of Phase 5	2025 to 2027
Construction of Phase 6	2028 to 2030.

This schedule would involve 24 months of construction activity every three years, and would allow completion of the Core Program in 17 years.

11.8 REGIONALIZATION

Benefits may accrue to the Town of Orleans if it shares its proposed wastewater facilities with other towns. The two best opportunities are associated with Eastham and Brewster.

The Town of Eastham will be required to remove nitrogen from the Nauset embayment, just as will Orleans. Eastham's options include building its own wastewater facilities and sharing facilities with Orleans. A preliminary estimate of Eastham's nitrogen control needs in that watershed translates to about 160,000 gallons of wastewater per day on an average annual basis. Pending completion of ongoing regionalization studies, Orleans should consider reserving capacity for Eastham's wastewater in the proposed new facilities at the Tri-Town site, based on the expected cost advantages to both towns. Since Eastham has just begun formal wastewater planning, its decision-making process may not allow participation in Orleans' first-phase project. It would be prudent however to keep the lines of communication open with Eastham with the possibility of including capacity in a later phase.

Nitrogen loads from the Town of Brewster are estimated to be about 11% of the total nitrogen loads to Pleasant Bay. Those loads exist in the watersheds of sub-embayments that are nitrogen sensitive; consequently some degree of nitrogen control is required. The phased construction of wastewater facilities at the Tri-Town site will allow the Town of Orleans to monitor Brewster's progress with wastewater planning and possibly to participate with Brewster in a Pleasant-Bay focused regional solution, similar to Plan 3, but involving wastewater only from South Orleans. That facility could also include flow from easterly portions of Harwich and northerly neighborhoods of Chatham. The deferral of sewer construction in South Orleans until Phase 5 (see Tables 11-2 and 11-3 and Figure 11-4) is intended to accommodate that decision-making process, based on the expected cost advantages.

The Town of Orleans is evaluating these regionalization opportunities under a grant from the Cape Cod Water Protection Collaborative. That study will not be complete until after the publication of this draft CWMP, but its results will be incorporated in the final CWMP.

Regionalization opportunities also exist with respect to septage. The new Orleans wastewater facilities will include capacity for Orleans septage, and can also provide for septage from Eastham, Brewster and other nearby towns. The regional concept has been successful in the Ti-Town District, and an expansion of that relationship to include cooperation on wastewater management may be beneficial to Orleans, Eastham and Brewster.

11.9 SOIL AND GROUNDWATER STUDIES AT TRI-TOWN SITE

11.9.1 Studies Conducted to Date

To determine the suitability of the Tri-Town site for wastewater disposal, studies have been undertaken to characterize the site soils and to model the local and regional groundwater movement. The first evaluation, including a large-scale hydraulic loading test, was completed in February 2008 and is reported in Appendix E. Appendix F includes a report on the second evaluation, which focused on groundwater mounding and regional groundwater flow, and that was completed in June 2008.

These studies were conducted to address four potential limitations on effluent disposal at this location. Those potential limitations, and the results of these studies, are as follows:

Surficial Soil Permeability. The surface soils must be sufficiently permeable to accept the quantities of wastewater that will be applied during the highest periods of the design year. Based on preliminary layouts of the site, a loading rate of more than 6.7 gallons per day per square foot is needed to be able to properly dispose of the effluent quantities expected at the completion of the Core Program. Permeabilities were determined to be somewhat variable across the site, but sufficient to allow a composite loading rate of 7.7

gallons per day per square foot. Therefore the site has capabilities for effluent disposal beyond the Core Program.

Mounding. The application of wastewater effluent will cause the groundwater to rise in a mound under the site. Analytical and numerical modeling shows that the top of the mound will be no closer than 25 feet below the ground surface, well below the 4-foot minimum separation required by DEP.

