

MARTHA'S VINEYARD
WASTEWATER MANAGEMENT STUDY



Prepared for:

Martha's Vineyard Commission

Prepared by:
Wright-Pierce

May 2010

WRIGHT-PIERCE 
Engineering a Better Environment





TABLE OF CONTENTS

	Page No.
CHAPTER 1--INTRODUCTION	1-1
CHAPTER 2--PRELIMINARY NEEDS ASSESSMENT	
Island-Wide Land Use and Demographics	2-1
Existing Wastewater Infrastructure	2-1
Existing Water Infrastructure	2-1
Overview of Wastewater Needs	2-4
Estimate of Island-Wide Wastewater Flows	2-4
CHAPTER 3--IDENTIFICATION AND EVALUATION OF MANAGEMENT STRUCTURES	
Introduction	3-1
Basic Functions to be Accomplished.....	3-1
Typical Current Practices.....	3-2
Alternative Management Structures	3-3
Evaluative Criteria.....	3-5
Evaluation of Options with Respect to Criteria	3-6
CHAPTER 4--IDENTIFICATION AND EVALUATION OF WASTEWATER TREATMENT APPROACHES	
Introduction	4-1
Definitions.....	4-1
Nitrogen Removal Capabilities	4-2
Generalized Cost Estimating Approach.....	4-6
Generalized Cost Estimates	4-9
Application of Generalized Costs to Martha's Vineyard	4-16
CHAPTER 5--IDENTIFICATION AND EVALUATION OF REGULATORY TOOLS	
Introduction.....	5-1
Description of Tools for Individual Septic Systems.....	5-1
Description of Tools for Coastal Pond Protection	5-3
Description of Tools for Minimizing Impacts of Discharges	5-5
Evaluative Criteria.....	5-6
Ranking of Tools with Respect to Evaluative Criteria	5-7
CHAPTER 6--REVIEW OF EXISTING POLICIES, BYLAWS AND REGULATIONS	6-1
CHAPTER 7--NITROGEN CONTROL CASE STUDIES	
Goal	7-1
Overview.....	7-1

Aquinnah Case Study	7-1
Chilmark Case Study.....	7-5
Edgartown Case Study.....	7-8
Oak Bluffs Case Study.....	7-11
Tisbury Case Study.....	7-14
West Tisbury Case Study.....	7-16
Important Lessons from Case Studies	7-19

CHAPTER 8--GUIDANCE FOR FUTURE WASTEWATER MANAGEMENT PLANNING

LIST OF TABLES AND FIGURES

Table 2-1. Land Use and Population Data
Table 2-2. Existing Wastewater Treatment Facilities
Table 2-3. Wastewater Flow Estimates - Current Conditions
Table 2-4. Wastewater Flow Estimates - Future Conditions.
Table 2-5. Nitrogen Loads to Principal Watersheds
Table 4-1. Typical Effluent Limitations for Facilities Larger than 10,000 gpd
Table 6-1. Summary of Current Wastewater-Related Regulations
Table 7-1. Overview of Case Studies
Figure 4-1. Types of Wastewater Systems
Figure 4-2. Mix of Centralized and Decentralized Systems
Figure 4-3. Generic Wastewater Management System
Figure 4-4. Results of Construction Cost Survey
Figure 4-5. Results of O&M Cost Survey
Figure 4-6. Capital Costs for Wastewater Management Options
Figure 4-7. Equivalent Annual Costs for Wastewater Management Options
Figure 4-8. Nitrogen Removal Costs for Wastewater Management Options
Figure 7-1. Case Study Locations
Figure 7-2. Aquinnah Case Study
Figure 7-3. Chilmark Case Study
Figure 7-4. Edgartown Case Study
Figure 7-5. Oak Bluffs Case Study
Figure 7-6. Tisbury Case Study
Figure 7-7. West Tisbury Case Study

CHAPTER 1 -- INTRODUCTION

PROJECT GOALS

The Martha's Vineyard Commission has embarked on this study to assist the six Island towns in wastewater management planning. Martha's Vineyard is faced with significant challenges in restoring and maintaining water quality in coastal ponds, where excessive nitrogen loading has resulted from on-site wastewater disposal and other causes. The watersheds of these ponds typically span two or more towns, so regional solutions are needed. Each of the towns might normally conduct expensive studies called comprehensive wastewater management plans. While such studies may be needed in certain cases, this study is intended to substitute for those projects in some cases and to help direct later more formal activities in other towns.

PROJECT APPROACH

This study has been conducted as a series of inter-related tasks. First a broad assessment has been conducted of the wastewater management needs on the Island that is based on an up-to-date evaluation of assessors and water supplier data. Next, a number of wastewater management structures has been identified and evaluated, ranging from individual towns acting alone to various regional approaches. Four technical approaches to wastewater treatment and disposal have been evaluated, including individual on-site systems, small cluster systems, satellite plants and traditional municipal wastewater facilities. Their effectiveness and cost have been analyzed. Then many regulatory tools were identified and evaluated as to their effectiveness in addressing wastewater nitrogen impacts given local needs and circumstances. Last, a review has been conducted of existing regulations, bylaws and policies to ascertain their effectiveness and to recommend possible enhancements. From all of this evaluation, the Towns and the Commission can formulate an informed plan to facilitate wastewater management improvements.

REPORT STRUCTURE

This report is presented in eight chapters. Following this introduction, Chapter 2 summarizes pertinent land use and demographic information and presents an Island-wide estimate of wastewater quantities and treatment needs. Chapter 3 identifies and evaluates a number of administrative structures that could be established to address those wastewater needs. In Chapter 4, the performance and cost of individual, cluster, satellite and centralized systems are presented. Chapter 5 presents a wide range of available regulatory tools and evaluates them for applicability to the Island. Existing regulations, bylaws and policies are evaluated in Chapter 6. In Chapter 7, six case studies are discussed that illustrate a range of solutions for the management of wastewater and nitrogen. Chapter 8 presents major conclusions of this study, along with some guidance related to future wastewater planning activities.

ACKNOWLEDGMENTS

Funding

This study and summary report were supported in part by funds from the Department of Housing and Community Development District Local Technical Assistance, the Edey Foundation, the Massachusetts Department of Conservation and Recreation, and the Sewer Commissions of the Towns of Oak Bluffs and Edgartown.

Wastewater Management Steering Committee

This project was conducted under the oversight of William Wilcox with valuable input from Chris Seidel and Mark London of the Martha's Vineyard Commission. Joseph Alosso, facilities manager at the Oak Bluffs and Edgartown wastewater treatment facilities, provided extensive cost and operational data for those systems. This project was guided by a steering committee comprised of the following individuals:

Joseph Alosso
Terry Appenzellar
Wes Brighton
Ken Garde
Jenny Green
Amanda Hutchinson
Fred Lapiana
Matt Poole
John Powers
Bruce Rosinoff
Bret Stearns

The hard work and valuable insights of this committee added substantially to this project, and those efforts are appreciated.

CHAPTER 2 -- PRELIMINARY NEEDS ASSESSMENT

ISLAND-WIDE LAND USE AND DEMOGRAPHICS

Martha's Vineyard is comprised of 6 towns. In terms of geographic area, Aquinnah and Tisbury are the smallest and Edgartown and West Tisbury are the largest. Edgartown has the largest year-round population and Aquinnah the smallest. Edgartown, Oak Bluffs and Tisbury collectively account for about 75% of the winter population and 80% of the summer population. Key land use data and demographics are summarized in Table 2-1, for each town and Island-wide.

A significant factor in Island life is the seasonal nature of the population. Summer populations swell to at least 60,000 people (and perhaps as many as 75,000), four to five times the year-round residency, due to both summer residents and a significant number of short-term visitors. This seasonal variation in population imposes unique constraints on methods for managing wastewater flows and nitrogen loads.

EXISTING WASTEWATER INFRASTRUCTURE

Five public or quasi-public wastewater facilities exist on the island. Traditional municipal wastewater plants have been built in Edgartown, Oak Bluffs and Tisbury. Dukes County owns a small wastewater system that serves the County airport and nearby commercial development. The Housing Authority of the Wampanoag Tribe owns a small wastewater system in Aquinnah. Island-wide, approximately 1,600 properties are served by these five wastewater plants.

Table 2-2 summarizes important data on the five wastewater treatment plants. In the aggregate, they treated about 105 million gallons of wastewater in 2007, with 55% of the total handled at the Edgartown facility.

All of the five wastewater facilities perform well, with effluent nitrogen concentrations routinely below 10 mg/l at all plants, and often below 5 mg/l.

EXISTING WATER INFRASTRUCTURE

Public water supplies are administered by the Towns of Edgartown, Oak Bluffs and Tisbury, and serve nearly 10,000 developed properties. All water suppliers draw water from public wells, whose Zone IIs cover nearly 14 square miles (15% of the total land area of the Island). Development density is light in these Zone IIs, and water quality is good. Nitrate loading is not sufficient in Zone IIs to approach the drinking water standard of 10 parts per million.

An analysis of town-by-town water billing records indicates the following typical water use per property:

Residential properties	140 to 210 gpd per property.
Non-residential users	400 to 1,500 gpd per property.

TABLE 2-1

SUMMARY OF LAND USE AND POPULATION DATA

	Town						Island Total
	Aquinnah	Chilmark	Edgartown	Oak Bluffs	Tisbury	West Tisbury	
Land Area, acres							
Nitrogen-sensitive watersheds	1,309	5,955	15,219	4,023	2,515	11,290	40,311
Phosphorus-sensitive watersheds	0	2,236	475	86	0	1,542	4,339
Open ocean discharge	<u>2,107</u>	<u>3,411</u>	<u>1,436</u>	<u>571</u>	<u>1,668</u>	<u>3,196</u>	<u>12,389</u>
Total	3,416	11,602	17,130	4,680	4,183	16,028	57,039
Zone II area, acres	0	0	2,998	1,849	894	3,171	8,912
Winter Population	354	953	3,918	3,761	3,801	2,643	15,430
Developed Parcels							
Residential	422	1,256	4,112	3,677	2,380	1,806	13,653
Non-Residential	<u>11</u>	<u>40</u>	<u>177</u>	<u>148</u>	<u>226</u>	<u>81</u>	<u>683</u>
Total	433	1,296	4,289	3,825	2,606	1,887	14,336
Density, devel parcel/ac	0.13	0.11	0.25	0.82	0.62	0.12	0.25
Parcels served by Municipal Utilities							
Public water	0	100	2,949	4,026	2,502	0	9,577
Public wastewater	0	0	874	656	115	0	1,656

TABLE 2-2

EXISTING WASTEWATER TREATMENT FACILITIES (LARGER THAN 10,000 GPD)

	Aquinnah Tribal Facility	Dukes County	Edgartown	Oak Bluffs	Tisbury
Wastewater Process	RBC	RBC	Act. sludge	SBR	SBR
Wastewater Flows					
Design flow, gpd	25,000	37,000	750,000	370,000	104,000
Permitted flow, gpd	15,000	37,000	750,000	370,000	104,000
Annual avg. flows, gpd					
2005	4,190	10,910	167,200	63,190	37,100
2006	3,330	9,100	164,900	64,556	35,200
2007		8,340	161,200	79,078	35,800
Max. month flows, gpd					
2006	5,300	16,680	336,100	153,090	59,700
2007		16,390	330,000	186,499	57,300
Max. day flows, gpd					
	14,080	22,040	422,200	194,528	75,700
		20,820	447,300	225,856	68,100
Recent Effluent Quality, mg/l					
BOD	9.2	3.2 to 7.8	1.3 to 7.9	5.7	2.6
TSS	7.3	ND to 11.0	0.6 to 6.4	6.8	0.8
Total N	1.6 to 7	4.4 to 6.7	1.7 to 10.8	4.4	7.8
Total P	5 to 5.6	7.2	2.3 to 16.3	7.08	8.5
Permit Renewal Date	28-Jun-12	13-May-13	7-Sep-09	14-Feb-10	13-Feb-13
Recent Violations	None since 05	BOD Jan 08	None	2008 Leaching Fields	2005 2006
Recent Complaints	None	None	Odors 2006, 2008	None	None
Upgrading Plans	None	Add RBC and UV	None	Adding Primary Clarifier & Screen	Add Centrifuge
Effluent Disposal Method	SL	SL	RI	Leach Field	SL(2)
Watershed	Squibnocket	Oyster	Edg Great Pond	Nant. Sound	Tashmoo /Harbor
Sludge Disposal	Liquid to Edgartown	Liquid to Taunton	Cake to Yarmouth	Liquid to Edgartown	Liquid to Fitchburg
Septage Capacity, gpd	None	None	No limit	None	8,000/4,000
					Winter/ Summer

OVERVIEW OF WASTEWATER NEEDS

Current wastewater management practices in any unsewered community may be inadequate for one or more of the following reasons:

1. **Sanitary:** Public health problems related to failed septic systems or improper set-backs from on-site wells.
2. **Nitrate loading to water supplies:** Too many private septic systems in water recharge areas that lead to high nitrate concentrations at the wellhead.
3. **Nutrient enrichment of surface waters:** Septic system densities in the watersheds of freshwater ponds or coastal embayment that lead to water quality problems related to phosphorus or nitrogen.
4. **Aesthetics and convenience:** On-site septic systems that are unsightly, require excessive pumping or are otherwise inconvenient or expensive.
5. **Sustainable community development:** The community desires selected development at a greater density than is allowable with on-site wastewater disposal (examples include affordable housing or industrial/office parks).

A town-by-town assessment of wastewater management needs is typically accomplished through a comprehensive wastewater management plan. For the purposes of this study, interviews of local health agents and water resource planners indicates that the primary wastewater management need on Martha's Vineyard is the control of septic nitrogen loading to coastal embayments. As shown in Table 2-1, approximately 71% of the land area on Martha's Vineyard is located in the watersheds of sensitive coastal ponds.

ESTIMATE OF ISLAND-WIDE WASTEWATER FLOWS

To provide a sound footing for the analyses presented in this report, estimates were prepared of Island-wide wastewater flows for both current and build-out conditions.

Methodology

This estimate of wastewater flows was conducted as a series of sequential steps, as follows:

1. First the Commission mapped and estimated the land area of Martha's Vineyard in three general categories:
 - a. Watersheds of embayments that have been determined to be nitrogen limited.
 - b. Watersheds of embayments that are thought to be phosphorus limited.
 - c. Watersheds that lead directly to well-mixed ocean waters.

Data provided by the Commission staff are summarized in Table 2-1, and indicate that 71% of the Martha's Vineyard land area falls in 19 watersheds of embayments that are nitrogen limited, and that 22% of the land area is in watersheds that are directly tributary to well-mixed ocean waters. A total of 5 significant watersheds and many small watersheds comprise the remaining 7% of Island land area, where phosphorus loading may be an issue. About two-thirds of the land in nitrogen-sensitive watersheds is located in West Tisbury and Edgartown.

2. The Commission staff then enumerated the developed lots in each of the watersheds in two subtotals:

- Residential
- Non-residential

The second category is thought to be largely commercial, but technically includes all uses other than residential. The Commission's database contains about 14,300 developed parcels, of which about 13,600 are residential. The non-residential parcels (about 700) represent about 5% of all developed lots.

3. Estimates of water use on developed parcels were derived from an analysis of Annual Statistical Reports (ASRs) filed by three Island water purveyors for the years 2006 through 2008. These reports indicate a total of 8,700 residential service connections using an average of 195 gallons per day (gpd) as an annual average, and 735 non-residential connections using an average of about 750 gpd. These averages appear consistent with data compiled from 16 Cape Cod water purveyors (170 gpd residential and 600 gpd non-residential) that provide water to 129,000 service connections.
4. Estimates of water use in each town were then made by multiplying typical average per-parcel water use figures by the number of developed parcels in that town. Some adjustment was made in the per-connection water use figures for Edgartown, Oak Bluffs and Tisbury to reflect the fact that some parcels have multiple services. For up-island towns, where there is no public water service and thus no data on actual water use, the assigned per-parcel figures were based on judgment, considering the nature of development there. The assigned per-parcel residential water use ranges from 147 gpd (Aquinnah) to 210 gpd (Tisbury and Edgartown). For non-residential parcels the per-parcel water use ranges from 350 gpd (West Tisbury) to 1,500 gpd (Oak Bluffs).
5. Total water use in each watershed was then estimated by adding the residential and non-residential subtotals.
6. Wastewater flow was then estimated to be 90% of the water use; that is, 10% is assumed to be consumed in lawn watering, car washing, outside showers, and other such activities.
7. It was assumed that nitrogen load reductions in the watersheds of overloaded embayments would be achieved by installing public sewers to eliminate septic systems to the degree necessary to reach threshold loadings as determined by the Commission. These percentage reductions in septic load were applied to the total wastewater flows in each watershed to determine the amount of wastewater that would need to be collected if public sewers were the sole means of reaching those nitrogen thresholds. No credit was given for non-structural nitrogen control measures, such as fertilizer control.
8. To recognize the fact that towns may elect to provide sewer service to certain properties for reasons other than nitrogen control (such as addressing sanitary, water supply protection or other needs), a flow allowance was included as a fixed percentage of the total wastewater flow in the town. That percentage was generally 5%, but somewhat higher allowances were included in certain instances to reflect the fact that existing sewers in some towns now serve properties that are not in nitrogen-sensitive watersheds. The allowance for other needs was added to the flows associated with nitrogen control.

9. Estimates were prepared to document the amount of wastewater that is now treated at 5 centralized municipal wastewater facilities (municipal facilities in Edgartown, Oak Bluffs and Tisbury, the County plant at the Airport, and the tribal facility in Aquinnah).
10. The final step in estimating current needs was to subtract the flow now treated (Step 9) from the overall estimate of wastewater that should be collected for all categories of need (Steps 7 and 8). (Where the Commission's nitrogen reduction targets already account for sewered parcels in sensitive watersheds, this subtraction step only included the sewered flow in non-sensitive watersheds.)
11. Future wastewater flows were computed for watershed-specific growth rates based on the Commission's analysis of growth potential. These growth rates range from about 30% for Oak Bluffs to about 100% for Aquinnah.

Results for Current Wastewater Flows

The key findings of this analysis are summarized in Table 2-3 for current conditions. The most important findings with respect to current flows are:

1. Island-wide potable water use is estimated to be about 3.0 million gallons per day (mgd) as an annual average. This figure includes parcels served by either municipal systems or private wells, and excludes large-scale irrigation, such as at golf courses.
2. Island-wide wastewater flows are estimated to be about 2.7 mgd, as an annual average. Edgartown and Oak Bluffs together account for about 60% of the total.
3. Annual average wastewater flows of approximately 2.0 mgd are generated in nitrogen-sensitive watersheds, and approximately 610,000 gpd must be collected there to achieve the known or expected septic nitrogen removals associated with water quality restoration.
4. About 290,000 gpd is now treated at public wastewater treatment facilities, as an annual average, of which 85% is treated in Edgartown and Oak Bluffs.
5. Considering nitrogen control and an allowance for other needs, an annual average of 670,000 gpd of additional wastewater flow should be collected Island-wide. This represents 2.3 times the volume now collected.

Results for Future Wastewater Flows

Table 2-4 summarizes the results of this study with respect to future flows:

6. Anticipated growth in the six towns may increase the total wastewater volume by 1.5 mgd, a 55% increase, from 2.7 to 4.2 mgd.
7. Nitrogen control will dictate that about 58% of the "new" wastewater flows should be collected. That percentage increases to 60% with an allowance for other needs. Because a large fraction of these possible flow increases could occur in nitrogen-sensitive watersheds, the "new" flow that should be collected is even greater than the current collection need (the 670,000 gpd current need would grow by 900,000 gpd to a future total of nearly 1.6 mgd). That is, growth in nitrogen-sensitive watersheds will more than double the collection need. The total future flows could be 6 times the amounts currently treated.