Local impacts of Mounding. The higher groundwater resulting from effluent application at the site must not cause flooding of the basements of nearby homes, unacceptable reductions in separation of local septic systems from the seasonal high water table, and substantial surface water flow into nearby wetlands. The groundwater modeling shows that the mound dissipates quickly downgradient from the site, and that such impacts will not occur.

Disposition of Effluent-Impacted Groundwater. The wastewater effluent will contain low levels of nitrogen. The regional groundwater flow will carry that nitrogen downgradient to Cape Cod Bay and associated wetlands. Groundwater modeling shows that the new nitrogen loads from effluent disposal will not cause the overall watershed loads to exceed their respective assimilative capacities, as reported in the draft MEP technical reports. The modeling shows that none of the effluent nitrogen will flow to Town Cove or Rock Harbor, two systems that are believed to be already over their nitrogen thresholds.

11.9.2 Future Testing Program

The recent testing program at the Tri-Town site has been sufficient to confirm its suitability for the quantities of effluent expected from the Core Program, and a bit beyond. As this draft CWMP is being developed, additional soil testing is underway to determine the site's capabilities in areas not previously tested. Further, once the first phase of effluent disposal facilities is constructed and placed in operation, those initial rapid infiltration basins should be subjected to full-scale testing as the best way to definitely determine long-term capacity. That testing will be very helpful in the design of later phases of the effluent disposal facilities, with possible cost savings.

11.9.3 Long-term Monitoring Plan

Once operation of the new wastewater facilities begins, the groundwater impacts will be measured through a series of monitoring wells within and around the periphery of the site. Those monitoring wells will be used to confirm the mounding analysis reported herein and will form the basis for possible future actions. Monitoring wells downgradient from the site will be used to discern any higher-than-expected water table elevations that might impact cellars or septic systems. This long-term monitoring program should be viewed as a very conservative approach. Extensive investigations at the Tri-Town site (spanning several decades) has shown quite definitively the suitability of this location for effluent disposal without significant impact on local groundwater levels.

11.10 IMPLEMENTATION STEPS

The recommended wastewater management plan is a complex one, with multiple phases, structural and non-structural components, and significant financial impact on the Town. Many administrative steps must be taken to properly implement the plan and ensure its efficient and effective operation.

11.10.1 Establishment of a Managing Entity

With no existing wastewater facilities and no public works department, the Town of Orleans must create a management entity for this Plan. Significant steps in this direction have been taken through a change in Town charter that will allow the formation of a Board of Water and Sewer Commissioners, incorporating and building on the existing Board of Water Commissioners. The final step in its formation will be a town-wide ballot question in the spring of 2009. Assuming passage, the next important step will be the assignment of existing staff or hiring of an individual to serve as Wastewater Superintendent. That person can have a vital role in the implementation of this plan. Other tasks include developing and implementing a staffing plan (including certified operators and a project manager for construction), making arrangements for office space, deciding on a method of internal financial management (enterprise fund versus special revenue fund) and determining appropriate interfaces with other Town departments and boards.

11.10.2 Land Acquisition

It is generally advisable for a town to identify all of the parcels it must acquire for the project and to acquire them (fee simple interest or easement) at the beginning of the project. Parcel identification should occur as part of preliminary design activities slated to begin in 2009. The extent of sewer construction in private roads should be addressed through a comprehensive easement process.

11.10.3 Regulations, Bylaws and Policies

Existing Town codes should be supplemented with bylaws and regulations that enable the Town to effectively implement the proposed wastewater plan.

The Town should adopt a regulation or bylaw that restricts flow from sewered properties to the maximum flow that the parcel could sustain under Title 5. Such a limitation is necessary to obtain the most favorable funding under the State Revolving Fund, and, for consistency with the overall goal of formulating a "growth neutral" wastewater plan.

One of the most fundamental needs is for a set of Sewer Use Rules and Regulations. These would establish policies and procedures related to new sewer connections, allowable and prohibited discharges, user fees, and many administrative matters. These Rules and Regulations should be drafted by the Water and Sewer Department staff, with assistance from the Town's wastewater consultant, and promulgated during the design phase of the Core Program.

As part of the Sewer Use Rules and Regulations, the Board of Water and Sewer Commissioners should detail the requirements and restrictions related to a "checkerboard" sewer system. These provisions should be in accordance with the 2008 Environmental Bond Bill, or the Town's separate special legislation, or both. The Town must have clear authority to reject an application for sewer service if the connection of that property is not in accordance with the CWMP. The clearest example of this restriction is where the wastewater collection system must pass through watersheds that are not nitrogen sensitive, such as the Namskaket and Little Namskaket systems. It may also apply when applications are made to connect lightly developed neighborhoods with a relative high cost of service per foot of collecting pipe.

Another important document is the User Charge System. This plan establishes the basis for billing for wastewater services. It should be drafted by the Water and Sewer Department staff, with assistance from the Town's wastewater consultant, and adopted during the design phase of the project.

The Orleans Board of Health has drafted and received public input on a nutrient control regulation that is intended to slow the growth of nitrogen loading in the watersheds of sensitive embayments and to account for some of the growth in nitrogen load that has occurred since the start of the planning process (and that will continue to occur through the completion of Phase 1 facilities). That regulation should be adopted in the near future and its effectiveness and need re-evaluated when Phase 1 facilities come on line.

The Board of Health should adopt a policy that allows the deferral of construction of new septic systems, particularly those that include enhanced treatment systems, for properties to be included in the early phases of sewer construction. Such deferral should be accompanied by the placement in escrow the avoided costs to be later applied toward that property's betterment assessment.

A policy on private wastewater facilities should also be adopted by the Board of Health. That policy should establish guidelines for the use of nitrogen-removing septic systems in the watersheds of nitrogen-sensitive embayments, and town-wide. In general, the Town should not encourage nitrogen-removing systems on individual lots, since the extent of the sewer system has been formulated to allow all unsewered parcels to get by with simple Title 5 systems, and expenditures for individual nitrogen removing systems are a diversion of capital. Exceptions may be needed for near-shore-areas located in the later phases of the Core Program, where the time needed to provide public sewer may be comparable to the design life of the individual system. Another exception would involve situations where enhanced treatment is needed to address public health issues related to inadequate setbacks or depth to groundwater.

11.10.4 Permitting

There are a number of regulatory programs and permitting requirements that apply to the planning, design and implementation of the Recommended Plan. These include:

- DEP approval of the CWMP.
- DEP Groundwater Discharge Permitting under 314 CMR 5.0. A groundwater discharge permit is required for the new wastewater facilities planned for the Tri-Town site. Depending on the plan for short-term septage management, the existing permit held by the Tri-Town District may need to be extended for two or more years beyond its current 2012 end date.
- Compliance with the federal Clean Water Act through nitrogen-based TMDLs as implement by DEP.
- DEP Reclaimed Water Guidelines will apply to any effluent reuse activities.
- DEP Plan Review is required for the proposed new wastewater treatment facility, once final plans and specifications have been prepared.
- DEP Site Assignment under MGL Chapter 83 Section 6 is required for any publicly-owned wastewater site. The existing site assignment for the Tri-Town site may need to be expanded to account for the proposed wastewater facilities
- DEP Sewer Extension Permits will be needed for system expansion after completion of the first phase.

- Compliance with the Massachusetts Wetlands Protection Act and local supplemental bylaws is necessary for all impacts on protected resources.
- The project must be reviewed under the requirements of the Massachusetts Environmental Policy Act (MEPA) which will require both an Environmental Notification Form and an Environmental Impact Report.
- The project must comply with the Cape Cod Commission's Regional Policy Plan and undergo review as a Development of Regional Impact (DRI).
- Review must be conducted under the Massachusetts Natural Heritage and Endangered Species Program, pursuant to the Massachusetts Endangered Species Act; see Section 8.5.7 for a discussion of issues related to Eastern Box Turtles.
- Review must be conducted under the program of the Massachusetts Historical Commission; see Section 8.5.8 related to archaeological resources.
- All activities must be consistent with the two Areas of Critical Environmental Concern.
- Compliance with the regulations of the Old Kings Highway Regional Historic District is required for above-grade structures located in the District (all areas of Orleans north and west of Route 6A).
- The Town must issue building permits for treatment facilities and pumping stations after compliance with the State Building Code is demonstrated.
- Permits are required from Mass Highway for all construction work in state roads.