TABLE 2-3

SUMMARY OF WASTEWATER FLOW ESTIMATES - CURRENT CONDITIONS

	Town						Island Total
	Aquinnah	Chilmark	Edgartown	Oak Bluffs	Tisbury	W. Tisbury	
Water Use, annual average, gpd							
Residential	62,200	201,000	863,500	588,300	499,800	289,000	2,503,700
Non-Residential	<u>4,400</u>	<u>16,000</u>	<u>128,600</u>	<u>222,000</u>	<u>130,000</u>	<u>28,400</u>	<u>529,300</u>
Total	66,600	217,000	992,100	810,300	629,800	317,300	3,033,000
Wastewater Flow, annual average							
Total Flow, gpd	59,900	195,300	892,900	729,300	566,800	285,600	2,729,700
Wastewater to be Collected, gpd							
Nitrogen needs	13,200	87,500	113,800	262,800	53,900	80,800	611,600
Other needs	<u>2,300</u>	<u>6,200</u>	<u>203,700</u>	<u>66,000</u>	<u>57,800</u>	<u>13,400</u>	<u>349,500</u>
All needs	15,600	93,800	317,500	328,800	111,800	94,300	961,100
Current Collected Flow, gpd							
Nitrogen-sensitive watersheds	4,000	0	24,400	53,200	1,900	0	83,500
Other watersheds	<u>0</u>	<u>0</u>	<u>149,500</u>	<u>26,700</u>	<u>35,000</u>	<u>0</u>	<u>211,200</u>
All areas	4,000	0	173,900	79,900	37,000	0	294,700
Add'l Collection Needs, gpd	11,600	93,800	143,600	248,900	74,800	94,300	666,300

TABLE 2-4

SUMMARY OF WASTEWATER FLOW ESTIMATES - FUTURE CONDITIONS

	Town						Island Total
	Aquinnah	Chilmark	Edgartown	Oak Bluffs	Tisbury	W. Tisbury	
Current Wastewater Flow, annual average							
Total Flow, gpd	59,900	195,300	892,900	729,300	566,800	285,600	2,729,700
Wastewater Flow Increase at Planning Horizon							
Percentage of current	104%	81%	65%	32%	52%	60%	55%
New flow, gpd	62,200	157,400	576,700	235,300	292,000	170,200	1,493,800
Future Wastewater Flow, annual average							
Total Flow, gpd	122,100	352,600	1,469,600	964,600	858,800	455,800	4,223,500
New Wastewater to be Collected, gpd							
Nitrogen needs	21,700	92,900	282,700	186,600	166,800	115,000	865,700
Other needs	<u>2,000</u>	<u>3,200</u>	<u>14,700</u>	<u>2,400</u>	<u>6,000</u>	<u>6,600</u>	35,000
Total	23,700	96,100	297,400	189,100	172,800	121,600	900,700
Future Collection Needs, gpd							
Nitrogen needs	34,900	180,400	396,500	449,400	220,700	195,300	1,477,300
Other needs	<u>4,400</u>	<u>9,500</u>	<u>218,400</u>	<u>68,400</u>	<u>63,900</u>	<u>20,000</u>	384,500
Subtotal	39,300	189,900	641,200	517,800	284,600	215,300	1,861,800
Less already collected	<u>4,000</u>	<u>0</u>	<u>173,900</u>	<u>79,900</u>	<u>37,000</u>	<u>0</u>	294,700
Net collection need	35,300	189,900	441,000	438,000	247,600	215,300	1,567,100

Sensitivity Analysis

Many important assumptions were needed to generate these estimates. The areas of greatest uncertainty in these estimates are as follows:

1. The definitive studies of nitrogen loading are being conducted by the Massachusetts Estuaries Project (MEP), and only one embayment study (Edgartown Great Pond) has been completed to date. This analysis relies on the Commission's early estimates of nitrogen thresholds, and it is likely that the MEP results will be somewhat different. The Commission and the Towns have no choice but to wait for those MEP studies before adjusting this analysis for nitrogen loading reasons. Table 2-5 presents Commission estimates of nitrogen loads in principal watersheds and notes the expected completion schedule of draft MEP technical reports.
2. This analysis is based primarily on nitrogen-based sewer needs, with only a modest allowance for other needs such as water supply protection, sanitary needs, convenience/aesthetics and community development. Consideration should be given to revising upward the 5% allowance, perhaps after input from the Towns.
3. Most of the wastewater flows estimated in Steps 7 and 8 above represent wastewater quantities that are now disposed of through on-site septic systems. If these flows are collected in municipal sewer systems, then infiltration and inflow (I/I) will occur that will add to the collected amount. The Commission should consider adding a factor for I/I based on data from the existing plants. This factor may be 10% to 25% of the collected wastewater volume.
4. Future growth is a very important factor, since 100% of the growth in wastewater flow in sensitive watersheds must be treated. The Commission has completed a detailed analysis of potential development in each town that leads to the predicted 55% increase in wastewater volume. This is such a large increase, and the cost implications are so significant, that the Commission and the Towns should aggressively address growth controls in all sensitive watersheds. Adoption of a shorter-term planning horizon and formulation of a phased approach may be warranted.

General Observations

There are several interesting findings that derive from this analysis:

1. Existing wastewater infrastructure was developed prior to a full understanding of the nitrogen problem in coastal ponds. Only 28% of wastewater flow to the existing 5 public wastewater facilities is collected in nitrogen-sensitive watersheds.
2. While the Commission's analysis of growth potential indicates high percentage increases in Aquinnah (104%) and Chilmark (81%), nearly 75% of the overall wastewater flow increase would occur in Edgartown, Oak Bluffs and Tisbury.

TABLE 2-5

NITROGEN LOADS TO PRINCIPAL WATERSHEDS

Watershed	Current N Load, lb/yr		Future N Load, lb/yr		Nitrogen Load Limit, lb/yr	Watershed Area, ac	Areal Nitrogen Loads, lb/ac/yr		Indicated Septic N Removal Need, %	Schedule for MEP Report
	Septic	Total	Septic	Total			Septic	Total		
	Note 1		Notes 1 and 2				Note 3			
Squibnocket Pond	456	8,635	1,261	9,586	7,497	1,229	0.37	7.03	100	Note 4
Menemsha Pond	4,608	24,965	6,055	28,056	62,218	1,832	2.52	13.63	0	Note 4
Chilmark Pond	3,680	11,023	5,984	13,704	4,516	3,297	1.12	3.34	100	1 st Q 2012
Tisbury Great Pond	10,813	32,136	18,015	40,060	27,563	11,005	0.98	2.92	42	4 th Q 2011
James Pond	609	1,345	1,477	2,321	448	357	1.70	3.77	100	1 st Q 2012
Tashmoo Pond	14,169	26,356	23,166	37,300	30,870	2,605	5.44	10.12	0	2 nd Q 2010
Lagoon Pond	27,699	45,562	41,527	62,710	33,075	3,968	6.98	11.48	45	4 th Q 2010
Oak Bluffs Harbor	6,763	11,352	9,093	12,951	8,064	367	18.43	30.93	49	Note 5
Farm Pond	2,496	4,062	2,979	4,659	1,656	402	6.21	10.10	96	4 th Q 2011
Sengekontacket Pond	21,177	42,651	31,203	55,330	38,588	4,464	4.74	9.55	19	2 nd Q 2010
Katama Bay	25,851	51,262	40,969	67,815	120,644	3,038	8.51	16.87	0	Note 5
Cape Poge	752	24,601	2,170	27,787	100,321	816	0.92	30.15	0	Note 5
Pocha Pond	2,152	5,567	3,640	7,199	12,518	921	2.34	6.04	0	Note 5
Edgartown Great Pond	12,207	33,351	27,640	48,137	26,159	4,776	2.56	6.98	(Note 6) 30	June 2007
Oyster Pond	2,188	7,529	3,903	10,044	3,887	2,685	0.81	2.80	100	Note 5
Total/Average	135,621	330,395	219,082	427,661		41,762	3.25	7.91		

- NOTES:
1. Current and future nitrogen load exceeds estimated load limit.
 2. Only future nitrogen load exceeds estimated load limit.
 3. Current septic load less than 3.0 lb/ac/yr.
 4. These embayments are on the MEP alternate list; technical reports will be issued under the current contract only if other embayments are dropped.
 5. These embayments are not expected to be studied as part of the current MEP contract.
 6. The septic load reduction of 30% presumes a 3750-pound reduction in the existing treatment plant plume.

3. Six watersheds account for nearly 85% of the current nitrogen control needs. Those watersheds, and the associated wastewater flows that should be collected to control nitrogen load, are as follows:

- Lagoon Pond 165,000 gpd
- Oak Bluffs Harbor 111,000 gpd
- Chilmark Ponds 68,000 gpd
- Tisbury Great Pond 65,000 gpd
- Edgartown Great Pond 54,000 gpd
- Sengekontacket Pond 51,000 gpd.

4. Of all the wastewater that should be collected for nitrogen control purposes, 70% is generated within the town boundaries of Edgartown, Oak Bluffs and Tisbury, where municipal wastewater infrastructure already exists. Based on the Commission's growth projections, those three towns account for 72% of the future nitrogen control needs.

5. These estimates of wastewater collection and treatment needs assume that the collected wastewater is removed from the sensitive embayments and that effluent disposal occurs in watersheds that are not nitrogen sensitive. If effluent disposal must occur in nitrogen-sensitive watersheds, then a greater number of septic systems must be eliminated to account for the effluent nitrogen that remains in those watersheds. Wastewater quantities would be 20% to 40% higher if effluent disposal occurs in sensitive watersheds.

CHAPTER 3 -- IDENTIFICATION AND EVALUATION OF MANAGEMENT STRUCTURES

INTRODUCTION

When faced with the need to address wastewater and nutrient problems across Martha's Vineyard, there are two fundamental questions:

- What needs to be done?
- Who should be responsible?

This chapter identifies all of the functions that must be accomplished to manage wastewater or nitrogen. It also identifies logical options for entities that can complete those functions. The viable options are then evaluated against a set of criteria to explore which may be best for the Island.

BASIC FUNCTIONS TO BE ACCOMPLISHED

Whether the project entails the installation of a individual septic system, or the creation of a municipal sewerage system, there are many common functions that must be accomplished. The following 11 functions include the vast majority of the responsibilities:

1. **Planning.** This task involves identifying and quantifying wastewater or nutrient management needs; estimating wastewater flows; determining the necessary level of treatment; evaluating options for collection, treatment and disposal; identifying and evaluating sites; estimating project costs; and obtaining public input. (All of these tasks are usually completed as part of a comprehensive wastewater management plan.)
2. **Facilitating Regional Solutions.** For public projects involving protection of coastal ponds, someone must determine each town's share of the nitrogen removal need (TMDL allocation), promote regional solutions, and synchronize and harmonize the efforts of each town in the watershed.
3. **Implementing a Non-Structural Plan.** A set of regulations, bylaws and policies is needed to supplement public projects involving traditional infrastructure, or to serve as the wastewater/nutrient plan where traditional infrastructure is not feasible. This task involves the development, adoption and implementation of regulatory tools.
4. **Land Acquisition.** Regardless of the size of the project, it is necessary to obtain fee simple interest or easement rights for land for collection, treatment and disposal functions.
5. **Permitting.** Someone must obtain all the permits and regulatory approvals to allow the proposed wastewater facilities to be built, including one or more of the following: the disposal system construction permit, a groundwater discharge permit, site assignment, MEPA review, and Commission approval of developments of regional impact (DRIs).
6. **Design.** This task involves selection and contracting with design professionals to prepare plans and specifications for the facilities to be built.

7. **Construction.** It is necessary to bid and let contracts for the construction of wastewater facilities, and to oversee the construction.
8. **Operation.** Someone must be responsible for operating and maintaining the wastewater facilities, including periodic replacement of failed equipment.
9. **Monitoring.** It is necessary to monitor the performance of the wastewater facilities and measure their impact on the immediate environment.
10. **Enforcement.** Someone must review the performance of the wastewater facilities against the permit requirements and conditions, and take appropriate action in the event of noncompliance.
11. **Funding.** This task involves appropriating (or otherwise arranging for) funds to pay the capital costs for wastewater facilities and the expenses for ongoing operation and maintenance.

In a successful project or program, all of the necessary functions will be accomplished without undue cost or complexity.

TYPICAL CURRENT PRACTICES

For the typical municipal wastewater system, the following entities accomplish the 11 functions identified above:

- A town takes responsibility for most of the functions.
- The Commonwealth of Massachusetts reviews and approves the CWMP (DEP), conducts site assignment (DEP), provides environmental review (MEPA), and enforces the terms of groundwater discharge permit (DEP).
- Regional Planning Commissions are in a position to facilitate regional solutions.

When nitrogen-based TMDLs are the driving force behind a project, someone must decide how much of the responsibility for nitrogen control lies with each town in the watershed. While DEP has provided some guidance on that issue, there is no precedent for how that function is accomplished. Regional planning commissions may be the preferred party for that role.

For the typical homeowner in a nitrogen-sensitive area (who had been required to install a nitrogen-removing septic system), the following entities accomplish the 11 noted functions:

- The homeowner takes responsibility for most of the functions.
- The town dictates that the nitrogen-removing system is needed, reviews plans, checks construction, monitors performance and takes any enforcement action.
- The Commonwealth of Massachusetts reviews and approves certain variances under Title 5 (DEP).
- On Cape Cod, Barnstable County may provide loans to the homeowner.

The requirement to install the nitrogen-removing septic system may be dictated by Title 5 (a state requirement for new developments in Zone IIs), or it may come from the board of health,

the conservation commission or the planning board. In current practice, there is often a lack of coordination among these entities.

For the private commercial development with wastewater flow over 10,000 gallons per day (for example, a shopping center or nursing home), the 11 noted functions are typically accomplished as follows:

- The private developer takes responsibility for most of the functions.
- The town may review the groundwater discharge permit application (when comments are solicited by DEP), impose certain design requirements (if the town has adopted a regulation on this subject), and require that the developer tie in nearby homes and businesses (again, based on a regulation).
- The Commonwealth of Massachusetts provides environmental review (MEPA), reviews and approves the groundwater discharge permit application (DEP, including deciding if a 10-mg/l effluent limit is adequate for nitrogen), and enforces the effluent limits in the GWD permit (DEP).
- In Barnstable County, the Cape Cod Commission may require the developer to meet a "no net nitrogen increase" policy, which could result in compensatory payment toward overall nitrogen control goals, extension of nearby sewers, or providing nitrogen removal somewhere else in the watershed. A similar approach is used by the Martha's Vineyard Commission.

Coordination between the DEP and towns with regard to groundwater discharge permits has not been ideal in the past. Application of the "no net nitrogen increase" policy has been applied mostly to larger projects in Barnstable County, with about \$0.5 million in compensatory funds accumulated Cape-wide. There has been less use of this approach on the Island, although mitigation fees are allowed within the Martha's Vineyard Commission's Interim Water Quality Policy.

ALTERNATIVE MANAGEMENT STRUCTURES

On Martha's Vineyard, there are three municipal wastewater systems, one system owned by the Wampanoag Tribe, one owned by Dukes County, and several private systems that would be categorized as cluster or satellite systems (see definitions in Chapter 4). Therefore, there are examples of the traditional municipal approach as well as precedents for regional (County) ownership.

The primary need for additional wastewater management appears to be the control of nitrogen in the watersheds of coastal ponds. Given that need, there are several alternative management structures that may be applicable to the island. They are described briefly below:

1. **Individual towns acting alone.** Each town would address its own wastewater needs through a sewer department or sewer commission for traditional sewerage and through town boards (chiefly the board of health) for individual and cluster system. The board of health, in conjunction with other boards and commissions, would oversee an expanded

non-structural program. The Martha's Vineyard Commission could provide regional facilitation and selective assistance in the non-structural program using existing authority for review and regulation of large projects. This model would be the closest to the current situation, but would enhance some regulatory programs. Inter-town cooperation would be through joint committees facilitated by the Commission.

2. **Host Towns and IMAs.** Towns with existing municipal wastewater infrastructure would offer wastewater service to neighboring towns that do not now have such infrastructure. Edgartown, Oak Bluffs and Tisbury would be the host towns, and wastewater needs in Aquinnah, Chilmark and West Tisbury would be either met locally by small-scale systems or handled by transport to one of the host towns. Dukes County and the Wampanoag Tribe could also act as hosts through the expansion of their existing wastewater systems. Each town would implement its own non-structural program, with the Commission providing support in regionalization issues.
3. **Single Regional Public Entity.** The County, alone or in conjunction with the Commission, could take the lead role in wastewater management. Wastewater planning would be done regionally, with individual town input in key areas (such as facility siting). All wastewater treatment plants (cluster, satellite and centralized) would be County-owned, and capacity would be provided based on documented needs irrespective of town boundaries. Non-structural programs would be a mix of County and town control.
4. **Single Wastewater or Nutrient Management District.** This approach would be similar to the single regional public entity discussed above, except that the overseeing agency would be a newly-formed special purpose district dedicated to just wastewater or nutrient issues. There would be more focus on the wastewater/nitrogen issues, because the district would not have any other responsibilities. Non-structural programs would be administered locally where appropriate and by the district where that makes economic or practical sense. (It is also possible to establish one or more smaller districts that would focus on a specific village or pond.)
5. **Single Regional Private Entity.** The County or Commission would solicit proposals from and then select a private company to manage regional wastewater and nitrogen issues. This would be similar to the County/Commission approach described above, where the ultimate responsibility would lie with the County/Commission, but the day-to-day operations would be performed by a private company under contract. A logical extension of this concept is for the private entity to purchase some of the existing wastewater infrastructure (for example, the wastewater treatment plants and effluent disposal facilities), and take whatever upgrading steps were appropriate to the wastewater and nitrogen control needs. The sale of existing infrastructure could provide capital infusion to municipal budgets, an important aspect of infrastructure privatization elsewhere in the country.
6. **Combined Water and Wastewater Entity.** A variation of Options 4 and 5 above would bring together both wastewater and water functions to afford even greater economies of

scale and/or capital infusion. Such an entity could also be responsible for stormwater management and serve as an integrated water management agency.

7. **Regional Health District.** It is possible to perform the roles of the local boards of health through a regional health district. This entity could implement an Island-wide, non-structural program to optimize the management of nitrogen through decentralized means. It would probably be unable to own and operate traditional municipal infrastructure, so would be a supplement to other management structures.

EVALUATIVE CRITERIA

Each of the management options described above has advantages and disadvantages. The strong and weak points of each approach can be identified by considering the following evaluative criteria:

1. **Ease in implementation.** If a new management structure is difficult to implement, there is less chance of success and higher cost to bring it to fruition. Some options could be implemented under existing laws and regulations, but some would require special legislation.
2. **Political acceptability.** The political status quo would constitute an impediment to a new structure, based on past hard-won political gains and fear of unidentified problems that would be expected with any new entity.
3. **First costs to implement.** The ideal option would carry low costs for formation. It would also use existing public employees wherever possible.
4. **Potential for long-term cost savings.** The more functions are handled regionally, the greater the potential for savings due to economies of scale.
5. **Ability to raise money.** The principal means of financing wastewater projects has been through property taxation and betterment assessments. An effective entity should have access to funds through both means, and others if possible.
6. **Loss of local control.** A regional entity will suffer from a real or perceived loss of local control. To the extent that decisions impacting cost and environmental quality are made by someone other than one of the six boards of selectman and six town meetings, there will be some opposition.
7. **Impact on community growth.** The public typically supports wastewater regulations or programs that neither promote nor restrict growth compared with Title 5 or existing zoning. (A new state loan program uses growth neutrality as a loan condition.)
8. **Potential for optimizing watershed-based solutions.** Town-by-town approaches sometimes suffer from lack of a regional or watershed-based focus. While these tendencies can be overcome, there may be less potential for optimum watershed-based solutions if a regional entity is not involved.
9. **Interface with local programs.** Any regional entity would need to coordinate with those core functions that would still be provided by the towns. For example, a regional wastewater entity might be able to take on aspects of a non-structural program that a board of health would normally do, but would still have to closely coordinate with individual conservation commissions and planning boards.

10. **Ability to obtain grants and loans.** State revolving loans, and the potential grants associated with economic stimulus programs, are traditionally available to towns for wastewater infrastructure. Any of the alternative structures identified here would have to be carefully established to be eligible for such funding programs. A privatized entity might not have that eligibility.
11. **Public accountability.** Any regional entity has the disadvantage of real or perceived limits on public accountability. This may be particularly the case in the privatization option.

These criteria cover a broad range of issues. Individual towns or interest groups may have other criteria to add to this list, and may place differing emphasis on these criteria.

EVALUATION OF OPTIONS WITH RESPECT TO EVALUATIVE CRITERIA

With the above noted evaluative criteria in mind, there are obvious advantages and disadvantages associated with each alternative management structure.

Individual Towns Acting Alone

This option is the most easily implemented because it involves fine-tuning of existing structures and no major changes. It would thus have a low first cost to set up and would be most politically acceptable. There would be no loss of local control and public accountability would be consistent with current structures. There would be much less potential for problems interfacing with local boards compared with other options. Each town would have access to traditional funding sources.

The principal drawbacks of this approach relate to optimizing regional solutions. Effective regional solutions are not precluded in this approach, but they may be more difficult to attain than with some of the other options. Each town acting alone provides little opportunity for cost savings through economies of scale, although such savings could be achieved by a regionalization initiative imposed as an overlay on the current structures.

Host Towns and IMAs

This alternative shares many of the advantages of the first option, including good local control, easy interfacing among town boards, etc. Providing sewer service to neighboring towns may make administrative sense, but may also suffer from high cost due to long transport distances (see Chapter 4). If the currently unsewered towns can gain service from seweried towns, there will be some economies of scale. Inter-municipal agreements have proven to be a workable mechanism for town-to-town sharing, but can also be contentious. This option may be somewhat more amenable to watershed-based solutions because the terms of sharing can be built into the IMAs.

Single Regional Public Entity

This structure could be ideally suited to addressing wastewater problems on a watershed basis, because the interests of individual towns would be made secondary by the regional entity. The associated disadvantage is the loss of control and fear of less public accountability that comes with a regional entity. If the County were the regional entity, there would be little start-up costs; new functions would be added to the existing framework. Economies of scale would accrue through operations by a single entity. Access to good disposal sites would be improved, since the County could make available sites in towns adjacent to the wastewater collection system more readily than through individual town negotiations.

Single Wastewater or Nutrient Management District

The advantages and disadvantages of this option are similar to Option 3. The principal new advantage is the fact that the district could not be burdened by the other functions of the County and could concentrate on just wastewater and nutrient management. One drawback of this approach is the need to apportion costs to all towns and rely on 6 separate town meetings for funding capital expenses. If it were properly formulated, the district would have the power to levy fees (distinct from taxes and betterments) that could be targeted to nitrogen loading.