Compliance with these programs must be demonstrated at various stages of project development.

11.10.5 Coordination with OBEGWPD on Septage Management and Land Requirements

Septage and grease wastes pumped from properties in Orleans are now disposed of at the Tri-Town Septage Treatment Facility. The buildings, tanks and equipment are owned and operated by the Orleans Brewster Eastham Groundwater Protection District (OBEGWPD). The 26-acre site is owned by the Town of Orleans.

One option for constructing the Phase 1 wastewater facilities at the Tri-Town site would be to utilize land not currently used by the District. This would allow septage handling in District facilities during the construction period. The Phase 1 wastewater facilities should include new modern septage handling facilities, which, once completed, can replace the aging plant and equipment owned by the District. Therefore, the Tri-Town facilities could be abandoned, demolished or partially reused once Phase 1 is complete. The proposed construction by the Town of Orleans on the Tri-Town site would require an amendment to the existing inter-municipal agreement if construction is to occur before 2015. (Resolution of real estate issues with the Tri-Town District will require a full legal review of the inter-municipal agreement and development of alternatives by the Orleans Board of Selectmen for discussion with its counterparts in Brewster and Eastham.)

New septage handling facilities should be sized for the reduced septage quantities from Orleans. They can also include capacity for septage from Eastham and Brewster, the other members of the District, as well as from other nearby towns. Groundwater modeling and nitrogen mass-balance analyses have demonstrated that a regional septage handling capability will not cause the assimilative capacities of Namskaket and Little Namskaket systems to be exceeded.

To ensure a smooth transition, the Town of Orleans should:

- Make whatever arrangements are needed to build Phase 1 facilities on the land the Town owns at the Tri-Town site that is not currently used by the District.
- Coordinate with Brewster and Eastham Boards of Selectmen on the abandonment, demolition or reuse of District buildings and tanks;
- Support the development of a contingency plan to address potential major equipment repairs and funding limitations; and
- Approach towns in the region to discuss providing dedicated capacity in the new wastewater facility for septage receipt and treatment.

Those discussions should begin in the near future, with a goal of obtaining Eastham and Brewster concurrence with the septage management aspects of the Recommended Plan by mid

2009. The contingency plan should be completed and put into place in 2009. Clear access to the site should be obtained by mid 2010.

11.10.6 Coordination with Brewster and Eastham on Wastewater Regionalization

The Town of Orleans has embarked on a wastewater regionalization study, funded by the Cape Cod Water Protection Collaborative, which is expected to show that cost savings can accrue to both Orleans and its neighbors through shared wastewater facilities. That study will be completed after the issuance of this draft CWMP, but before the final CWMP is completed. Orleans should address the recommendations of that study as soon as they are available and if appropriate, begin discussions with Eastham and Brewster to be able to adjust the phasing program to reflect possible participation by those towns. These discussions should be part of a DEP-mediated assessment of watershed-wide progress toward TMDL compliance.

11.10.7 Pond and Estuary Monitoring

A critical part of the Town's adaptive management approach is the monitoring of water quality in its ponds and sensitive embayments. With respect to the nitrogen-based TMDLs, monitoring is needed to demonstrate eventual compliance. As important, however, is regular monitoring to establish baseline conditions and then to track progress toward the TMDLs that will allow adjustment of the phased program. Monitoring must include water column concentrations of nitrogen and other key parameters, as well as periodic assessments of eelgrass coverage and the number and diversity of bottom organisms.

The Town should work closely with the Pleasant Bay Alliance which is developing a monitoring program for that estuarine system in conjunction with DEP. The Pleasant Bay monitoring program should serve as good basis for similar programs for other embayments impacted by Orleans. Existing pond monitoring programs should be reviewed and adapted as necessary to track improvements related to phosphorus loading. The final CWMP will present a summary of those programs based on progress expected in late 2008 and early 2009.

While wastewater sources of nitrogen dominate the nutrient loading to coastal waters, freshwater ponds receive phosphorus loads from other significant sources such as runoff, waterfowl and benthic recycling. The Town should systematically evaluate all of its major freshwater ponds to determine what other phosphorus controls are needed to supplement the reduction in wastewater loadings effected through the Core Program.

11.10.8 Energy Conservation/Generation and Green Design

Wastewater management facilities use large amounts of energy to run equipment, to heat and ventilate structures and to fuel vehicles. An energy conservation plan should be developed as part of the preliminary design of the structural elements of the Core Program to ensure that all cost-effective energy conservation and generation options are appropriately considered. Such a study is required under MGL Chapter 149, Section 44M. Appendix D contains a list of primary areas for energy conservation that will be evaluated in the preliminary design. At that time, the decision should be made on whether or not to pursue LEED certification of the major buildings associated with the wastewater treatment plant. The LEED program (Leadership in Energy and Environmental Design) establishes benchmarks against which building design can be judged, and should be pursued to the extent that the program identifies capital expenditures with reasonable pay-back periods.

The Tri-Town site is being considered as the location for a Town wind turbine. The preliminary design of wastewater facilities should be closely coordinated with the efforts of the Town Renewable Energy/Wind Committee to ensure appropriate synergy.

11.10.9 Water Service to Properties Near Wastewater Disposal Locations

While the design and siting of all new wastewater facilities will be in full accordance with all applicable regulations and codes, it would be prudent for the Town to ensure that public water service is provided to all developed properties located downgradient from all effluent disposal locations.

11.10.10 Independent Review of MEP Studies

In early 2009, the Town hired an independent contractor to review certain aspects of the MEP technical report for Pleasant Bay. The DEP may be initiating an effort to more broadly review the technical aspects of the linked watershed-embayment models used in the MEP approach. The findings of these studies should be reviewed and incorporated in the final CWMP.

11.10.11 Implementation Schedule

Some of the many important implementation steps are summarized in Table 11-4, which includes a tentative schedule for action.

Based on the Special Town Meeting endorsement of the October 2008 draft CWMP on October 27, 2008, the final CWMP should be prepared for publication by late 2009. Many important steps should occur during the finalization of the CWMP, including completion of the Regionalization Study, completion and validation of MEP technical studies, initial review through the MEPA program, and additional soils testing at the effluent disposal site. The Final CWMP should be submitted to DEP for approval with a target approval date of April 2010.

This CWMP is subject to review by the Executive Office of Energy and Environmental Affairs under the Massachusetts Environmental Policy Act (MEPA) and by the Cape Cod Commission as a Development of Regional Impact (DRI). A joint review process has been established, with a goal of initiating this review in the spring of 2009 based on this updated draft CWMP.

Table 11-4 also lists the key steps in the preliminary and final design processes, leading up to bidding of Phase 1 construction contracts late in 2012, to allow the start of construction in July of 2013. Once the preliminary design is complete for the sewer system, it should be coordinated