Single Regional Private Entity

Privatization has interesting advantages and a number of potential drawbacks. This option would have many of the features of the single regional public entity. In addition, private entities are often able to build and operate infrastructure at lower costs than public entities. The procurement process, used to select and contract with the private entity, can be cumbersome in some circumstances. In communities that have privatized the operation of public wastewater facilities, there have been reports of inadequate long-term maintenance, and labor issues related to retention of prior public employees. Raising capital can be difficult, because there would be one more layer of responsibility on top of the need to go to the individual town meetings for financial support. Privatized operations are sometimes criticized as lacking public oversight.

Combined Water and Wastewater Entity

In terms of functions, an existing water utility (if properly formulated) could be easily expanded to be responsible for wastewater activities, using current employees, equipment and administrative procedures (including billing). This would afford a degree of efficiency. Most water utilities are viewed favorably by the public and are generally publicly accountable. Raising capital is somewhat more difficult than for towns, but some water utilities can levy property taxes.

Regional Health District

A regional health district could be ideally suited to implementing a regional wastewater plan that relies largely on decentralized systems and non-structural programs. It could provide economies of scale with respect to the typical health department functions. There is little or no precedent

however for a regional health district to build and maintain traditional wastewater infrastructure. Such an entity would suffer from the drawbacks of significant start-up costs, difficulty in raising capital, possible problems qualifying for grants and loans, and real or perceived problems with local control. It would benefit from staff dedicated to wastewater issues whose activities would not be diluted by the need to deal with non-wastewater matters.

CHAPTER 4 -- IDENTIFICATION AND EVALUATION OF WASTEWATER TREATMENT APPROACHES

INTRODUCTION

There is a broad range of available options for the collection and treatment of wastewater. In the simplest case, wastewater is treated and disposed of on the property where it is generated. For towns where such on-site disposal is not viable, a municipal sewerage system may be developed to serve some or all of the community. In some cases, wastewater from several towns is treated and disposed at a regional facility at some significant distance from many of the individual homes served by that facility. This chapter identifies four distinct wastewater management approaches and presents their costs and effectiveness.

DEFINITIONS

For the purposes of this study, four approaches to wastewater management have been evaluated:

Individual On-site Systems: An individual system, in general, is a septic tank and leaching field system 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 implies treatment in a simple septic tank prior to discharge to a subsurface disposal system. Some individual on-site systems involve enhanced treatment, typically to provide some degree of nitrogen removal beyond the nominal removal effected in the septic tank.

Cluster Systems: These are 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.

Satellite Systems: These are facilities for wastewater collection, treatment and disposal that require a DEP groundwater discharge permit and are intended to serve a closely defined area. (In general, DEP groundwater discharge permits are required for facilities that have wastewater flows exceeding 10,000 gpd, which is roughly equivalent to 30 three-bedroom homes.) Many of the satellite systems in southeastern Massachusetts 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, such as the project recently completed by the Town of Falmouth to serve the New Silver Beach neighborhood.

Centralized Wastewater System: Centralized systems provide public sewerage in the most developed area of a city or town in the form of a wastewater collection system leading to a publicly-owned wastewater treatment plant with effluent disposal. These systems are typically larger than 100,000 gpd in capacity, and are usually managed by local sewer commissioners or departments of public works.

Figure 4-1 depicts examples of each of these four types of systems. On Martha's Vineyard, the municipal plants in Edgartown, Oak Bluffs and Tisbury are considered centralized facilities. The Dukes County plant at the airport, and the Wampanoag plant in Aquinnah, are considered to be satellite systems. There are few if any cluster systems on the Island, and all other wastewater facilities are individual on-site systems.

The term "decentralized systems" is commonly used to describe individual, cluster and satellite approaches. Figure 4-2 shows how one town may have a combination of centralized and decentralized wastewater systems.

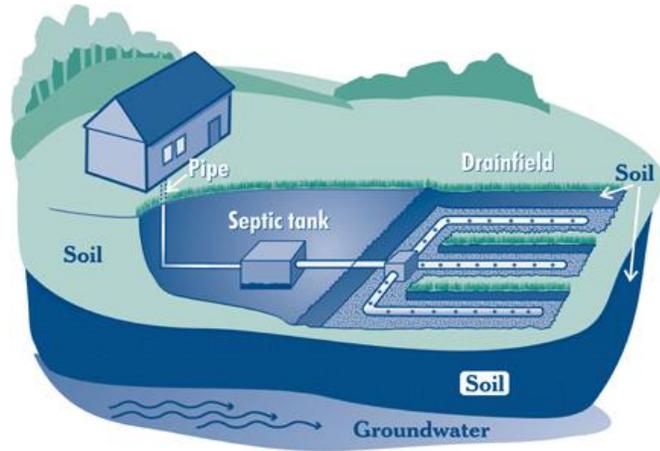
NITROGEN REMOVAL CAPABILITIES

While Title 5 systems do remove some nitrogen, the nitrogen remaining in the effluent of those systems is primarily responsible for significant deterioration of water quality in coastal ponds at relatively low housing densities. For many years, it has been commonplace to assume that Title 5 systems produce an effluent with 35 mg/l nitrogen. The Massachusetts Estuaries Project has more recently used a Title 5 effluent concentration of 26 mg/l to quantify watershed nitrogen loads, assuming more nitrogen removal in the septic tank and leaching field than prior studies. The principal focus of many strategies to address coastal water quality problems has been the removal of nitrogen to levels much lower than 35 or 26 mg/l.

Wastewater treatment systems can routinely remove nitrogen down to effluent concentrations below 5 mg/l in well-designed and well-operated centralized plants and larger satellite systems. In smaller systems, nitrogen removal is more difficult because: these systems have less operational oversight; low construction cost is often a significant factor in equipment selection; and day-to-day fluctuations in waste volume and strength make the wastewater more difficult to treat. These realities are reflected in the effluent limits that are established in DEP programs.

Table 4-1 summarizes the applicable effluent standards for satellite and centralized facilities in Massachusetts. These standards are established by the Groundwater Discharge Permit program and by DEP's Reclaimed Water Regulations. The typical groundwater discharge permit includes an effluent nitrogen standard of 10 mg/l, but a limit of 5 mg/l has been set in some nitrogen-sensitive locations. (For wastewater discharges in the Zone IIs of public waters supply wells, a nitrogen limit of 5 mg/l applies if the groundwater travel time is less than 2 years to the wellhead. Under those circumstances, DEP also requires the removal of total organic carbon to 1 mg/l, and imposes special limits on effluent disinfection.) When effluent is to be reused, the effluent nitrogen limitation will be 10 mg/l, coupled with high levels of disinfection and best management practices in the reuse application.

INDIVIDUAL



CLUSTER



SATELLITE

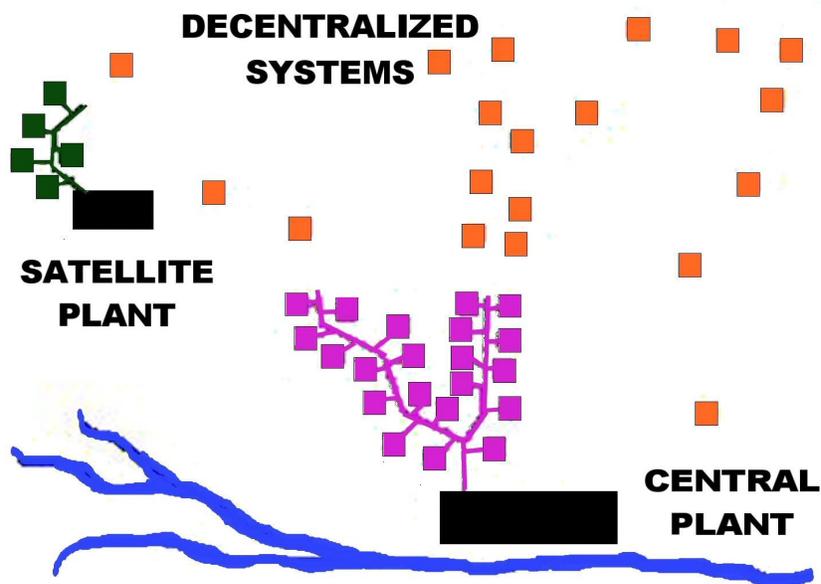


CENTRALIZED



FIG. 4-1 TYPES OF WASTEWATER SYSTEMS

FIG. 4-2 MIX OF CENTRALIZED AND DECENTRALIZED SYSTEMS



Several reliable wastewater treatment process exist that allow larger plants to routinely achieve sub-5 mg/l effluent nitrogen, and the Edgartown and Oak Bluffs facilities have performed to that level.

Performance of satellite facilities is more variable. Some such facilities have routinely produced effluent nitrogen concentration at or below 5 mg/l. However, there are many satellite facilities in Massachusetts that regularly exceed their 10 mg/l permit limits. Those that have trouble meeting the 10 mg/l limit include smaller systems (less than 20,000 to 25,000 gpd), those serving schools, and those with inadequate operator attention or significant seasonal use.

In recognition of the difficulties removing nitrogen in very small system, DEP has approved technologies that can achieve 19 mg/l for residential flows and 25 mg/l for commercial situations. A recent survey of individual nitrogen-removing systems on Cape Cod showed that about half of the surveyed residential systems did not meet the 19 mg/l target. This finding illustrates the difficulties inherent in applying a sophisticated technology to individual homes.

A 2008 survey of 6 southeastern Massachusetts cluster systems showed the ability to remove nitrogen to the range of 12 to 15 mg/l. These clusters perform better than the typical individual systems because they receive a more constant waste flow, more uniform waste strength and tend to be less susceptible to seasonal occupancy. The typical individual and cluster system uses a single stage of nitrogen removal. Some systems use a two-stage process for nitrogen removal, and produce a lower effluent nitrogen concentration, sometimes at or below 5 mg/l. These two-stage systems cost more to install, often require an external carbon source, and often need supplemental alkalinity through a chemical feed system.

TABLE 4-1. EXPECTED EFFLUENT LIMITATIONS FOR FACILITIES LARGER THAN 10,000 GPD

	Effluent Discharged to Groundwater*						6. Effluent Reuse ***		
	1. Traditional GWD Permit	2. High Level N Removal	3. Average P Removal	4. High Level P Removal	5. Zone II Recharge **		Class A	Class B	Class C
					<2-yr travel	>2-yr travel			
BOD, mg/l	30	30	30	30	10	30	10	30	30
TSS, mg/l	30	30	30	30	5	10	5	10	30
Nitrogen, mg/l									
Nitrate/Nitrite	10	5	10	10	---	---	---	---	---
Total	10	5	10	10	5	10	10	10	10
Oil & Grease, mg/l	15	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	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5
Phosphorus, mg/l	---	---	1	0.3	---	---	---	---	---
Turbidity, NTU									
Average	---	---	---	---	2	5	2	5	10
Maximum	---	---	---	---	10	---	---	---	---
Total Org. Carbon, mg/l	---	---	---	---	1	3	---	---	---
Fecal coliform, #/100ml									
Mean	200	200	200	200	---	200	---	---	---
Median	---	---	---	---	0	---	0	14	200
Maximum	---	---	---	---	14	---	14	100	800
Required Treatment									
Secondary	yes	yes	yes	yes	yes	yes			
Filtration	no	no	no	no	yes	??			
Disinfection	maybe	maybe	maybe	maybe	yes	yes			

* "Advanced secondary treatment" required for all groundwater discharges, as a minimum

** Zone II discharges are prohibited if within Zone I, if travel time is less than 6 months, or if wastewater includes industrial wastes

*** Reuse Categories

Class A Unrestricted landscape irrigation, toilet flushing, direct-contact agricultural use, laundries, car washes

Class B Restricted landscape irrigation, wetland creation, non-contact agric

Class C Industrial, non-contact agriculture, silviculture

For the purpose of planning wastewaters facilities on Martha's Vineyard, the following effluent nitrogen concentrations have been used in residential settings:

Individual systems	26 mg/l
Cluster systems	8 to 15 mg/l
Satellite systems	6 to 10 mg/l
Centralized systems	5 to 8 mg/l

GENERALIZED COST ESTIMATING APPROACH

In evaluating wastewater management options, some broad conclusions can be drawn by applying generalized cost information to existing conditions on Martha's Vineyard.

Estimating costs for wastewater infrastructure is best accomplished by considering the various elements of any wastewater system. These are:

- Wastewater collection from the homes or businesses that need an off-site solution
- Transport of wastewater from the collection area to the treatment facility site
- Treatment of wastewater (including disposal of residuals)
- Transport of effluent to a disposal site (if it is not at the treatment site); and
- Disposal of effluent.

These functions are illustrated in Figure 4-3. This figure shows that wastewater collection may span more than one watershed; the wastewater treatment facility may also accept septage from unsewered areas; the treatment facility may also produce effluent of adequate quality for reuse; and that effluent disposal can take several forms.

Construction costs for collection are largely determined by the length of the collection system and the number of pump stations. Sewer length is in turn closely related to the density of development; larger lots translate to greater distances between homes, and more sewer pipe per lot served.

Construction costs for wastewater treatment are closely related to the size of the facility and the level of treatment. While larger plants cost more to build than smaller plants, there is a definite economy of scale; that is, the cost per gallon treated declines as the size increases. This trend is illustrated in Figure 4-4, which shows the results of a survey of 24 satellite and centralized plants in New England, most of which are in southeastern Massachusetts. (Data points 17, 19, and 21 are the municipal facilities in Tisbury, Oak Bluffs and Edgartown, respectively.) Wastewater treatment facilities that are categorized as small satellite plants cost between \$50 and \$80 per gallon-per-day of capacity, compared with \$10 to \$20 per gpd at the size of about 1 mgd.

Construction costs for wastewater or effluent transport are very strongly related to the transport distance and the nature of the transport route (town streets vs. overland, for example).

Once a wastewater system is built, there are ongoing costs for operation and maintenance (O&M). These costs include labor for operational oversight and maintenance, electricity, chemicals, sludge

FIG. 4-3 GENERIC WASTEWATER MANAGEMENT SYSTEM

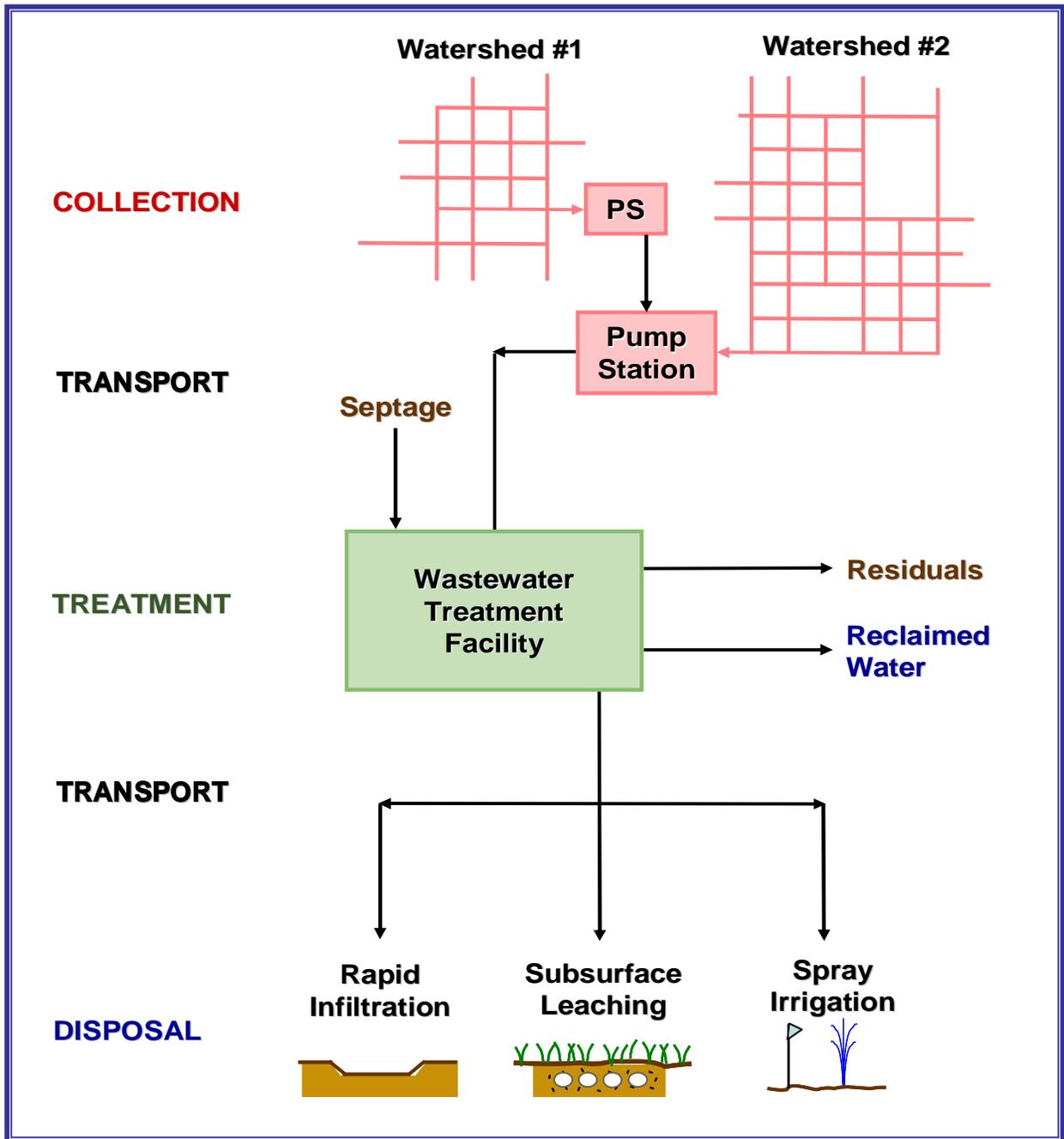


FIGURE 4-4
RESULTS OF CONSTRUCTION COST SURVEY

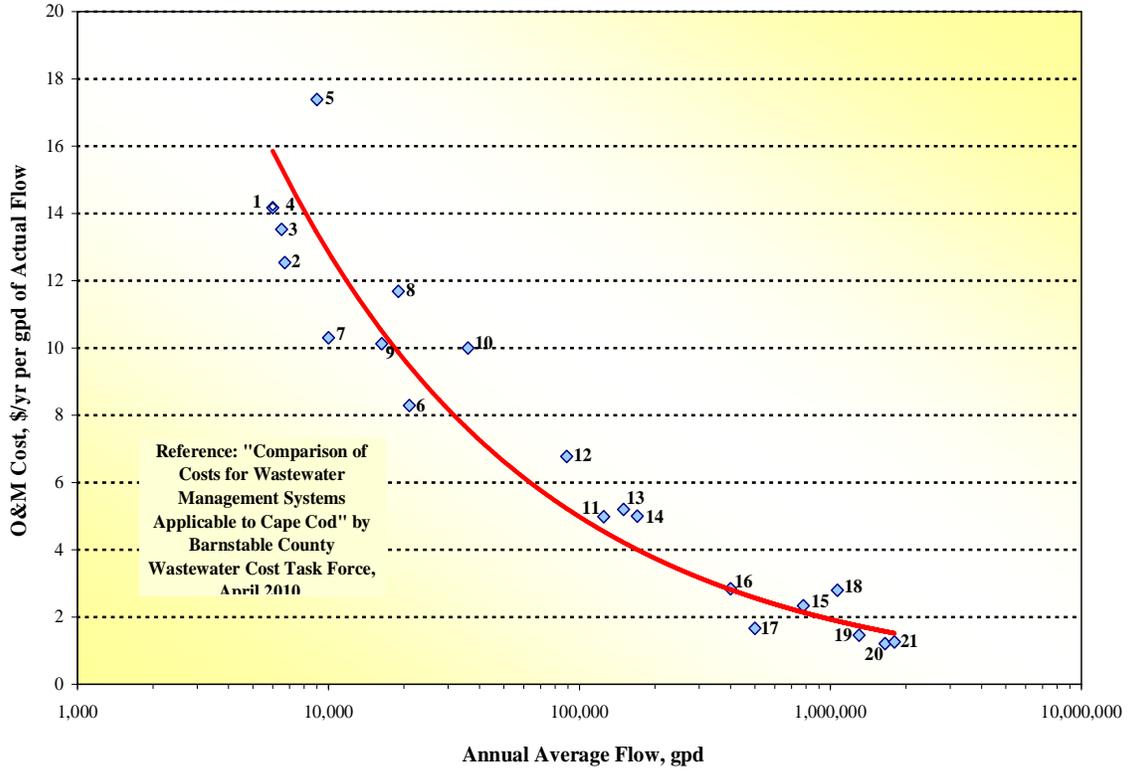
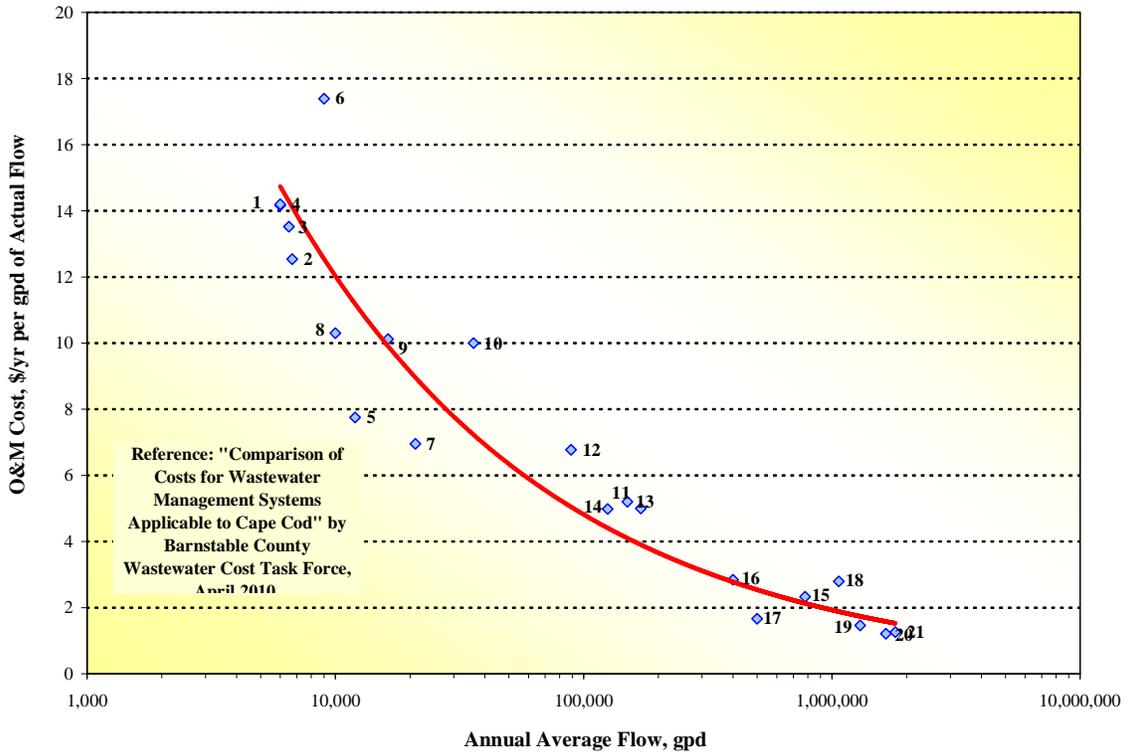


FIGURE 4-5
RESULTS OF O&M COST SURVEY



disposal, and monitoring, among others. Most of the O&M costs are related to the treatment, with much smaller annual costs for collection, transport and disposal. Figure 4-5 summarizes the results of a survey of 21 New England wastewater treatment facilities. (Data points 10, 12, and 14 are the municipal facilities in Tisbury, Oak Bluffs and Edgartown, respectively.) These costs, like construction costs, show significant economies of scale. On average, smaller plants have annual O&M costs of \$10 to \$15 per gpd of average flow, compared with \$1 to \$3 for larger plants.

GENERALIZED COST ESTIMATES

The broad categories of wastewater systems (individual, cluster, satellite and centralized) have been evaluated with respect to capital cost, O&M cost, and overall cost per pound of nitrogen removal. The basis for these estimates is the scenario where one or more wastewater management options must be implemented to allow nitrogen removal in a neighborhood that is currently unsewered. The options are:

1. Construct individual nitrogen removing septic systems for all lots;
2. Construct one or more cluster systems to remove nitrogen with local disposal of effluent;
3. Construct a satellite system to serve the entire neighborhood with local disposal;
4. Extend a public sewer to allow the neighborhood's wastewater to be treated at an existing centralized plant.

The capital cost of these options is summarized in Figure 4-6, which shows the estimated capital cost per property as a function of the distance to the nearest public sewer.

For individual on-site systems, capital costs have been estimated at \$13,000 per residential property for traditional Title 5 systems and \$24,000 to \$28,000 per property for systems with nitrogen removal to 13 to 19 mg/l. The higher cost is associated with a more rigorous design and more oversight of construction. The lower effluent nitrogen concentration is achievable assuming more oversight of operations. This category of wastewater management is characterized by widely varying costs that depend on:

- the size of the home,
- the degree to which existing system components can be reused,
- the presence of constraints that trigger unusual design features (such as mounded systems to accommodate shallow groundwater), and
- the nature of existing landscaping and other improvements that must be disrupted and restored as part of the septic system installation.

For all other options, a wastewater collection system is needed. Separate capital cost estimates have been prepared that indicate costs ranging from \$15,000 per lot served (assuming 100-foot road frontage and homes on both side of the street) to \$40,000 per lot (assuming 300-foot frontage).

For cluster systems, a typical size of 8,800 gpd has been used. Such a system could serve 20, 4-bedroom homes, and would not require a DEP groundwater discharge permit. The capital costs of the treatment and disposal system has been estimated to be \$330,000 to \$400,000, in addition to collection costs. Two levels of performance of the cluster system have been considered: 15 mg/l and 8 mg/l. The lower effluent nitrogen concentration is feasible in systems designed in accordance with the DEP groundwater discharge permit program and subject to more oversight and testing.

In the case of the satellite system, capital costs have been derived from Figure 4-4, with allowances for engineering, land and other costs added to the construction cost. Given the significant economies of scale, satellite systems have been considered in two sizes: one serving 200 homes (88,000 gpd), and one serving 300 homes (132,000 gpd). The site of the treatment facility has been assumed to be only 500 feet from the closest segment of the collection system and the effluent disposal area has been assumed to be 500 feet from the treatment facility.

For the centralized option, the costs include the collection system, the transport facilities to the nearest existing sewer (handled as a variable) and some share of the capital costs of the existing treatment plant. The three existing centralized plants on the Island all have significant unused capacity. As a base case, it was first assumed that there would be no capital cost for treatment assigned to the outlying new service area. As a second case, it was assumed that the outlying neighborhood would be responsible for the estimated incremental capital cost of the existing treatment plant. (In actuality, an administrative decision would be required, that could vary among the three towns, as to how much of an already-expended capital cost would be recovered from new users. This analysis is intended to show a range of possibilities.)

The results of this analysis are summarized in three graphs. Figure 4-6 summarizes the estimated capital costs (projected to January 2010) for these options. In Figure 4-7, O&M costs are included by reporting the "equivalent annual cost" (the sum of the O&M cost and a 20-year amortization of the capital cost). Figure 4-8 factors in the nitrogen removal efficiency of the wastewater management option by comparing the equivalent annual cost and the amount of nitrogen removed. In all three graphs, the public sewerage option includes the incremental costs of treatment at one of the existing municipal facilities. For the decentralized options (individual, cluster and satellite), the costs are independent of the distance to an existing sewer system.

Many interesting conclusions can be drawn from each of these three graphs. The conclusions all depend strongly on the assumption made for each option, and a sensitivity analysis is warranted to illustrate how the conclusions could change.

Conclusions with respect to capital cost

Figure 4-6 shows how small-scale systems have the least cost, if only capital costs are considered. Cluster system can also be competitive if the associated collection system costs are low due to small lot frontage and limited need for pumping.

On a capital cost basis, satellite systems are much more expensive than individual systems (\$46,000 to \$67,000 per lot). The two principal contributing factors are the cost of collection and the cost for the treatment system. The best case for satellite systems is when the collection system costs are lower due to smaller lots, and the treatment system costs are reduced by the economies-of-scale associated with larger satellite systems. For a 300-home project with average lot frontage of 100 feet, the capital cost of the satellite option would be \$46,000 per lot, significantly less than the 200-lot, 200-foot-frontage scenario (\$67,000 per lot).

If a municipal sewer is immediately nearby, and has adequate capacity to serve the example neighborhood, the capital costs could be about \$40,000 (including an incremental allocation of capital cost for the existing treatment facility). For the assumptions of this analysis, connecting to an existing sewer is cost-competitive with the satellite options (serving 200-foot-frontage lots), if

FIG 4-6. CAPITAL COSTS FOR WASTEWATER MANAGEMENT OPTIONS

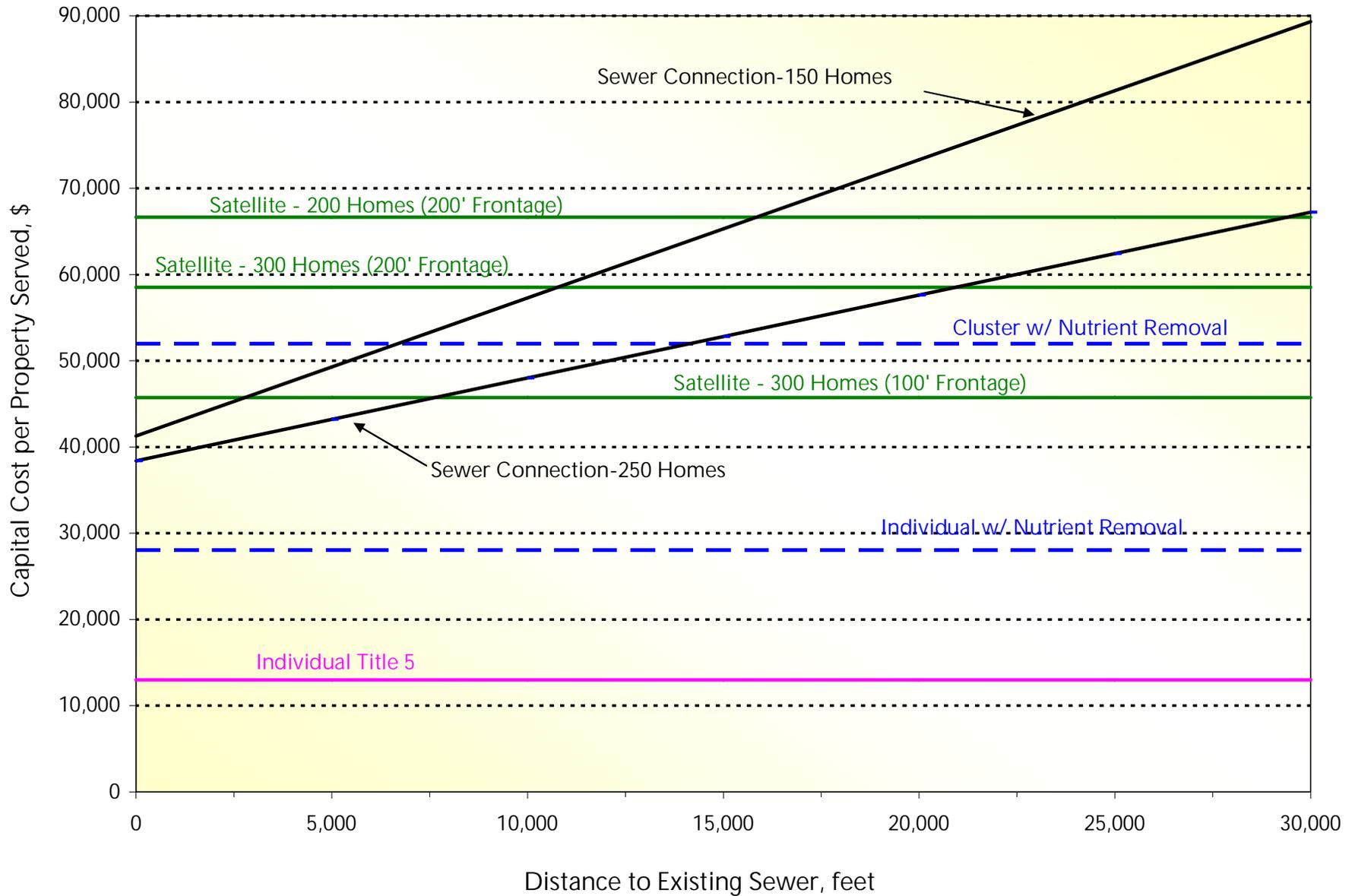


FIG 4-7. EQUIVALENT ANNUAL COSTS FOR WASTEWATER MANAGEMENT OPTIONS

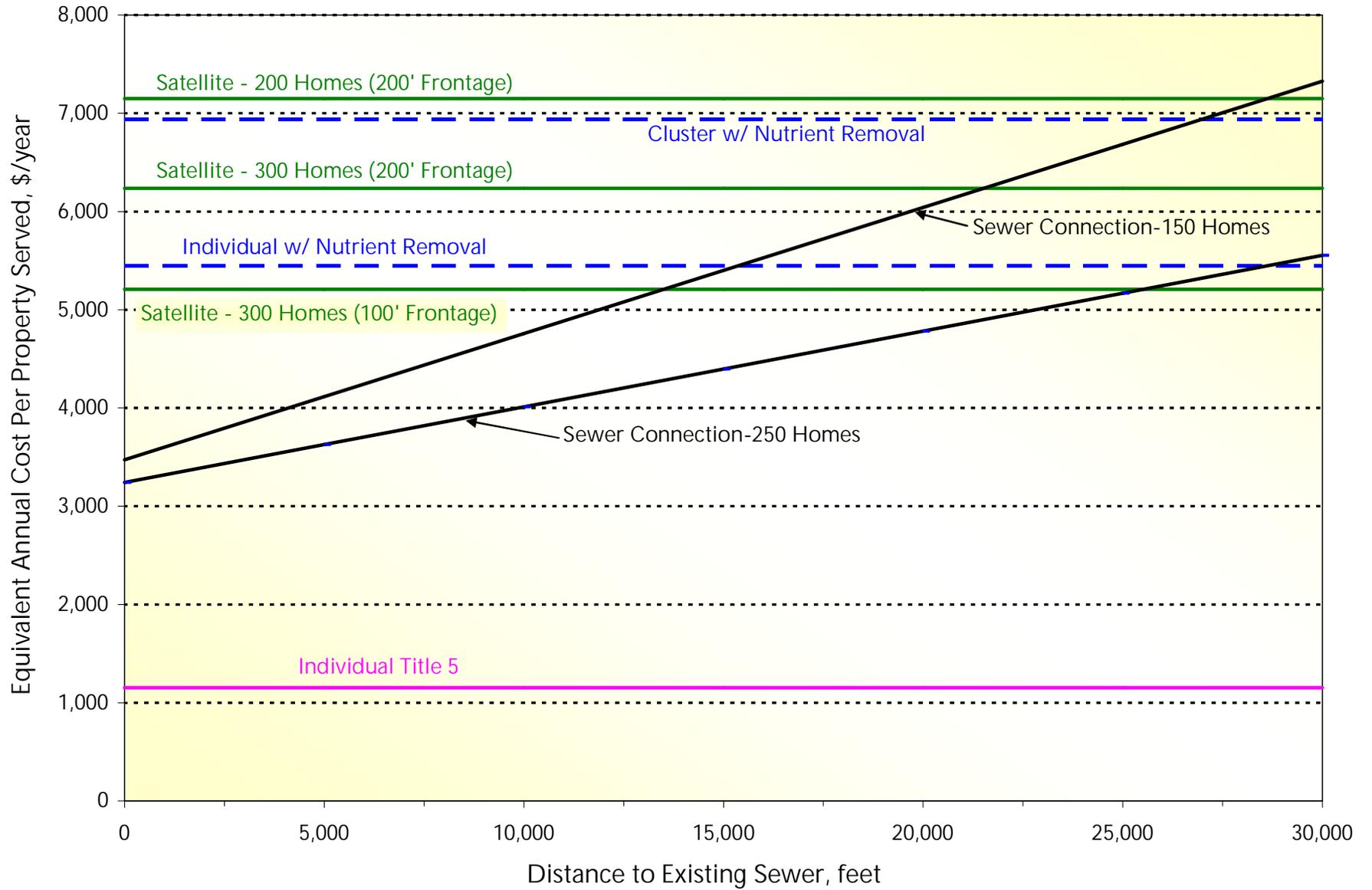
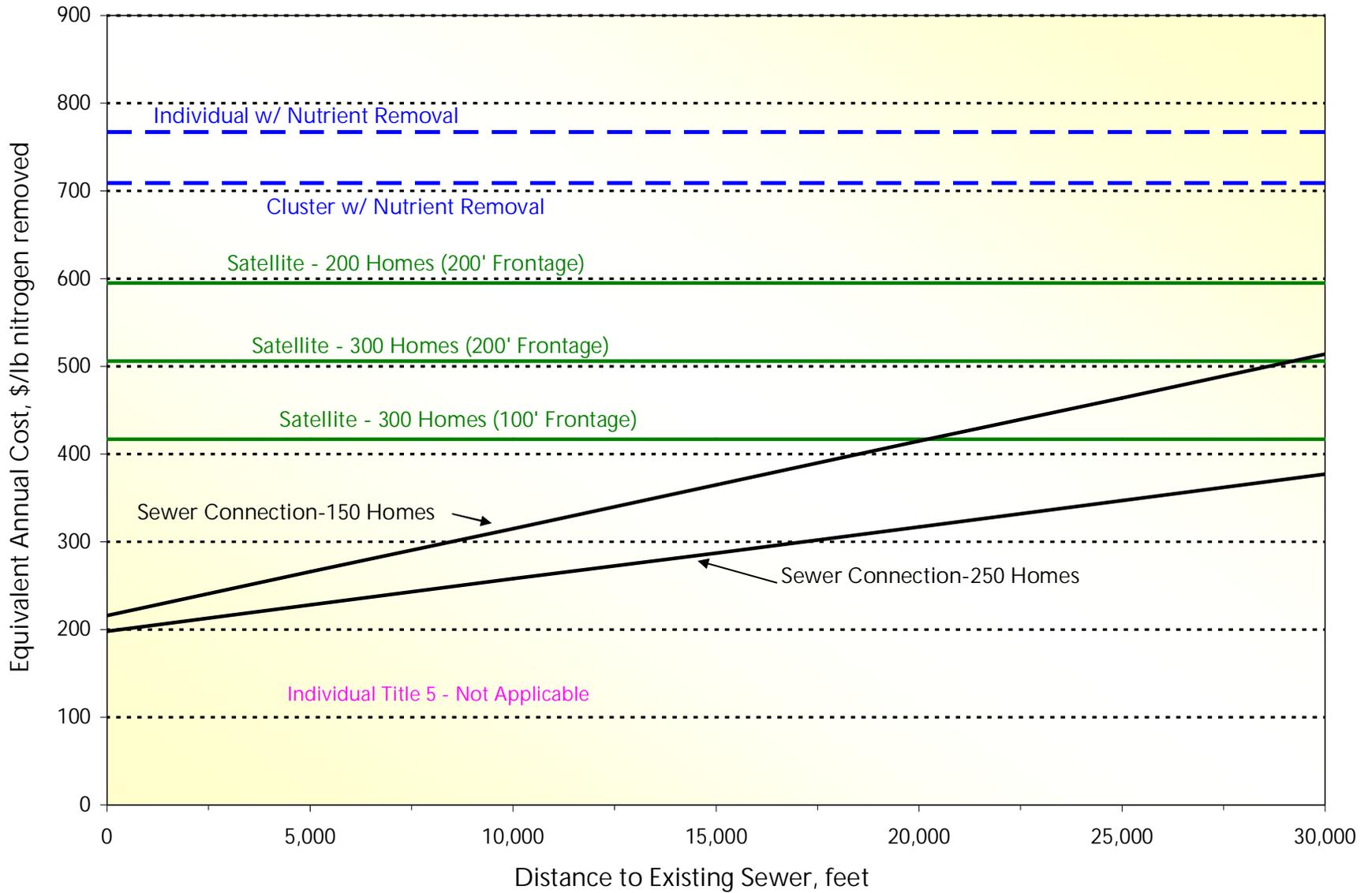


FIG 4-8. NITROGEN REMOVAL COSTS FOR WASTEWATER MANAGEMENT OPTIONS



the sewer is closer than about 10,000 feet considering only capital cost. That breakpoint is less (about 5,000 feet) if the project to be sewerred has 100-foot-frontage lots.

The costs portrayed in Figures 4-6, 4-7 and 4-8 include, where applicable, costs for collection, treatment and disposal. In the case of the sewer connection alternatives, it is assumed that some portion of the original cost of the existing treatment plan would be passed on to the new connections, as well as the incremental cost of O&M. The decision to allocate a portion of the prior construction costs is a local one, and must reflect the basis for cost recovery of the original project. For example, if property taxes were used to pay for the original construction, owners of previously-unconnected parcels have already contributed to the capital cost, and further allocation of those costs would be unwarranted. In this case, capital costs per property would be less than shown in Figure 4-6.

The collection system costs included in Figure 4-6 are significant, and may account for one-half or more of the total cost. In some circumstances, low-pressure collection systems can be built for about 20% less than traditional gravity systems, but with offsetting expenses for installation and operation of individual grinder pumps. For each sewer project, towns should thoroughly investigate these options and select the one that has the best mix of capital costs, O&M expenses and non-financial factors.

This analysis does not address all of the factors a town must address to recover the capital costs of a project. In translating these cost estimates to specific amounts that might be paid by specific properties in sewerred areas, the following factors should be considered:

- Towns must decide how to apportion capital costs between betterments (paid only by property owners served by the public infrastructure) and property taxes (paid by property owners town-wide). Amounts allocated to property taxes reduce the costs to properties that are served by the system.
- Betterments may be separately applied to collection costs and treatment costs, and collection system betterments may rely on one or more property features (such a total lot area or parcel frontage).
- No consideration has been given here to possible increases in property values for parcels connected to public sewers.

Conclusions that reflect both capital and O&M costs

Figure 4-7 can be used to evaluate the available options if both capital costs and annual O&M expenses are combined into an equivalent annual cost.

Individual nitrogen-removing systems are much less cost-effective in this analysis because of the relatively high cost to operate and maintain them and to monitor effluent and groundwater quality sufficient to demonstrate TMDL compliance. While the capital cost of the nitrogen removing system is about twice that of a Title 5 system, it is nearly five times as expensive when the O&M costs are factored in.