TABLE 11-4
SCHEDULE FOR IMPLEMENTATION TASKS

CWMP Completion	
Public Hearing on Draft CWMP	Oct 2, 2008
Special Town Meeting to Endorse Draft CWMP	Oct 27, 2008
Updating of Draft CWMP	Apr 2009
Submittal of MEPA Environmental Notification Form (ENF) and DRI application	Early May 2009
EOEEA Secretary's decision on ENF	Mid Jun 2009
Completion of Regionalization Study	Jun 2009
Completion of Town's independent review of MEP Pleasant Bay report	Jun 2009
Modifications to CWMP for MEP Nauset report	Aug 2009
Confirmatory embayment modeling	Oct--Nov 2009
Complete Final CWMP	Dec 2009
Submit CWMP to MEPA and Commission as EIR	Jan 2010
EOEEA Secretary's decision on EIR	Mar 2010
DEP approval of Final CWMP	Apr 2010
Design and Construction	
Annual Town Meeting appropriation for preliminary design	May 2009
Begin preliminary design	Jul 2009
Complete preliminary design	Apr 2010
Conduct land surveys	Mar--Aug 2010
Annual Town Meeting appropriations for final design and land acquisition	May 2010
Begin final design for Phase 1 facilities	Jul 2010
Complete design for Phase 1 facilities	Nov 2011
DEP approval of Phase 1 plans and specifications	Mar 2012
Obtain Groundwater Discharge Permit	Apr 2012
Bidding for Phase 1 facilities	Oct--Dec 2012
Annual Town Meeting appropriation for construction of Phase 1 facilities	May 2013
Award construction contracts	Jun 2013
Start construction of Phase 1 facilities	Jul 2013
Complete Phase 1 construction and start up Phase 1 facilities	Jun 2015
Administrative Items	
Annual Town Meeting approval of "growth neutral" bylaw	May 2009
Voter approval of Board of Water and Sewer Commissioners	May 2009
Hire project manager	Jul 2009
File SRF Project Evaluation Form	Aug 2009
Complete financing plan	Jul 2010
Complete site assignment	Apr 2012
Adopt Sewer Use Rules and Regulations	Jan 2014
Adopt User Charge system	Jan 2014
Hire staff for wastewater facilities	Jul 2014 to Jun 2015
Complete O&M Manual	Jan 2015

with the Town's road maintenance plan and any actions intended to take over private roads that may otherwise be subject to easements.

Important administrative steps are outlined in Table 11-4. These include establishing the Board of Water and Sewer Commissioners in 2009, completing the financing plan in 2010, adopting Sewer Use Rules and Regulation and a User Charge System in 2013 and hiring key operational staff in 2014 and 2015.

11.11 FINANCIAL PLAN

11.11.1 Current Estimates of Cost

As a basis for cost estimating, preliminary sizing has been conducted for the various structural elements of the recommended plan, including the collection system, the central treatment system, the effluent disposal facilities, the local treatment and disposal systems, and the septage handling facilities. This preliminary sizing information (see Appendix D) has been used to estimate the costs to build and operate the structural facilities.

11.11.2 Capital Costs

The capital costs of a public infrastructure project include both the costs of construction and the ancillary expenses for land, design, construction oversight, start-up and other essential items needed to create a self-sustaining system. Table 11-5 presents the current preliminary estimate of capital costs. Of the approximate $100 million construction cost, about three quarters is associated with the collection system and the rest with treatment and disposal and with septage handling. When costs for land, contingencies, engineering and legal expenses are included, a total capital cost of approximately $150 million is indicated.

The costs presented in Table 11-5 are expressed in mid 2008 dollars, and suitable inflationary factors must be considered to project those costs into the future. For simplicity, these estimates do not yet include the added costs of constructing the project in phases. A preliminary estimate of capital costs for Phase 1 is $50 to $60 million. The normal course of project development will include a preliminary design phase and a final design phase, both of which allow the opportunity to update costs estimates based on increasingly more detailed information.

The costs presented in Table 11-5 pertain only to the Core Program. Should the Town later decide that the Extended Program is needed or desired, approximately $96 million (2008 dollars) would be added to the capital cost.