Satellite systems are relatively expensive to operate and maintain, so their equivalent annual cost (\$5,000 to \$7,000 per property) is higher than all of the other options, unless an existing public sewer is within 10,000 to 15,000 feet (serving smaller projects) or about 25,000 feet (serving

larger projects). The breakpoint where satellite systems have lower equivalent annual costs than sewer connections is much greater compared with the capital-only analysis.

In summary, when equivalent annual costs are considered, the cost per property is as follows for the various options:

Individual Title 5	\$1,200/yr
Sewer connection (10,000')	\$4,000 to \$4,800/yr
Sewer connection (20,000')	\$4,800 to \$6,000/yr
Satellite (300 homes -100' frontage)	\$5,200/yr
Individual with N removal	\$5,400/yr
Satellite (300 homes - 200' frontage)	\$6,200/yr
Cluster with N removal (8 mg/l)	\$6,900/yr
Satellite (200 homes - 200' frontage)	\$7,100/yr

This ranking of equivalent annual costs can be different if changes in key assumptions are made.

Conclusions based on the cost per pound of nitrogen removal

Figure 4-8 includes both the equivalent annual cost and the annual nitrogen removal (that removal is in comparison to a Title 5 system at 26 mg/l). This analysis favors those options that can achieve a low effluent nitrogen concentration.

Given the relatively poor performance of most individual systems for nitrogen removal (assumed here to be 13 mg/l based on more oversight than now typically provided), they have the highest cost in this analysis, about \$770 per pound. By contrast, cluster systems with denitrification have lower costs of \$710 for 8 mg/l effluent.

Satellite systems have costs of \$420 to \$600 per pound, based on 6 to 8 mg/l effluent. These systems have the potential for better effluent quality, and the per-pound cost would be about 10% lower with 5 mg/l effluent.

The potential for very high nitrogen removal at centralized systems, coupled with economies of scale, result in competitive costs for sewerage options. These costs are less than \$300 per pound for distances up to 10,000 to 15,000 feet. The breakpoint where sewer connections have the same per-pound costs as satellite systems is greater than 20,000 feet, for the assumptions used in this analysis.

In summary, when equivalent annual costs are combined with typical nitrogen removal efficiency, the cost per pound of nitrogen removed is as follows for the various options:

Individual Title 5	N/A
Sewer connection (10,000')	\$260 to \$320/lb
Sewer connection (20,000')	\$320 to \$420/lb
Satellite (300 home - 100' frontage)	\$420/lb
Satellite (300 homes - 200' frontage)	\$510/lb
Satellite (200 homes -200' frontage)	\$600/lb
Cluster with N removal (8 mg/l)	\$710/lb
Individual with N removal	\$770/lb

Caution is warranted in reviewing the capital costs and O&M costs presented in Figures 4-6 and 4-7 on a pre-property basis. For wastewater management projects that are aimed at reducing nitrogen loading in sensitive watersheds, the goal is to find the least cost solution that removes sufficient nitrogen from the watershed to restore water quality in coastal waters. If a town addresses a watershed-wide problem by sewerage a portion of the watershed, attributing all the costs to just the sewerage properties may not be appropriate. Further, to compare a sewerage option with one that relies on decentralized alternatives, the latter may involve more properties. Therefore, the watershed-wide cost must consider both the average cost per property served and the total number of properties whose septic systems would be eliminated to meet a TMDL. That consideration is inherently incorporated in the dollar-per-pound measure of cost-effectiveness reported here, and therefore that cost measure should be the one given most consideration in CWMPs.

APPLICATION OF GENERALIZED COSTS TO MARTHA'S VINEYARD

While these estimated costs are not specific to any one situation on Martha's Vineyard, some general conclusions can be drawn.

1. For homes and businesses that are located outside of nitrogen-sensitive watersheds, the traditional Title 5 system is by far the most cost-effective option. While providing a higher level of treatment in those locations may occasionally be necessary to offset reduced set-backs or other site-specific environmental concerns, nitrogen removal is generally ill-advised.
2. Collection costs are the largest single cost item. If a wastewater management system must be put in place to reduce coastal pond nitrogen loading, then the first focus should be on existing unsewered neighborhoods with small lots.
3. Requiring cluster systems with nitrogen removal may be an appropriate step for new development in nitrogen-sensitive areas, with reduced lot size and land set aside for treatment and disposal as part of the development.
4. For existing or new development on the fringes of the existing sewer systems, connection to those systems is a prime option, at distance up to about 10,000 feet or more. This breakpoint distance may be as high as 30,000 feet if opportunities do not exist for satellite systems in dense neighborhoods.
5. If a satellite system is constructed to serve a new private development, and the capital cost of that system is paid by the developer, then the cost of connecting nearby existing homes may be quite attractive. (This assumes that such connection would be condition of approval of the development.)

With this general guidance in mind, the costing approach presented in this chapter can be applied to specific situations on the Island to determining the best options in a case-by-case approach. The cost data presented herein are derived from the April 2010 report "Comparison of Costs for Wastewater Management Systems Applicable to Cape Cod" That report contains an extensive sensitivity analysis which provides insight into the factors that most influence the costs for each type of system.

The focus of this chapter has been the costs of various wastewater and nitrogen management options. Each of these options has a distinct set of environmental advantages and drawbacks, which should be considered but are not discussed here. Environmental issues include: maintaining water balances among watersheds; managing local impacts of effluent disposal; controlling growth pressures created by public sewers; addressing potential odor and noise impacts of wastewater treatment facilities; and a host of short-term construction-related issues.

CHAPTER 5 -- IDENTIFICATION AND EVALUATION OF REGULATORY TOOLS

INTRODUCTION

Any plan for managing wastewater must consider both structural and non-structural components. The structural aspects of a wastewater plan include the physical infrastructure built to collect and treat wastewater and discharge the effluent. The non-structural aspects of a wastewater plan are those regulations, bylaws, and policies that reduce structural costs or improve the effectiveness of the entire program. This report chapter deals with those non-structural components.

It is instructive to consider non-structural tools in two categories. The first category involves steps that can improve wastewater management where problems are focused on individual lots and there is no regional impact. The second category includes those wastewater problems that are cumulative in nature, such as phosphorus loading to freshwater ponds, or nitrogen loading to public water supply wells or sensitive coastal embayments. In the first category, the burden of compliance or repair falls exclusively to the property owner. In the second category, no one property owner is at fault; it is the cumulative effect of many septic systems that creates the problem.

DESCRIPTION OF TOOLS FOR INDIVIDUAL SEPTIC SYSTEMS

In general, Title 5 is an effective state sanitary code. In the absence of cumulative problems such as nutrient loading, individual systems built in accordance with Title 5 can be expected to provide effective protection against unsanitary conditions. Nonetheless, there are some tools that can be put in place to optimize the use of individual systems in these circumstances.

Septage Management

The effective life of a septic system can be prolonged with regular inspections and septage pumping. Towns should consider the following programs:

- Mandatory septage pumping at a predetermined interval, such as every four years, or at the time of property transfer; or
- Mandatory inspections at a predetermined interval, with mandatory pumping if the inspection deems it appropriate; or
- Inspection/pumping reminders sent to property owner with the annual tax bill.

Effective septage management can be hindered if there is no available receiving station nearby with acceptable fees. Septage disposal fees are high on Martha's Vineyard, so every effort should be made to ensure adequate disposal capacity at the local wastewater treatment plants at the lowest possible cost.

Appropriate Conditions Associated with Title 5 Variances

When variances from Title 5 (or local supplemental regulations) are required, boards of health can impose conditions to help mitigate the impact of the variance. Each board of health should review its past practices with respect to variances to ensure that its approach is both uniform and consistent with the resource to be protected. It is common for a board of health to require an individual nitrogen-removing septic system as a condition for a reduced set-back, say from a nearby wetland. While a higher degree of wastewater treatment may be warranted when setbacks are reduced, the removal of nitrogen may not be as important as basic biological treatment to reduce organic or solids load, or provide some degree of pathogen reduction. Unless the property is located in a nitrogen-sensitive area (not the subject of this section of the report), the installation of a nitrogen-removing systems may be wasted capital. Should public wastewater service become available later, the property owner will be reluctant to abandon a recently-installed nitrogen-removing system and pay to be connected to the sewer.

Consistency Among Town Boards and Commissions

Towns should provide a consistent approach among various town boards. In general, conditions related to wastewater disposal should be imposed by the board of health and not the planning board or conservation commission. Should the conservation commission or planning board adopt policies related to wastewater disposal, those policies should be consistent with board of health practices.

Inventory of Problem Systems

Each town should identify and maintain a record of all individual septic systems that do not comply, or are in marginal compliance, with Title 5 and local supplementing regulations. When off-site wastewater disposal opportunities arise, such as the permitting of a new commercial development with a cluster wastewater systems, boards of health should be ready to identify those nearby properties that would benefit from participation in the cluster system.

Escrow Accounts and Covenants

If a property owner is faced with the costly upgrading of a septic system, and some off-site solution (such as public sewers) is expected in the near term, the board of health can consider deferring that upgrading. That deferral should only be given if the problem is not a significant threat to public health. The deferral is most effective if there is in place a program of escrow accounts to allow the cost of the deferred upgrading to be set aside. The funds the property owner placed in escrow could be used to offset the betterment assessment if public sewers are later available. If the off-site solution is delayed, or the upgrading need becomes more severe, then the board of health could allow the release of the escrowed funds to pay for the upgrading.

Covenants are a useful tool to supplement a program of escrow accounts. The covenant is a written document, recorded in the registry of deeds, that formally acknowledges the property owner's obligation to participate in a future program to control nitrogen loading, even if the board of health has required and approved an interim repair or upgrading.

DESCRIPTION OF TOOLS FOR COASTAL POND PROTECTION

When considering tools for improved wastewater management in the watersheds of nitrogen-sensitive embayments, there are three cases of interest, as follows:

- **Case A:** current nitrogen loads are well below threshold levels even with expected growth well into the future.
- **Case B:** current nitrogen loads are below threshold levels but those thresholds will be exceeded with expected growth in the near term.
- **Case C:** current nitrogen loads exceed threshold levels and the situation will worsen with any future growth.

In Case A, nitrogen management is not a concern, and the tools described in the previous section are applicable.

In Case B, the concern is with growth in the nitrogen load, so-called "new nitrogen", and in the absence of growth, there is no need for nitrogen management.

In Case C, actions must be taken to address both current nitrogen loads (so-called "existing nitrogen") as well as "new nitrogen".

Regulatory Tools for Controlling "Existing Nitrogen"

The most effective means for dealing with current high nitrogen loads in the watersheds of sensitive embayments is to connect the appropriate number of homes to an off-site municipal wastewater system. That system can be a cluster, a satellite or a centralized system. The point of discharge of treated effluent can be either within or outside the watershed in question. If it is within the watershed, a greater number of homes or businesses must be connected to effect the needed nitrogen removal.

In nitrogen-sensitive areas where off-site wastewater options do not exist, towns can require the installation of individual nitrogen-removing septic systems. That requirement could be effective at a date certain, within a fixed number of years, or at the time of upgrading for other reasons.

In areas that will not be reached by municipal sewerage over the near term, private developments may hold the potential for reducing nearby nitrogen loads. If that new private development requires a cluster or satellite wastewater system, it is possible to require the connection of some nearby homes or businesses to that private wastewater infrastructure as a condition of approval of the new development. Towns need a regulation or bylaw governing such private development that would include some formula for determining the number of existing homes to be connected. See the discussion below concerning "no net nitrogen increase" programs.

While not directly related to wastewater, towns can reduce the need for wastewater management in nitrogen-sensitive areas by reducing nitrogen loads from lawn, garden and golf course fertilization and through improved stormwater management.

It is also possible to reduce household nitrogen loads at the source by banning garbage grinders and encouraging the use of composting and urine-diverting toilets.

Small-scale decentralized systems can benefit significantly from regular inspection and proper operation and maintenance. A regional program that provides these services would yield measurable benefits, both for existing and new nitrogen loads.

Regulatory Tools for Controlling "New Nitrogen"

Means for reducing future nitrogen loads must address both new development on currently vacant land and "redevelopment". Redevelopment includes commercial establishments that expand their operations, conversions from commercial operations with low flow to ones with higher flows, the addition of bedrooms to existing homes, and the increased occupancy of existing homes without expansion.

New nitrogen loads can be avoided or reduced by constraining the amount of new development on currently vacant land. This goal can be accomplished by re-zoning to require larger minimum lot sizes, or by placing new restrictions on the intensity of use. A moratorium on new development in Case C situation would be most effective, but probably only a temporary solution. Instead of placing restrictions on development, towns can purchase land or development rights in sensitive areas to preclude future development. It is also possible for towns to require private developers to set aside portions of development sites for resource protection, or to contribute to a fund for future land purchase in the same watershed.

There are several regulatory approaches that focus on limiting future wastewater flows or nitrogen loads. The simplest such approach is to prohibit additional wastewater flow from developed properties in nitrogen-sensitive areas. A less draconian approach might allow a small percentage increase in current flows, say at 10% or 20%. The allowable increase would be related to the stringency of the nitrogen threshold and coordinated with measures that deal with both existing nitrogen loads and new nitrogen loads from development on vacant land.

Title 5 now restricts unsewered development in Zone IIs to 110 gallons per day (gpd) per 10,000 square feet (sf) of lot area. Such a restriction could be extended by a town to watersheds of nitrogen-sensitive embayments. Towns could select a different allowable flow rate (say 50 or 150 gpd/10,000 sf) to reflect the stringency of the embayment's nitrogen threshold. Such limitations could also be expressed as pounds of nitrogen per unit lot area. These limits can be applied to either redevelopment or development on vacant land or both. There is significant potential for new nitrogen loads from currently-developed properties, and this source should be addressed.

For either redevelopment or vacant land development, a town could require developers to meet a "no net nitrogen increase" standard. The developer would be required to offset the new nitrogen from the proposed project with a reduction in existing nitrogen from sources in the same watershed. That offset could be accomplished by:

- a private wastewater treatment system that includes capacity for the connection of nearby residential or commercial properties currently using Title 5 systems; or

- extension of municipal sewers to portions of the watershed; or
- funding of individual or clustered nitrogen-removing septic systems; or
- purchase of developable land.

The offset could be numerically equal to the new nitrogen load, resulting in no net nitrogen increase. It is also possible to require the offset to be some multiple (say 1.5 or 2.0) of the new nitrogen load. In that case, there would be a net reduction in nitrogen load.

The Cape Cod Commission has informally adopted a "fair share" policy that promotes the allocation of the nitrogen threshold to new projects on a pound-per-acre basis. The nitrogen threshold is divided by the total land area in the watershed, and new development must not exceed that pound-per-acre "fair share". This approach has merit when current loads are less than the threshold. When existing watershed loads exceed the threshold, the "fair share" policy only places a limit on the new nitrogen without addressing the existing nitrogen. A more effective approach would be to allocate the difference between the threshold and the current load, thus assuring that the threshold is not exceeded.

Existing and new private wastewater treatment facilities may represent a resource that towns can use to effect additional nitrogen control. Close oversight of plant operations may result in better effluent quality at existing facilities. At the time of renewal of the groundwater discharge permit, the towns should advocate for a 5 mg/l effluent limit on nitrogen, instead of the standard 10 mg/l limit. In some circumstances, towns should consider municipal take-over of private plants to facilitate improved effluent quality or expanded service area.

Reducing nitrogen loads at the source, through use of urine-diverting toilets or banning of garbage grinders, can be effective for new development as well as existing systems.

Towns can reduce the overall cost of nitrogen removal in sensitive watersheds by encouraging new dense development (such as affordable housing projects) near developed areas with sewer service. Such steps should be coupled with density reductions in more remote areas.

Any steps that towns take to deal with new nitrogen are more effective if towns have completed thorough build-out estimates. In Case B situations (see above definition), an effective plan to stay below a nitrogen threshold must be based on a realistic appraisal of the growth potential. The Commission could provide guidance and a standard approach for completing build-out analyses.

DESCRIPTION OF TOOLS FOR MINIMIZING IMPACTS OF MUNICIPAL WASTEWATER DISCHARGES

If a municipal wastewater treatment facility discharges within the watershed of a sensitive embayment, the degree of sewerage in the watershed is directly related to the effluent nitrogen load that remains after treatment. The lower the treatment facility's effluent nitrogen load, the fewer septic systems must be eliminated in the watershed. Therefore, the following steps should be taken:

- Provide the highest level of nitrogen removal at the treatment plant that is economically justified;

- Strategically locate new effluent disposal facilities upgradient from natural attenuation opportunities;
- Implement an effluent reuse program that allows further polishing of effluent quality before contaminants reach the groundwater;
- Use a "checkerboard" sewer system to prevent sewer connections from properties with recently installed individual nitrogen-removing septic systems, that are located upgradient from natural attenuation regimes, or that have low-intensity uses; or
- Implement a "growth neutral" bylaw that restricts sewer flow to that which could occur anyway under Title 5. A more restrictive cap than Title 5 may be warranted, especially in areas of large lots.

All of these steps can help reduce nitrogen loading from wastewater facility discharges. If those steps are not adequate, the relocation of the discharge point to a non-sensitive watershed should be explored.

In the sections above, potential tools are often described as steps that "towns" can take. It should be recognized that some of these regulatory measures might be implemented by the County, the Commission, or a special-purpose wastewater or nutrient management district.

EVALUATIVE CRITERIA

Each of the regulatory tools described above has advantages and disadvantages. The strong and weak points of each approach can be identified by considering the following evaluative criteria:

1. **Freedom from legal challenge.** New regulatory tools must have a firm basis in law so that their effectiveness is not reduced by protracted or widespread legal action.
2. **Ease in implementation.** Any new regulation or bylaw will be most effective if it is readily put in place and fits within a consistent overall program. Those that require special legislation are less favored.
3. **Adaptability to different watershed conditions.** The best approaches are those that allow different requirements for different watershed conditions (see Cases A to C above).
4. **Addresses both existing and new nitrogen sources.** For Case C situations (and some Case B) the best tools are those that address both existing and new nitrogen loads.
5. **Amount of nitrogen removed.** These tools vary in their effectiveness in controlling nitrogen. Those that remove the most nitrogen should be given priority, other issues being equal.
6. **Growth neutrality.** The public typically supports wastewater regulations or programs that neither promote nor restrict growth compared with Title 5 or existing zoning. (A new state loan program establishes growth neutrality as a loan condition.)
7. **Avoids proliferation of individual nitrogen-removing septic systems.** Solving nitrogen loading problems one lot at a time may be the best approach in some circumstances, but can be counterproductive if it creates opposition to a later community approach that requires property owner to pay a second time.
8. **Convenience.** Nitrogen control approaches that are inconvenient tend to lack public support and be less effective than those that involve little or no inconvenience. For example, composting and urine-diverting toilets are considered to be unnecessarily inconvenient by some.

9. **Effective for both seasonal and year-round occupancy.** Regulation and programs must be effective in both settings, given Martha's Vineyard's highly seasonal character.
10. **Consistent across multi-town watersheds.** Approaches that apply across town boundaries will be more effective in dealing with watershed issues.
11. **Fairness between residential and commercial sectors.** The most effective regulations or policies impact residential and commercial sectors in a way that is considered fair by both.
12. **Moderate cost.** Regulations that impose high compliance costs tend to be more difficult to implement.

These criteria cover a broad range of issues. Individual towns or interest groups may have other criteria to add to this list, and may place differing emphasis on these criteria.

RANKING OF TOOLS WITH RESPECT TO EVALUATIVE CRITERIA

Many of the identified regulatory tools can be developed and implemented in a way that meets most of these evaluative criteria. Issues such as "fairness" and "ease in implementation" can only be addressed through the process of drafting the documents and taking them through standard public consultation processes. The most difficult criteria to meet are "consistency across multi-town watersheds" and "growth neutrality".

Most of the regulatory tools that are discussed herein are most easily implemented, and most likely to be successful, if they are promulgated by individual towns. Boards of health, conservation commissions and planning boards already exist and have well-established programs that these regulatory tools will supplement. To the extent that funding must be provided, such as for staff additions, those decisions are typically made through the municipal budgeting process and town meeting. The significant hurdle in controlling watershed nitrogen loading is the need for consistency across the watershed if it covers more than one town. Therefore, some of these regulatory tools may be best implemented by the Commission or by a watershed district. Alternatively, special efforts are needed to ensure that actions by individual towns are closely coordinated across watersheds. The Commission could draft standard regulations and facilitate adoption by individual towns. Please refer to Chapter 3 for further discussion of the structures available.

Wastewater planning must be closely coordinated with the towns' local comprehensive plans. There is often public opposition to wastewater projects or programs if they appear to promote more growth than would be expected in the absence of those programs or projects. Conversely, individual property owners object to restrictions being placed on their land that lessen its value. If a wastewater or nitrogen control initiative is neither "growth promoting" nor "growth restricting", then both sets of concerns are addressed. Since past and expected future growth in unsewered areas is the predominant cause of nitrogen overloading of coastal waters, many of the available regulatory tools are growth-restricting. Alternatives to those growth-restricting approaches involve expensive technology for widespread wastewater collection, high levels of wastewater treatment and new sites for effluent disposal. In many cases, communities must choose between costly measures and growth-restricting measures. Formulating a set of effective regulatory tools must recognize the importance of balancing those factors.

CHAPTER 6 -- REVIEW OF EXISTING POLICIES, BYLAWS AND REGULATIONS

Wastewater disposal on Martha's Vineyard is governed by Title 5, local supplements to Title 5, some local zoning provisions, and the Water Quality Policy of the Martha's Vineyard Commission.