TABLE 11-5
PRELIMINARY ESTIMATE OF CAPITAL COSTS FOR CORE PROGRAM

Component	Cost, $ million
Collection System	73.2
Central Treatment System	19.3
Effluent Disposal Facilities	5.5
Septage Handling	2.2
Local Treatment/Disposal Systems	1.3
Construction Subtotal:	**101.5**
Site Investigations (soils, archaeology)	0.6
Land	5.2
Evaluation of non-structural elements	0.3
Engineering, Legal and Administrative	15.2
Contingencies	25.4
Total:	**148.2**

Notes: All costs expressed in mid 2008 dollars.
No premium included for phased construction.

11.11.3 Operation and Maintenance Costs

Once the structural aspects of the recommended plan are in place, the Town will incur significant on-going costs for operation and maintenance (O&M). Table 11-6 presents a preliminary estimate of those costs, which total approximately $1.4 million per year. Labor, energy and sludge disposal are the most significant items and account for nearly 75 percent of the total. No credit has been included for revenues from septage haulers, nor have the costs of the Extended Program been included.

As with the capital costs, the preliminary and final design work will provide opportunities for updating these preliminary figures.

TABLE 11-6
PRELIMINARY ESTIMATE OF
OPERATION AND MAINTENANCE COSTS FOR CORE PROGRAM

Component	Cost, $ per year
Labor	580,000
Chemicals	50,000
Electricity	184,000
Fuel	50,000
Sludge Disposal	204,000
Maintenance	109,000
Equipment Replacement	83,000
Laboratory and Monitoring	40,000
Administrative	40,000
Engineering	30,000
Total:	**1,370,000**

Notes: All costs expressed in mid 2008 dollars.

11.11.4 Application for SRF Loans

The Town should view the State Revolving Fund (SRF) as a primary financing mechanism for the capital costs of this project. This program typically provides favorable interest rates for eligible costs and a 20-year repayment schedule. Eligible costs include most collection, treatment and disposal facilities, but do not include design costs or land purchase. The Massachusetts DEP administers this program. The Town should submit a Project Evaluation Form in August 2009 to provide DEP with an outline of the project and current cost estimates. DEP applies a series of priority rankings to determine which projects receive funding in given year, and places the selected projects on its Intended Use Plan annually. Factors that contribute to higher priority ratings include: the severity of the problem to be corrected by the project, regionalization, and the existence of any state or federal enforcement actions.

The SRF program is currently being revised to include a new more favorable financing mechanism provided under the 2008 Environmental Bond Bill. Orleans should be a prime candidate for that favorable financing for projects which focus on nutrient management. The bill sets forth five criteria:

- The project must have a nutrient management focus,
- The applicant must be free from enforcement orders related to nutrient control,
- The project must stem from a DEP-approved CWMP,
- The CWMP must be consistent with any applicable regional water resources management plans, and
- The approved plan must be "growth neutral"; that is, it should not allow any more wastewater flow than would have occurred anyway under current zoning and wastewater requirements.

This CWMP is being developed to comply with all of these criteria. The financing under this new program will include the equivalent of zero percent loans, and the term of the loan is 30 years. The legislation that establishes this financing program also extends the maximum allowable term for betterment assessments to 50 years.

11.11.5 Potential for Grants

The most applicable grant program for Orleans is administered through the Rural Development program of the US Department of Agriculture. Grants are available for up to 45% of eligible project costs, based on median family income, but typical state allocations are unlikely to be sufficient to cover any significant portion of the Orleans project cost. Loan funding is also available. Current terms are 3.75% ("intermediate rate") for 30 years.

As the project evolves, other grant funding should be pursued, including demonstration grants for evaluation of some of the non-structural plan components.

11.11.6 Financing Policy with Respect to Betterments and Taxes

The Town must establish a detailed plan that allows these very large capital and operating expenditures to be funded in a way that maintains the Town's sound financial standing. While that plan will evolve during the design phase of the project, certain policies need to be established to allow the public to understand the impacts on individual property owners. Those policies include:

- Recovery of annual operation and maintenance costs from users proportional to their wastewater flow; and
- Balancing betterment assessments and property tax increases to reflect the mix of benefits that accrue only to users and those benefits that accrue to all taxpayers.

On August 27, 2008, the Orleans Board of Selectmen addressed the latter issue, by establishing the goal of equalizing the annual costs paid by users and non-users. Based on preliminary cost information available at that time, the Board set forth a policy of recovering 80% of the project debt service through property taxation (paid by users and non-users) and 20% through betterment assessments (paid only by users).

11.11.7 Costs to Typical Users and Non-Users

Table 11-7 presents current estimates of the equivalent annual costs to typical sewered users and those who continue with private on-site septic systems. The basis for these cost estimates is presented in the notes of the table. Based on the August 27, 2008 Selectmen's policy, recovering 80% of the project costs through the property tax results in a rough equivalency between sewered and unsewered users, for the stated assumptions. While there may be property owners who are faced with different costs than the "typical" owner, this interim policy should eliminate any significant incentive for most residents to either seek or avoid sewer service.

For the owner of a $700,000 home (the 2008 average assessed value), the equivalent annual cost for the Core Program is about $2,600, given the assumptions listed in Table 11-7. For the owner of a $300,000 condominium in the 15% federal tax bracket, the equivalent annual cost would be approximately $2,100, other factors being equal. The equivalent cost would be approximately $3,400 per year for the owner of a $1,500,000 home in the 35% tax bracket.

TABLE 11-7
EQUIVALENT ANNUAL COSTS FOR TYPICAL RESIDENTS

	Equivalent Annual Cost, $/year	
Cost Item	**Typical Sewered Home**	**Typical Unsewered Home**
Betterment Assessment	623	0
Property Tax Increase	1,231	1,231
Sewer Connection	648	0
Septic System Replacement	0	1,570
Septage Pumping	0	88
User Fee	435	0
Income Tax Reduction	-345	-345
Total:	**2,592**	**2,544**

Basis: 20% of municipal debt service recovered from betterment assessments
80% of municipal debt service recovered from property taxes
$5,000 sewer connection cost financed at 5% over 10 years
$18,000 septic system replacement cost financed at 6% over 20 years
Typical home assessed at $700,000
Increased property tax deductible from federal income tax (28% bracket)
O&M costs of wastewater system recovered from 3,100 equivalent users

11.12 ENVIRONMENTAL MITIGATIONS

There are many mitigation measures that will be employed in the implementation of the Recommended Plan that will lessen its environmental impacts. These are described in detail in Section 8 of this report and include:

- Restricting sewer construction work to the period of October to May to avoid periods of high traffic;
- Segmenting sewer work on public streets to avoid protracted closures;
- Designing sewer lines and pump stations to avoid floodplains and to minimize encroachment on the buffers of wetlands and other protected resource areas, including compliance with all Coastal Zone Management conditions;
- Consideration of cross-country sewer routes to avoid traffic impacts during construction;
- Restricting work hours on construction sites near residential areas;
- Requiring contractors to implement dust control measures;
- Erosion and siltation controls at all construction sites as part of site-specific stormwater management plans;
- Compliance with all terms of Orders of Conditions for work in wetland buffers;
- Installation of odor and noise control systems on operating equipment and facilities;
- Implementation of policies that restrict potential odor-generating activities to times of the day with the least impact;
- Compliance with applicable standards for construction activities near historic structures, including compliance with local and Massachusetts Historical Commission conditions;
- Facility siting to avoid, minimize, and mitigate impacts to habitat of rare and endangered species, including compliance with all NHESP conditions;
- Facility site design to include vegetated berms and to maximize natural buffers; and
- Selection of wastewater treatment equipment to minimize energy use and maximize nitrogen removal.

The details of these mitigation measures must be closely coordinated with the applicable review agencies during the design phase of the project.

WRIGHT-PIERCE

Engineering a Better Environment