Table 6-1 summarizes the principal wastewater-related regulations in force in the six Island towns. All six towns have supplemented Title 5 and established Districts of Critical Planning Concern (DCPCs). Each town has significantly increased the minimum setbacks between leaching systems and wells, wetlands and the shoreline. All six towns have addressed the influence of septic density on watershed nitrogen loading by restricting the number of bedrooms per square foot of lot area. These limits are either one bedroom per 10,000 square feet or one bedroom per 15,000 square feet.

The Martha's Vineyard Commission has adopted a Water Quality Policy to guide applications for and the review of Developments of Regional Impact (DRIs). The current Water Quality Policy was last updated in February of 2007. It categorizes the Island's coastal ponds based on actual water quality and sets interim nitrogen loading limits for the watersheds of 15 of those ponds. The Commission's policy sets forth a procedure for limiting nitrogen loading from DRIs in the watersheds of these 15 ponds. First the applicant must implement Basic Nitrogen-Reduction Techniques. If those steps are not adequate to meet the watershed-specific nitrogen loading limit, then the applicant must provide a nitrogen offset. The offset can be accomplished by placing another property into permanent conservation, by reducing current nitrogen load at another project in the watershed, or (subject to Commission discretion) by a monetary contribution.

The following preliminary observations are made concerning the adequacy and appropriateness of current town and Commission regulations and policies:

1. Local supplements to Title 5 represent an aggressive approach to controlling the potential sanitary impacts of wastewater disposal (see needs categories discussed in Chapter 2).
2. Restricting the number of bedrooms per square foot of lot area is a reasonable first step toward limiting nitrogen loading in the watersheds of sensitive coastal ponds. However, these limits are not restrictive enough in many cases.
3. Local regulations and policies may inadvertently promote the widespread use of individual nitrogen-removing systems. These individual systems provide some degree of nitrogen control, but may not be the most cost-effective long-term solution (see Chapter 4 for cost information).
4. The foundation for the Commission's Water Quality Policy is the application of the Buzzard's Bay model. While this model may give some indication of allowable loading, it is of paramount importance that the more comprehensive evaluations conducted by the Massachusetts Estuaries Project (MEP) be completed as soon as possible. At that time the Water Quality Policy should be updated to reflect more accurate information.

TABLE 6-1

SUMMARY OF CURRENT WASTEWATER-RELATED REGULATIONS

	Town					
	Aquinnah	Chilmark	Edgartown	Oak Bluffs	Tisbury	West Tisbury
Local Supplements to Title 5	Yes	Yes	Yes	Yes	Yes	Yes
One or More Established DCPC's	Yes	Yes	Yes	Yes	Yes	Yes
Required Septic Inspections at Time of Property Sale or Transfer			Yes	Yes	Yes	Yes
Comprehensive Septic Inspection Program					Yes	
Required Septic System Setbacks in Sensitive Areas, feet						
Leaching system to property line	30	30				30
Leaching system to well	150-200	150	100-200	200	200-300	150
Leaching system to wetland	150	200-500		200	100-200	
Leaching system to salt water	200	200-500	200	200	200	150-200
Bottom of leaching system to GW	5	5	5	5	5	5
Flow Limits in Sensitive Areas, Minimum						
lot area per bedroom, square feet	15,000	10,000	10,000 to 15,000	15,000 and N load limit	15,000	15,000
Permit Required for Private Well	Yes	Yes	Yes			Yes
Zone II Overlay Districts				Yes	Yes	Yes

5. Once MEP technical studies are complete, the Commission should adopt a "no net nitrogen increase" approach, using multipliers on the estimated nitrogen offset to reflect the degree of impairment watershed-by-watershed.
6. Towns should adopt companion regulations to control nitrogen loading from new development and from re-development for projects that fall below the DRI threshold.
7. Towns should adopt regulations to require certain private projects to install cluster or satellite systems and provide wastewater service to nearby homes or businesses in sensitive watersheds.

CHAPTER 7 -- NITROGEN CONTROL CASE STUDIES

GOAL

The Martha's Vineyard Commission, in conjunction with local representatives, selected one case study in each of the six Island towns to illustrate specific steps that can be taken to reduce nitrogen loads in the watersheds of sensitive embayments. For each case study, wastewater flows were estimated by Commission staff, and one to five technical solutions were identified. For some of the potential solution, conceptual layouts were developed for possible wastewater infrastructure and generalized costs estimates were prepared. These case studies illustrate a range of wastewater-related solutions.

OVERVIEW

Table 7-1 summarizes key information on the six case studies. The locations of the case studies are shown in Figure 7-1, along with the boundaries of the major watersheds. Technical information on the watersheds is presented in Chapter 2.

The Martha's Vineyard Commission prepared estimates of water use and wastewater flow for all watersheds and all case study areas. These estimates are presented as annual average flows in gallons per day (gpd).

Where appropriate, cost estimates were prepared for both capital costs (the cost to design, permit and build the needed infrastructure) and for operation and maintenance (O&M, the annual cost for labor, chemicals, power, etc.) These two types of costs were combined into an equivalent annual cost, which is the sum of the O&M and the amortized capital. The equivalent annual costs were combined with estimates of nitrogen removal efficiency to produce indicators of costs expressed as dollars per pound of nitrogen removed. All costs are reported in mid 2009 dollars.

AQUINNAH CASE STUDY--TRIBAL HOUSING

The Tribal Housing area was selected for the Aquinnah case study; see Figure 7-2. Here the residential units and some office space are connected to a satellite wastewater treatment facility that is operating well below its peak capacity of 25,000 gpd.

The study area is located in the Squibnocket Pond watershed. Squibnocket Pond is showing signs of water quality degradation that are exacerbated by poor tidal exchange. The water quality situation here is unusual, in that the Pond's watershed is only 2 times the surface area of the pond itself. (By comparison, Tashmoo, Lagoon and Sengekontacket Ponds have watershed-to-pond-area ratios of 6 to 10.) The nitrogen loading from precipitation has a greater impact on Squibnocket Pond relative to nitrogen loading in its watershed, because precipitation falling directly on the pond surface is a relatively larger source of inflow and there is no attenuation of that nitrogen load as occurs in vegetated areas of the watershed.

TABLE 7-1

OVERVIEW OF CASE STUDIES

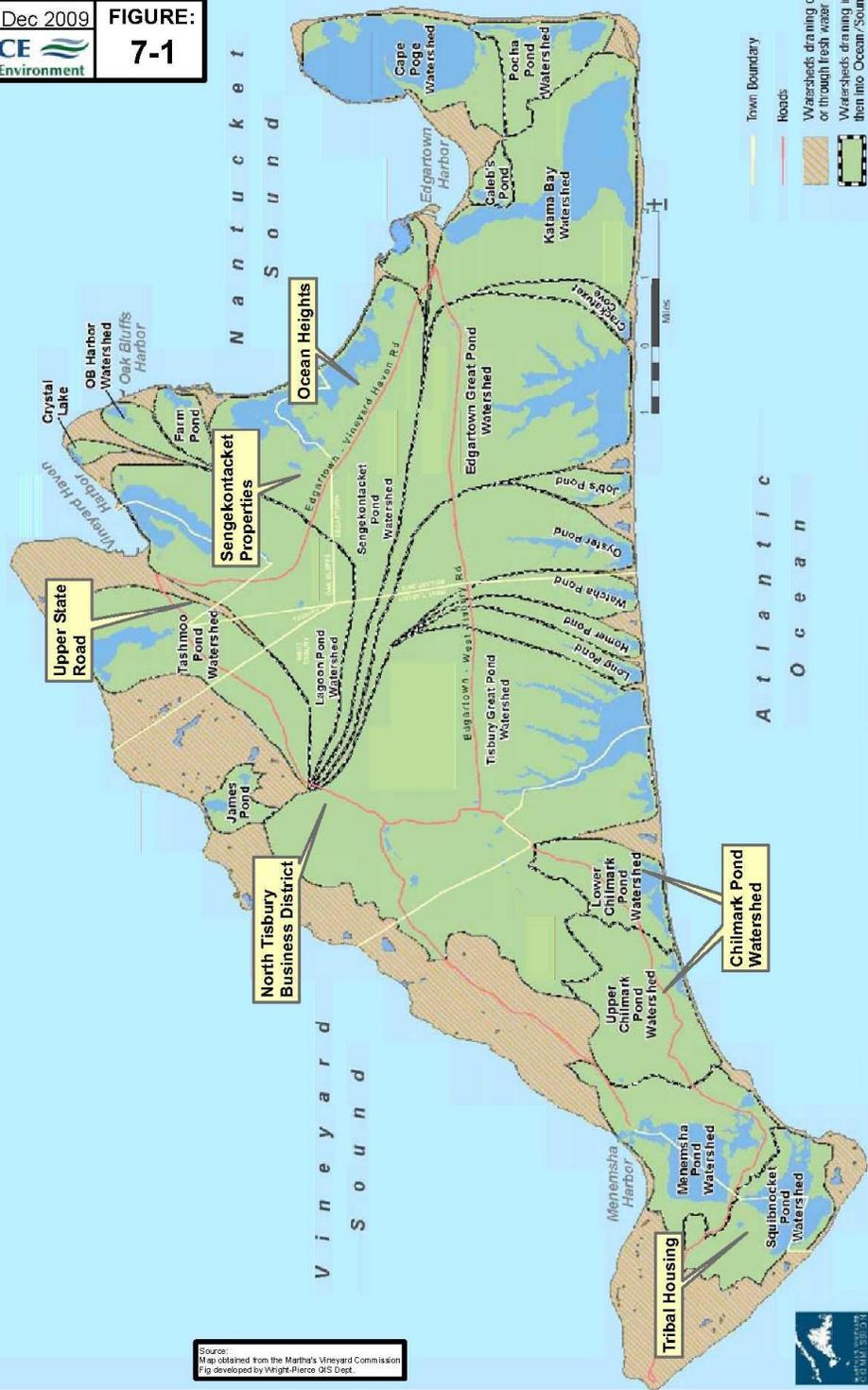
	Town					
	Aquinnah	Chilmark	Edgartown	Oak Bluffs	Tisbury	West Tisbury
Study Area	Tribal Housing	Chilmark Pond Watershed	Ocean Heights	Sengekontacket Properties	Upper State Road	North Tisbury Business District
Watershed Name	Squibnocket Pond	Chilmark Pond	Sengekontacket Pond	Sengekontacket Pond	Tashmoo Pond	Tisbury Great Pond
Embayment Water Quality	Impacted	Impacted	Somewhat Impacted	Somewhat Impacted	Somewhat Impacted	Impacted
Number of Developed Properties in Study Area						
Current	34	445	456	136	111	32
Build-Out	34		556	168	142	64
Annual Average Wastewater Flow in Study Area, gpd						
Current	2,000	67,500	76,400	22,400	19,700	7,700
Build-Out	4,000	114,000	100,000	28,000	31,400	15,200
Is case study area served by public water?	No	No	Yes	Yes	Yes	No
Is case study area within water supply Zone II?	No	No	No	No	Partially	Yes

Martha's Vineyard Wastewater Management Study

Case Study Locations

PROJ NO: 11279A DATE: Dec 2009 **FIGURE: 7-1**
WRIGHT-PIERCE
 Engineering a Better Environment

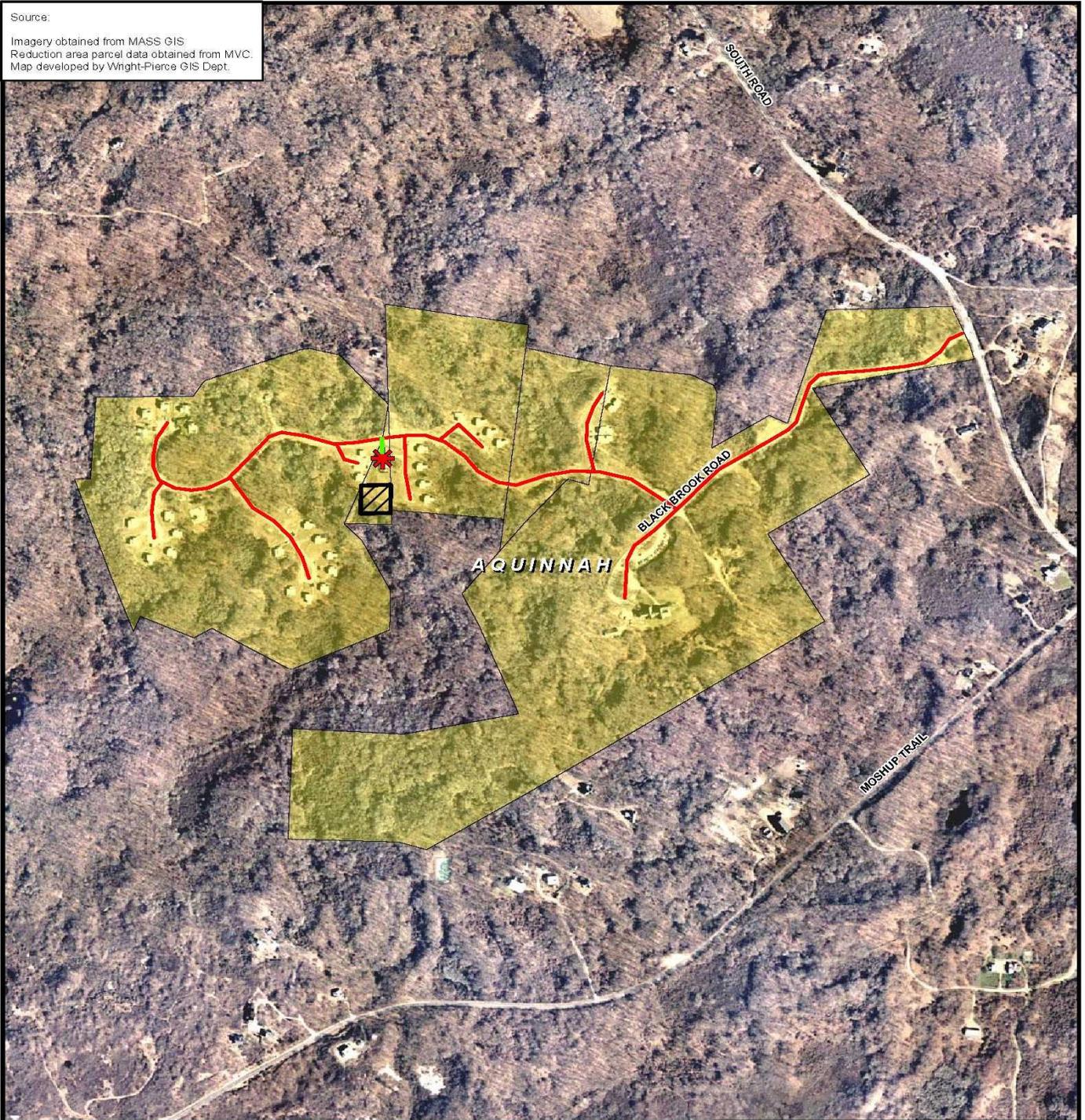
Watersheds of Martha's Vineyard Island



Source:
 Map obtained from the Martha's Vineyard Commission
 Fig. developed by Wright-Pierce GIS Dept.

W:\GIS_Development\Projects\11279-Martha's Vineyard\Figures\Report_Figs_12-16-2009\Fig_7-1_CaseStudyLocations_Bxt1.mxd
 Friday, December 18, 2009 2:15:41 PM

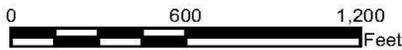
Source:
 Imagery obtained from MASS GIS
 Reduction area parcel data obtained from MVC.
 Map developed by Wright-Pierce GIS Dept.



Friday, December 18, 2009 8:49:30AM
 W:\GIS_Development\Projects\11279-Martha's Vineyard\Figures\Report_Fig_12-18-2009\Fig_7-2_Aquinnah_8x11.mxd

Legend

- Existing Sewer
- * Treatment Facility
- Effluent Disposal
- Wastewater Collection Area



Martha's Vineyard Wastewater
 Management Study

Aquinnah Case Study
 Tribal Housing Area

PROJ NO: 11279A DATE: Dec 2009

WRIGHT-PIERCE
 Engineering a Better Environment

FIGURE:
7-2

Studies by the Martha's Vineyard Commission show that the septic nitrogen load in the Squibnocket Pond watershed is only about 5% of the total watershed load. That septic load includes only unsewered development, and does not include the nitrogen discharged from the treatment facility through its subsurface leaching system. The total watershed load exceeds the Commission's estimate of the assimilative capacity of Squibnocket Pond, and would so even with complete elimination of septic systems in the watershed. That fact, coupled with the very light development density indicates that traditional approaches for managing nitrogen load may not be applicable.

With respect to the Tribal Housing area, the options for wastewater management include:

- A. Set aside the surplus capacity at the existing wastewater treatment facility for future development in the Tribal area (that is, use it to address future nitrogen loads only); and
- B. Make that surplus capacity available to nearby non-Tribal properties to reduce current septic loads in the Squibnocket Pond watershed.

Given the remote location and large land area (113 acres) occupied by the Tribal Housing complex, Option B would involve considerable wastewater collection costs, disproportionate to the marginal impact on water quality. Further, there would be administrative hurdles to using Tribal infrastructure to serve non-Tribal development.

Since the Tribal Housing area is served by individual wells, protection of water supplies is a second reason to use the existing treatment facility capacity to avoid septic systems for future development within the study area.

Option A should be preferred, pending technical studies of Squibnocket Pond under the Massachusetts Estuaries Project. Consideration should also be given to improving the tidal flushing by improving the hydraulics of the outlet stream.

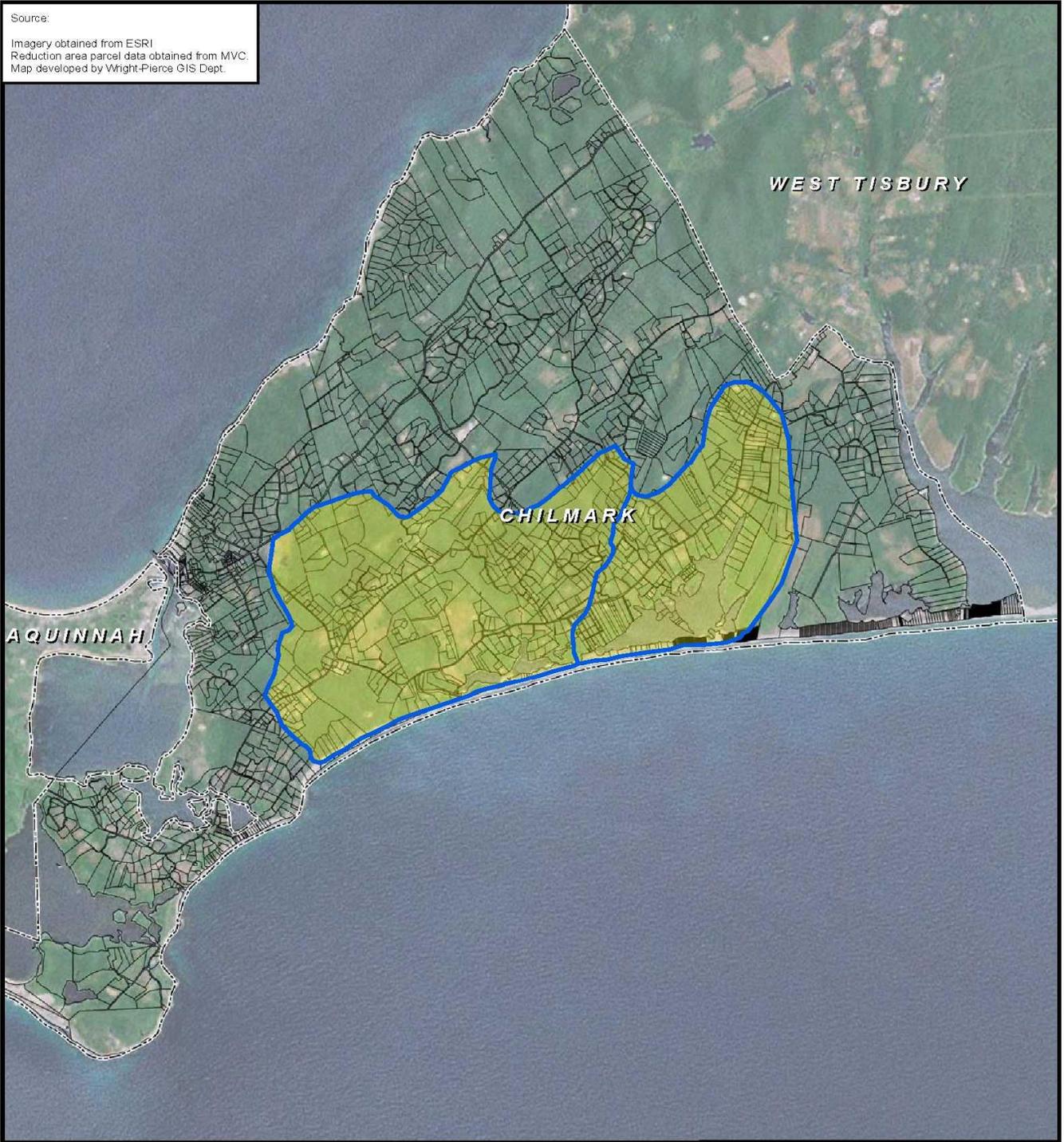
CHILMARK CASE STUDY--CHILMARK POND WATERSHED

Unlike the other five case studies, which focus on a well-defined area of existing wastewater flow and septic nitrogen loading, the Commission has chosen the Chilmark case study to consider the entire watershed of Chilmark Pond (Upper and Lower); see Figure 7-3. The watersheds of these ponds lie completely within the limits of the Town of Chilmark, and comprise 20% of the town's land area.

Lower Chilmark Ponds is characterized as "impacted" by the Martha's Vineyard Commission. The current total nitrogen load to the both ponds is estimated to be 11,000 lb/yr, of which about 33% is associated with septic systems. Of importance is the fact that 35% of the total load is from atmospheric deposition of nitrogen. Because the Upper Pond is fresh water, the Commission has assumed that 50% of its watershed nitrogen load is naturally attenuated.

The Martha's Vineyard Commission has estimated that the nitrogen assimilative capacity of the Chilmark Ponds is approximately 4,500 lb/yr. With a total load of 11,000 lb/yr, these ponds are the most overloaded of any major pond system on the Island. The load reduction needed to

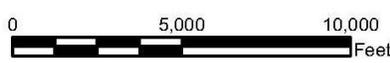
Source:
 Imagery obtained from ESRI
 Reduction area parcel data obtained from MVC
 Map developed by Wright-Pierce GIS Dept.



Friday, December 18, 2009, 8:55:51 AM
 W:\GIS_Development\Projects\11279A\Martha's Vineyard\Figures\Report\Fig_12-18-2009\Fig_7-3_Chilmark_8x11.mxd

Legend

- Watershed Boundary
- Case Study Area



Martha's Vineyard Wastewater
 Management Study

Chilmark Case Study
 Chilmark Pond Watershed

PROJ NO: 11279A DATE: Dec 2009



FIGURE:
7-3

restore and maintain water quality is 6,500 lb/yr, significantly greater than the entire septic load and approximately equal to all man-made loads (including landscape and farm fertilization and stormwater disposal). Said another way, the apparent load limit would not be met even if all local man-made source of nitrogen are eliminated. Only by reducing regional or national man-made sources (oxides of nitrogen imported via prevailing winds and precipitation) would water quality be restored in these ponds.

The low density of development also creates a significant hurdle for traditional wastewater management. The average density of development in the study area is 0.13 developed parcels per acre, compared with 0.62 parcels per acre in Tisbury and 0.82 parcels per acre in Oak Bluffs. The watershed septic load here is only about one pound of nitrogen per year per acre of watershed. By contrast the septic loads in the watersheds of Lagoon, Tashmoo, Farm and Sengekontacket Ponds, Katama Bay and Oak Bluffs Harbor are all greater than about 5 lb/yr/ac. For 23 watersheds on Cape Cod where MEP technical reports have been completed, septic loads range from 3 to 22 lb/ac/yr with an average of 10 lb/yr/ac.

Expressed as annual average flows, existing land uses in the watershed generate 67,500 gpd of wastewater, which is about 35% of the estimated town-wide flow. The Martha's Vineyard Commission has projected a 69% growth in the watershed and 81% town-wide.

On an areal basis, the Chilmark Ponds watershed loading is about 20 gpd of wastewater per acre as an annual average, or about 40 gpd/ac as a Title 5 flow. Title 5 sets a maximum of 110 gpd/acre for development in Zone IIs and nitrogen sensitive areas. The total current wastewater flow in the Chilmark Ponds watersheds is roughly equal to the current flow in the Ocean Heights case study area (see below), where the wastewater density is about 300 gpd/acre.

With low development density and apparent watershed load reduction targets that are greater than the current septic loads, traditional wastewater management techniques are not viable. The following options have been considered for the Chilmark Ponds:

- A. Identify pockets of development where cluster systems could be employed to allow some reduction in septic nitrogen loads;
- B. Require individual denitrifying septic systems in some areas of the watershed, perhaps within 10-year groundwater travel time of the ponds;
- C. Investigate the viability of enhancing the ponds' flushing rates by creating and maintaining a wider, deeper pond outlet;
- D. Deter growth in the watershed;
- E. Support state and national efforts to reduce air emissions of the oxides of nitrogen that represent the largest single load to this watershed.

It is likely that none of these options alone will be fully effective and that some combination will be required.

The first step should be the completion of the MEP technical studies of the Chilmark Ponds. The MEP technical report is due in early 2012 and should provide updated information on watershed nitrogen loads, and more importantly, a refined estimate of the ponds' assimilative capacity. The Town and the Martha's Vineyard Commission should request that enhanced flushing be studied and recommendations included in the MEP report.

In Option A, pockets of development could be served by cluster or satellite wastewater treatment systems. For example, properties at the Menemsha Cross Roads area now generate about 13,000 gpd of wastewater, about 20% of the watershed total. Using a system like that described in the West Tisbury case study, nitrogen removal could be effected at a cost of about \$400 to \$600 per pound. Individual denitrifying septic systems (Option B) avoid the cost of even a limited collection system and would cost \$700 to \$800 per pound. In both options, 30% to 50% of the wastewater nitrogen would remain in the watershed after treatment. If the need is to remove all of the septic nitrogen from the watershed, these options would be viable as supplements to a broader plan, and not the sole means of nitrogen control. Composting toilets and urine-diverting toilets are other options, albeit less acceptable to the general public, that may have applicability in this situation.

Improving the ponds' flushing rates (Option C) could increase the nitrogen load limit and make other options more viable. Flushing enhancements may be the only way to strike a balance between limited assimilative capacity and the dominance of atmospheric deposition in the overall nitrogen load. Nonetheless, there is a risk of other environmental impacts and the permitting requirements of this option should be viewed as significant. Costs are hard to predict, because there would be both an initial capital expense and what could be a large recurring cost for maintenance dredging.

Another non-traditional nitrogen control measure is aquaculture. By growing shellfish in the Ponds, and harvesting the shellfish and the nitrogen they take up, it may be possible to measurably reduce the impact of watershed and atmospheric nitrogen loads.

EDGARTOWN CASE STUDY--OCEAN HEIGHTS

Figure 7-4 shows the Ocean Heights and Arbutus Park developments that were selected for this case study. They are a 555-lot subdivision that occupies 360 acres in the watershed of Sengekontacket Pond. About 80% of the lots (455) are occupied and 100 parcels are vacant. The study area is located on both the north and south sides of the Edgartown-Vineyard Haven Road. Town water is available to most developed parcels and can be extended to new areas at cost to the landowners. This development abuts the westerly shore of the southerly portion of Sengekontacket Pond. It is located about midway between the Oak Bluffs-Edgartown town line to the west and the developed portion of Edgartown to the east. This case study area is located about 8,000 feet east of the Sengekontacket Properties case study (see below).

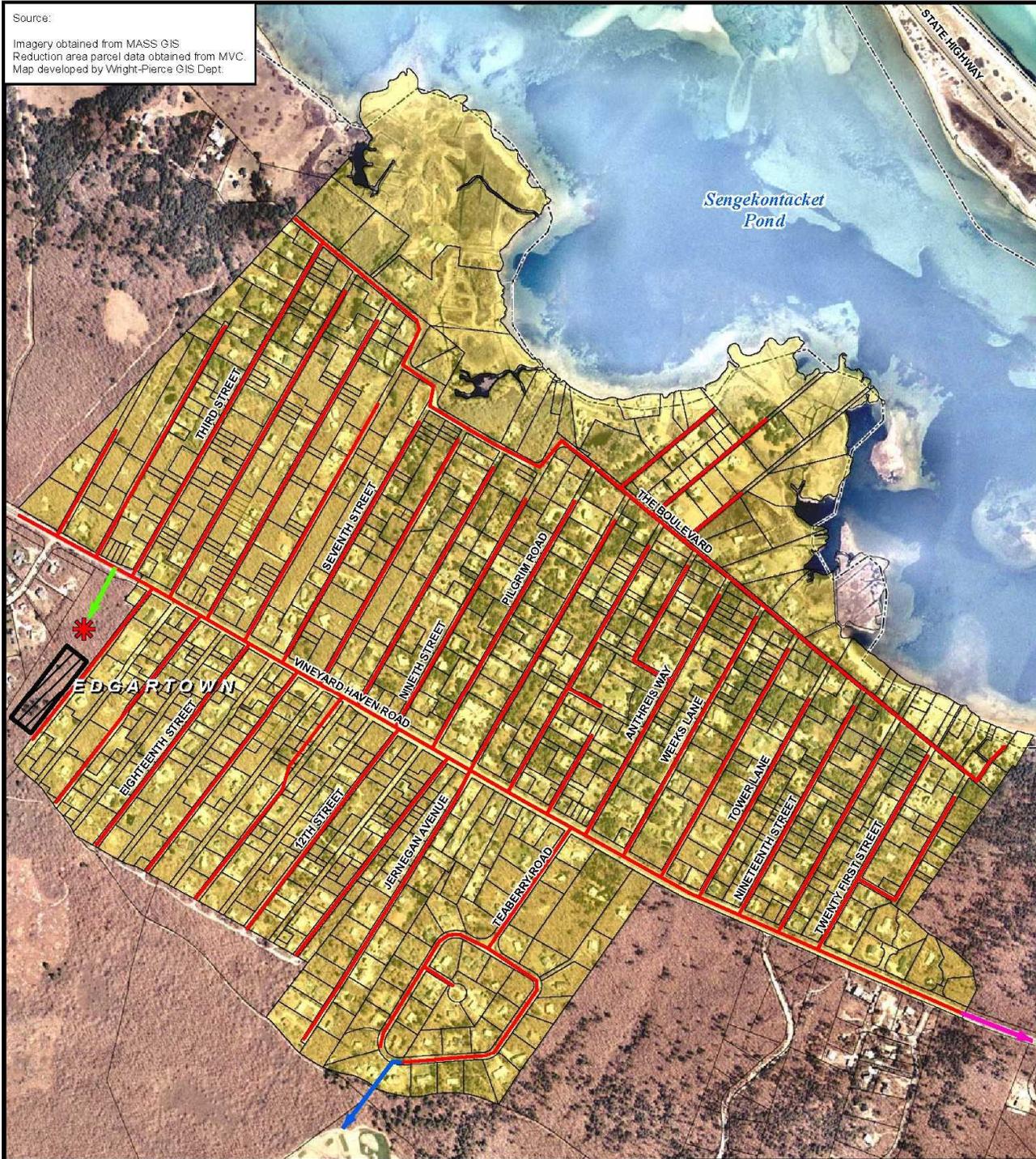
Sengekontacket Pond is characterized as "somewhat impacted" by the Martha's Vineyard Commission based in part on loss of eelgrass, which nearly disappeared from the system about 1990. The current septic nitrogen load to the Pond is estimated to be 21,000 lb/yr, of which about 30% is associated with septic systems in the study area.

Three options were investigated to provide wastewater service to this case study area:

- A. The same sewer system within the study area leading to a pump station that would convey the collected wastewater about 500 feet south through the Vineyard Golf Club to existing sewers leading to the Edgartown Wastewater Treatment Facility off the Edgartown-West Tisbury Road; and

Source:

Imagery obtained from MASS GIS
 Reduction area parcel data obtained from MVC
 Map developed by Wright-Pierce GIS Dept.



Friday, December 18, 2009 10:12:47 AM
 W:\GIS_Development\Projects\11279-Martha's Vineyard\Figures\Report_Figs_12-18-2009\Fig_7-4_Edgartown_Bx11.mxd

Legend

- Proposed Sewer
- Option A
- Option B
- Option C
- Treatment Facility
- Effluent Disposal
- Wastewater Collection Area



Martha's Vineyard Wastewater Management Study

**Edgartown Case Study
 Ocean Heights**

PROJ NO: 11279A DATE: Dec 2009 **FIGURE:**



7-4

- B. The same sewer system within the study area leading to a pump station that would convey the collected wastewater about 500 feet south through the Vineyard Golf Club not existing sewers leading to the Edgartown Wastewater Treatment Facility off the Edgartown-West Tisbury Road; and
- C. The same sewer system within the study area leading to a pump station that would transport the collected wastewater about 6,000 feet east along Edgartown-Vineyard Haven Road to existing sewers leading to the Edgartown Wastewater Treatment Facility.

An analysis of land use and water use by the Martha's Vineyard Commission staff resulted in wastewater flow estimates for this case study area of 76,000 gpd (current) and 100,000 gpd (build-out). Both of these figures represent average annual flows. The expected growth rate in the study area is 31%, compared with the 65% growth that the Commission has projected for the entire town.

Cost estimates were prepared with the following results:

	OPTION A: SATELLITE FACILITY	OPTION B: CONNECT TO EDGARTOWN WWTF Southerly Route	OPTION C: CONNECT TO EDGARTOWN WWTF Easterly Route
Capital Cost Total, \$M Per Property, \$	23 37,500	18 29,500	19 31,500
O&M Costs, \$/yr Total Per Property	228,000 410	90,000 160	90,000 160
Equiv. Annual Cost Total, \$ M/yr Per Property \$/yr	1.9 3,400	1.4 2,500	1.5 2,700
Cost Per Pound of N, \$	370	200	210

The relatively low cost of installing a force main to the existing Edgartown sewer system makes Options B and C considerably less expensive than building a satellite facility on the edge of the study area. Given the fact that the added flow at the Edgartown WWTF can be treated at small incremental costs, the relatively high O&M cost at the satellite facility is a significant factor in the cost difference. The transmission route through the golf course is about \$1 million less expensive than constructing a force main easterly along the Edgartown-Vineyard Haven Road.

Option A would collect about 7,200 pounds of septic nitrogen per year based on 26 mg/l, and about 30% would stay in the watershed in the discharge of the satellite facility. In Options B and C, the same 7,200 pounds of septic nitrogen would be collected and about 20% would be discharged in the Edgartown Great Pond watershed, reflecting the higher efficiency of the Edgartown treatment plant. While the import of nitrogen to the Edgartown Great Pond watershed must be compensated for to preserve water quality there, Options B and C provides a greater benefit to Sengekontacket Pond than Option A. (No costs have been included in Options B and C to address the associated nitrogen management issues in Edgartown Great Pond. The Town of Edgartown has considered options to recharge the appropriate amount of effluent at sites in the Sengekontacket watershed to address this issue.)

Removing 5,000 to 7,200 pounds of nitrogen per year from the Sengekontacket watershed addresses 125% to 175% of the current nitrogen control needs for the entire Pond. Implementation of this wastewater infrastructure would solve the current nitrogen overload to the Pond, and provide some buffer to offset future unsewered growth in the watershed. The responsibility for correcting the current overload should fall to the three towns in the watershed (Oak Bluffs, Edgartown and West Tisbury). If that responsibility for nitrogen control is shared proportional to the number of developed parcels, then sewerage this case study area addresses 180% (Option A) or 260% (Options B or C) of Edgartown's responsibility, assuming that Oak Bluffs reduces its share of the load as well.

OAK BLUFFS CASE STUDY--SENGEKONTACKET PROPERTIES

The Town of Oak Bluffs selected the residential development called Sengekontacket Properties for this case study. It is a 153-lot residential area located in the watershed of Sengekontacket Pond; see Figure 7-5. About two-thirds, or 115 of the parcels are occupied and 38 are vacant. The 150-acre study area has frontage on both County Road and the Edgartown-Vineyard Haven Road. Town water is available to all developed parcels. This development is very near the Oak Bluffs-Edgartown town line, and abuts Major's Cove, a westerly arm of Sengekontacket Pond. This case study area is located about 8,000 feet west of the Ocean Heights case study area (see above).

Sengekontacket Pond is characterized as "somewhat impacted" by the Martha's Vineyard Commission. The current septic nitrogen load to the pond is estimated to be 21,000 lb/yr, of which about 10% is associated with septic systems in the Sengekontacket Properties study area.

Two options were investigated to provide wastewater service to this case study:

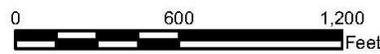
- A. A sewer system within the study area leading to a satellite treatment and disposal facility on a currently vacant parcel across County Road; and
- B. The same sewer system within the study area leading to a pump station that would transport the collected wastewater up County Road to the existing Oak Bluff Wastewater Treatment Facility.

Source:
 Imagery obtained from MASS GIS
 Reduction area parcel data obtained from MVC.
 Map developed by Wright-Pierce GIS Dept.



Legend

- Proposed Sewer
- Option A
- Option B
- Treatment Facility
- Effluent Disposal
- Wastewater Collection Area



Martha's Vineyard Wastewater Management Study Oak Bluffs Case Study Sengekontacket Property		
PROJ NO:	11279A	DATE: Dec 2009
 WRIGHT-PIERCE <small>Engineering a Better Environment</small>		FIGURE: 7-5

Friday, December 18, 2009 10:21:45 AM
 W:\GIS_Development\Projects\11279-Martha's Vineyard\Figures\Report_Fig_7-5_OB_8x11.mxd

The Martha's Vineyard Commission supplied estimates of water use that translate to annual average wastewater flows of 22,000 gpd under current conditions and 28,000 gpd at build-out. The expected 25% growth in the study area compares with a 32% growth rate projected for the entire town. These wastewater flows were converted to summer peak flows that formed the basis for the following cost estimates:

	OPTION A: SATELLITE FACILITY	OPTION B: CONNECT TO OAK BLUFFS WWTF
Capital Cost Total, \$M Per Property	7.8 45,700	7.4 43,200
O&M Costs, \$/yr Total Per Property	78,000 510	28,000 183
Equiv. Annual Cost, \$/yr Total Per Property	640,000 4,200	560,000 3,700
Cost Per Pound of N, \$	410	250

Even though the Oak Bluffs WWTF is about 8,000 feet away from the case study area, the relatively low cost of installing a force main up County Road is cost effective compared with building a satellite facility. The relatively high O&M cost at the satellite facility accentuates that difference, given the fact that the added flow at the Oak Bluff WWTF can be treated at small incremental costs. If the transmission facilities are constructed anyway to serve the YMCA and High School, then the Oak Bluffs connection is even more cost effective.

Option A would collect about 2,200 pounds of septic nitrogen per year based on 26 mg/l, and about 30% would stay in the watershed in the discharge of the satellite facility. In Option B, the same amount of septic nitrogen would be collected and about 20% would be discharged in the watersheds of Farm Pond, Oak Bluffs Harbor and Nantucket Sound, reflecting the higher efficiency of the Oak Bluffs treatment facility. While the import of nitrogen to the Farm Pond and Oak Bluffs Harbor watersheds must be compensated for to preserve water quality there, Option B provides a greater benefit to Sengekontacket Pond than Option A.

Removing 1,600 to 2,200 pounds of nitrogen per year from the Sengekontacket watershed, addresses 40% to 55% of the nitrogen control need for the entire pond. These load reductions represent about 150% to 220% of the responsibility for nitrogen control that might be attributed

just to the Town of Oak Bluffs. This assumes that the responsibility for nitrogen control in the Sengekontacket watershed is shared proportional to the number of developed parcels in each town.

TISBURY CASE STUDY--UPPER STATE ROAD

A mixed commercial and residential area along upper State Road was chosen for the Tisbury case study. As shown in Figure 7-6, this 72-acre area extends one or two blocks from Upper State Road, and a portion is immediately adjacent to the Tisbury Wastewater Treatment Facility.

Current wastewater flows have been estimated by the Commission to be approximately 20,000 gpd, growing to about 31,000 gpd at build-out. This 59% growth rate compares with rates of 40% to 70% projected for the Tashmoo Pond, Lagoon Pond and Vineyard Sound watersheds.

Some of the study area is clearly in the watershed of Tashmoo Pond, and some is tributary to Vineyard Sound. While relatively dense development of this nature would traditionally be connected to a town's wastewater infrastructure, especially with the treatment plant so close, the location of watershed boundaries must be considered. There is no nitrogen control need for parcels that fall between the Tashmoo Pond and Lagoon Pond watersheds, since Vineyard Haven Harbor and Vineyard Sound are not nitrogen sensitive. Further, capacity at the Tisbury Wastewater Treatment Facility is needed for nitrogen removal from wastewater collected in the Tashmoo and Lagoon Pond watersheds, and the Town has not yet located sufficient effluent disposal sites for the flow to be treated to protect those ponds.

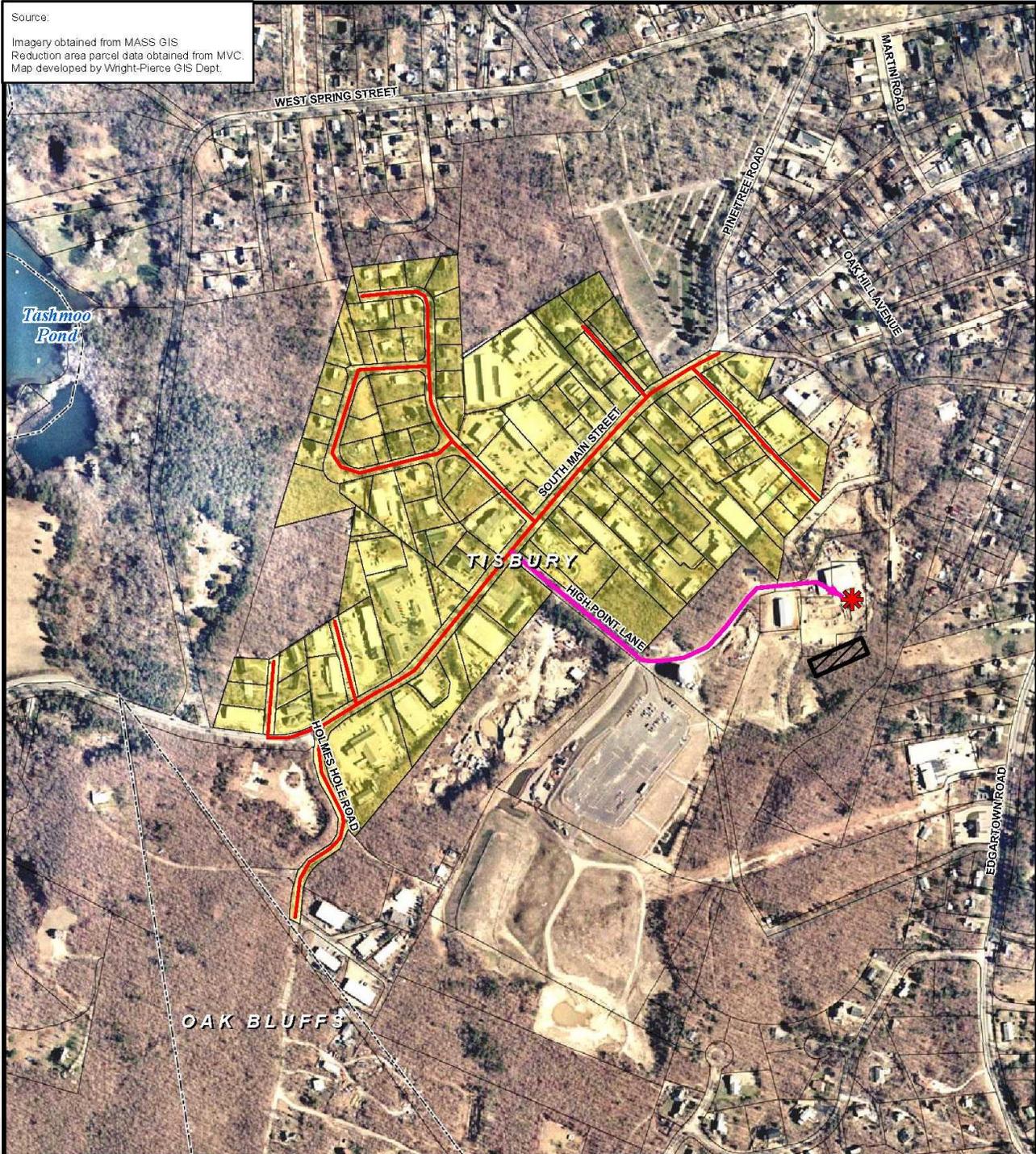
The current septic nitrogen load in the Tashmoo watershed is about 14,200 lb/yr. The septic load in the study area is approximately 1,600 lb/yr, not all of which is tributary to Tashmoo Pond. Current wastewater flows in the study area are about 10% of the wastewater flows in the Tashmoo watershed.

Therefore, the two options to be considered in this case study are:

- A. Collect all of the case study wastewater and transport it to the existing Tisbury Wastewater Treatment Facility for treatment; and
- B. Collect wastewater only from parcels in the Tashmoo Pond watershed, and have all other parcels in the study area remain on private septic systems.

This case study illustrates an important decision point in wastewater planning on the Island. Should a town plan only for nitrogen control in the watersheds of sensitive embayments? Or should it also consider so-called "non-nitrogen needs", that include dealing with unsanitary conditions, protection of public and private wells, enabling development such as commercial areas or affordable housing, and protection of freshwater ponds?

Source:
 Imagery obtained from MASS GIS
 Reduction area parcel data obtained from MVC.
 Map developed by Wright-Pierce GIS Dept.



Legend

-  Proposed Sewer
-  Option A
-  Treatment Facility
-  Effluent Disposal
-  Wastewater Collection Area



Martha's Vineyard Wastewater Management Study

Tisbury Case Study
 Upper State Road

PROJ NO: 11279A DATE: Dec 2009

WRIGHT-PIERCE
 Engineering a Better Environment

**FIGURE:
 7-6**

Friday, December 18, 2009 10:52:58 AM
 W:\GIS_Development\Projects\11279-Martha'sVineyard\Figures\Report_Figs_12-18-2009\Fig_7-6_Tisbury_bk11.mxd

The choice between the two options listed above could be driven primarily by cost. If the Town is able to find sufficient effluent disposal sites to address nitrogen control in the Tashmoo and Lagoon Pond watersheds, and to address other wastewater needs, then the decision on the extent of new sewers may be a financial one. However, it is expected that the search for new effluent disposal sites will be difficult, and the choice between nitrogen control and other wastewater needs may be influenced by site availability. Capacity at the treatment facility should also be considered, particularly if other areas of Tisbury are slated for sewerage.

Further complicating the decision process is the uncertainty about the watershed boundaries of Tashmoo and Lagoon Ponds. Groundwater modeling by Wright-Pierce in 2009 demonstrated the considerable sensitivity of the watershed boundaries to assumptions on soil properties and recharge rates from precipitation. Determining the best watershed boundaries to use for nutrient management is a critical first step that must be accomplished before meaningful wastewater planning can proceed. The Massachusetts Estuary Project is due to issue technical reports on Lagoon and Tashmoo Pond in 2010. Those reports should provide important data on both watershed boundaries and nitrogen loading thresholds.

Therefore the choice between the two options described above must wait for: 1) refinement of watershed boundaries; 2) determination of assimilative capacity of Tashmoo Pond; 3) recalculation of watershed nitrogen loadings; 4) identification of sufficient new effluent disposal sites; and 5) decisions on priorities for providing sewers between nitrogen-control needs and all other wastewater management requirements. These steps are best accomplished through the development of a comprehensive wastewater management plan.

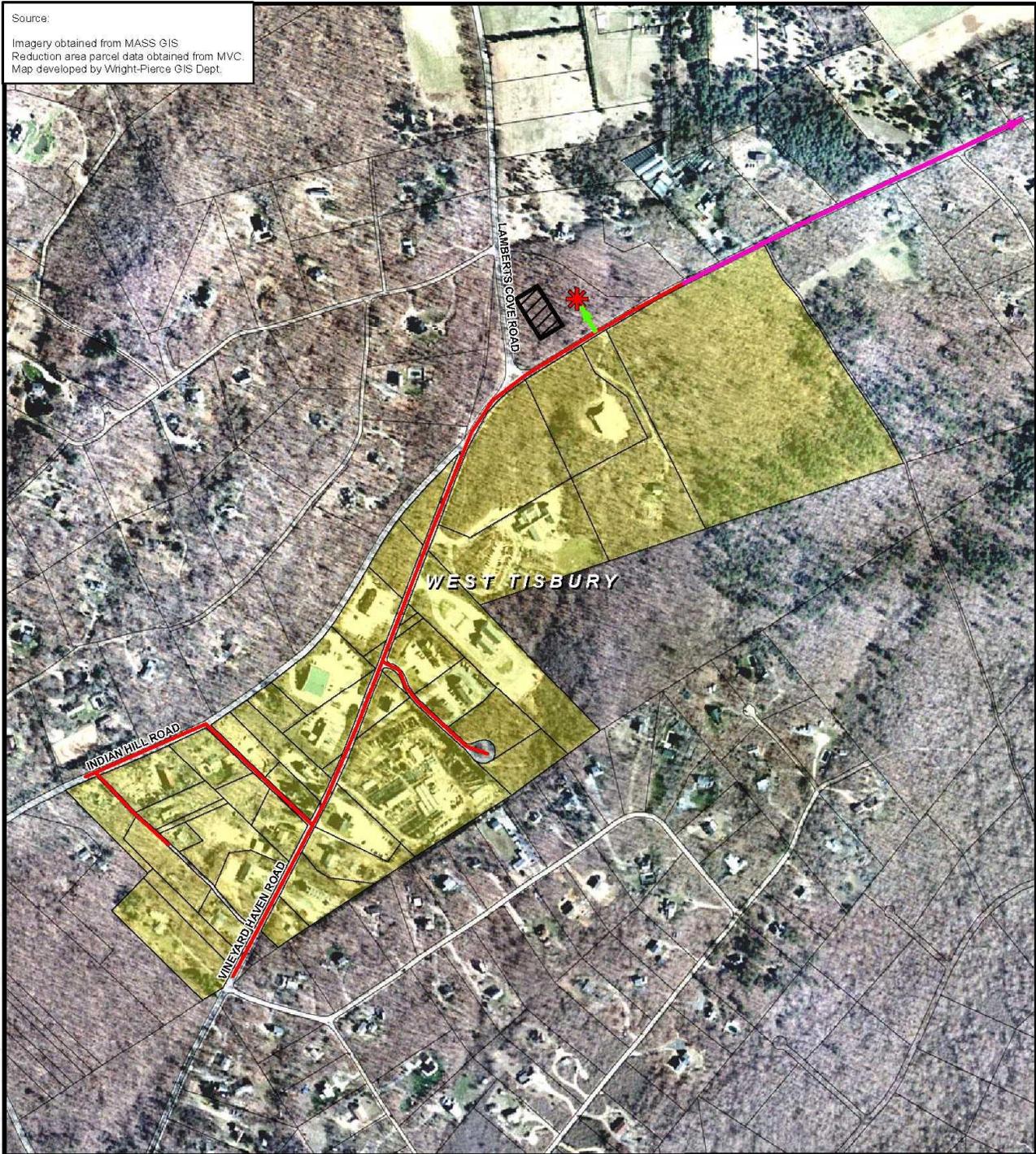
WEST TISBURY CASE STUDY--NORTH TISBURY BUSINESS DISTRICT

The so-called North Tisbury Business District was chosen as the case study for West Tisbury. The case study area is a collection of largely commercial properties located along State Road near its intersection with Lambert's Cove Road and Indian Hill Road; see Figure 7-7. There are 32 parcels in the study area that are currently developed, and another 32 parcels could add wastewater flow if developed in the future. No public water service is available. The study area covers 65 acres.

This study area is located near the point of origin of several coastal watersheds, and is considered to be within the Tisbury Great Pond watershed for the purposes of this analysis. The Tisbury Great Pond watershed has a total nitrogen load of about 32,000 lb/yr, of which about 11,000 lb/yr (45%) is related to on-site wastewater disposal. The Pond is considered to be "impacted" by the Martha's Vineyard Commission, which estimates that 42% of the septic nitrogen load should be removed to achieve water quality goals.

The Martha's Vineyard Commission has estimated that the current wastewater flow in the study area is approximately 7,700 gpd. Assuming that a large vacant parcel is developed for residential use, the build-out flow could be about 15,200 gpd. These flows represent about 10% of the wastewater generated in the Tisbury Great Pond watershed. The projected study area growth is 97% compared with an expected 60% growth town-wide.

Source:
 Imagery obtained from MASS GIS
 Reduction area parcel data obtained from MVC.
 Map developed by Wright-Pierce GIS Dept.



Friday, December 18, 2009, 11:29:05 AM
 W:\GIS_Development\Projects\11279A\Martha's Vineyard\Figures\Report_Fig_12_18-2009\Fig_7-7_W_Tisbury_8x11.mxd

Legend

- | | |
|--|--|
| Sewer |  Treatment Facility |
|  Proposed Sewer |  Effluent Disposal |
|  Option A |  Wastewater Collection Area |
|  Option C | |



Martha's Vineyard Wastewater Management Study

West Tisbury Case Study
 North Tisbury Business District

PROJ NO: 11279A DATE: Dec 2009



FIGURE:
7-7

Three options were investigated to provide wastewater service to this case study:

- A. A small-scale sewer system within the study area leading to a satellite treatment and disposal facility on a currently vacant parcel within the study area at the intersection of State Road and Lambert's Cove Road;
- B. A similar sewer system within the study area leading to two smaller cluster systems for treatment and disposal; and
- C. The same sewer system within the study area leading to a pump station that would convey the collected wastewater north and east along State Road approximately 23,000 feet to existing sewers leading to the Tisbury Wastewater Treatment Facility.

The two local treatment options (Options A and B) were formulated to investigate the potential savings by building two small treatment systems instead of a single larger one. While economies of scale typically benefit the single larger facility (other things being equal), building two so-called "cluster systems" here would avoid the need for a groundwater discharge permit which is required when design flows exceed 10,000 gpd.

The cost estimates for these three options are summarized as follows:

	OPTION A: SATELLITE FACILITY	OPTION B: 2 CLUSTER SYSTEMS	OPTION C: CONNECT TO TISBURY WWTF
Capital Cost Total, \$M Per Property, \$	4.1 66,000	2.0 48,000	7.4 120,000
O&M Costs, \$/yr Total Per Property	56,000 1,000	43,000 1,100	16,000 290
Equiv. Annual Cost, \$/yr Total Per Property	350,000 6,300	190,000 5,000	550,000 9,800
Cost Per Pound of N, \$	420	570	430

As expected, the option of transporting these small quantities of wastewater over 4 miles to the Tisbury wastewater treatment plant is cost prohibitive. Because they treat a smaller flow, the two cluster systems have the least cost (Option B). They are also less expensive because of the cost premium associated with small satellite systems (due to the need for more site studies to justify a groundwater discharge permit, as well as the costs of extra oversight and monitoring.) (It should be noted that the two cluster systems would serve only the current flow, and would not be large enough for the build-out case. Since most of the increase in flow would be associated with development of the large vacant parcel in the study area, wastewater management could be a condition of development of that parcel with the costs borne by the developer.)

Option A would collect about 1,300 pounds of septic nitrogen per year, and about 35% would stay in the watershed in the discharge of the satellite facility. In Option B, 660 pounds of septic nitrogen would be collected and 330 pounds would remain in the watershed after treatment, reflecting both the smaller service area of Option B and its less efficient treatment system. Option C transports 1,300 pound of nitrogen per year outside the watershed. A portion of that nitrogen would eventually reach two impacted embayments in Tisbury (Lagoon and Tashmoo Ponds), and some would go to Vineyard Sound (Vineyard Haven Harbor), after passing through the Tisbury effluent disposal systems.

Removing 840 (Option A) to 1,300 (Option C) pounds of nitrogen per year from the Tisbury Great Pond watershed addresses 20% to 30% of the nitrogen control need for the entire Pond, and about 30% to 40% of the nitrogen removal responsibility of the Town of West Tisbury, based on the fact that about 75% of the watershed lies in West Tisbury.

This analysis illustrates the lower capital cost of cluster systems compared with satellite systems. However, under these circumstances, the cost of the cluster systems is higher when expressed as dollars per pound of nitrogen removed from the watershed.

IMPORTANT LESSONS FROM CASE STUDIES

Several important discussion topics evolve from these case studies. Decisions on these key issues will help direct the overall wastewater plan for the Island. These topics are as follows:

Allocation of responsibility for nitrogen load reduction among towns in shared watersheds.

Many of the watersheds of the principal coastal ponds cross town boundaries. The exceptions are Upper and Lower Chilmark Ponds, Cape Poge, James Pond, Farm Pond, Oak Bluffs Harbor and Katama Bay. Where the best solution is reduction in septic loading through municipal wastewater infrastructure, the key questions becomes "which town should provide the infrastructure" and "which properties should be connected?".

The second question ("who should be connected?") must be answered first. Wastewater planning should be done on a watershed-wide basis that seeks the optimum solution, which will involve a balancing of the following factors:

- Focus on areas where development density is the highest, that is, where the least amount of pipe is needed to eliminate a sufficient number of septic systems to reach the nitrogen removal target;

- Near-shore areas should have higher priority than areas higher in the watershed, so that the water quality improvements are achieved as soon as possible;
- Locations where natural attenuation is occurring should be avoided, because some nitrogen removal is occurring there at no cost; and
- Phasing of construction should be considered, so that infrastructure costs can be spread over time, consistent with target dates for water quality improvements.

If the optimum sewer area falls substantially or completely in one town, then that town would be the logical candidate to implement the infrastructure. Regardless of the properties to be served, however, it is the location of the current septic load that should drive the cost sharing. For example, 75% of the current nitrogen loading in the Sengekontacket Pond watershed is located in Edgartown, with the remainder in Oak Bluffs and West Tisbury. If sewer extensions are made to one or both of Sengekontacket Properties and Ocean Heights to address nitrogen overloading in Sengekontacket Pond, then the negotiations among the three towns should start with the premise that Edgartown should pay 75% of the costs, regardless of the location of the properties served.

Cost sharing among Edgartown, Oak Bluffs and West Tisbury could be based on total land area, current nitrogen load, existing developed parcel counts, or current wastewater flows in the Sengekontacket Pond watershed. In this instance, these four indicators all yield about the same split in responsibility:

Edgartown:	64% to 73%
Oak Bluffs:	23% to 27%
West Tisbury:	4% to 9%

Allocation of costs to new projects for currently un-used treatment plant capacity.

The costs reported for sewer extensions to serve Sengekontacket Properties and Ocean Heights include allowances for the cost of treatment at the existing Oak Bluffs and Edgartown wastewater treatment facilities. While a simplified approach might assume that those costs are negligible, because reserve capacity exists at both plants, it will be important for the towns to establish policies on how such costs will be accounted for in the future. There is significant value to that unused capacity, which should be addressed as towns allocate the costs of nitrogen control in shared watersheds. Connection fees and impact fees should be established to fairly reflect the prior investments in existing infrastructure.

Transfer of nitrogen load among watersheds and determination of costs for dealing with impacts on receiving pond.

In three of the case studies, transport of collected nitrogen outside the subject watersheds provides the most benefit to that watershed. In all cases, however, some of that collected nitrogen reaches another embayment through the effluent from the receiving treatment plant. The costs reported here do not include the impact of that residual nitrogen on the receiving embayment. In the case where the receiving embayment is already over its assimilative capacity for nitrogen, a full accounting should include the cost of compensating for the added effluent nitrogen load.

Need for regional disposal sites in non-sensitive watersheds.

In the ideal case, one or more regional disposal sites would be developed that can accept nitrogen from the watersheds of threatened embayments without having consequential impacts. For example, a site along Vineyard Sound, where groundwater is quickly mixed with ocean watershed without passing through a coastal embayment, could accept effluent without the penalty of compensating nitrogen controls in its watershed. The cost effectiveness of such sites would depend on the distance from the threatened embayments, the cost of the compensating measures associated with alternative disposal sites, and the soil properties and hydrogeology at the regional site. Impacts on local water table elevations should be considered at both the collection points and the disposal points.

Prioritizing needs--nitrogen control versus non-nitrogen needs.

The costs for municipal wastewater infrastructure will depend on many factors, one of the most important of which is the quantity of wastewater to be collected, treated and disposed of. A significant portion of existing wastewater treatment capacity on the Island has been provided for reasons other than nitrogen control. Of all the wastewater currently collected in municipal systems less than 30% comes from the watersheds of nitrogen-impacted embayments. Both the costs of new facilities and limitations on effluent disposal sites will create significant pressure on minimizing the amount of wastewater that is collected in the future. Towns must make informed decisions about the reasons for sewerage. Is the goal only to eliminate septic systems in the watersheds of threatened embayments, or is it also to address water supply protection, avoidance of unsanitary conditions, the inconvenience and costs of on-site disposal, and economic growth? Each town should undertake a methodical identification of wastewater needs in these categories, coupled with identification of disposal sites and preparation of cost estimates. The Upper State Road case study illustrates the need for such decision-making, where a portion of the study area may not be contributing nitrogen to sensitive coastal waters.

Building capacity for future growth and paying for the unused capacity.

For each case study where cost estimates have been prepared, some portion of the quoted cost is associated with controlling future nitrogen loads. If no growth is expected in the case study areas, then the costs would be lower, in some cases significantly lower. Island-wide growth has been projected by the Martha's Vineyard Commission to add as much as 55% to the current wastewater volumes. Where that growth occurs in the watersheds of threatened embayments, 100% of the "new" wastewater must be managed for nitrogen. For the Commission's projected 55% increase in wastewater volume, the costs for controlling both current nitrogen loads (related to 28% of existing wastewater flows) and future nitrogen loads (related to 100% of the growth in sensitive watersheds) could be twice that associated with a no-growth scenario.

Not only must growth be planned for, but towns need to find ways to pay for the cost of increased capacity that is intended to serve that growth. By building wastewater infrastructure in phases, towns can mitigate the uncertainty associated with growth. Nonetheless, any growth allowance will come with a price tag, and towns must estimate the added cost and provide mechanisms to recover it.

The West Tisbury case study illustrates how wastewater facilities could be sized with only a limited growth allowance, and more speculative growth dealt with by imposing a nitrogen control requirement on the developer of the large vacant parcel in the study area.

Obtaining better estimates of N load and assimilative capacity.

The Martha's Vineyard Commission has used a simplified model to estimate the nitrogen sensitivity of all of the Island's coastal waters. While that approach is suitable for initial planning, so much is at stake in terms of water quality and costs to maintain it, that every effort should be made to apply more sophisticated modeling approaches, such as used in the Massachusetts Estuaries Project (MEP). MEP technical reports are expected over the next two years for most of the principal coastal waters on the Island. Decisions about expensive wastewater infrastructure should be deferred until the pertinent studies are in hand. It will be particularly important to learn more about the watershed loads and nitrogen sensitivity of Squibnocket Pond, Upper and Lower Chilmark Pond, James Pond and Oyster Pond, where complete elimination of the current septic load will address only 40% to 70% of the apparent overload. The MEP studies will allow thorough evaluation of non-traditional nitrogen control strategies, such as flushing enhancements that might reduce nitrogen management costs for Squibnocket Pond and the Chilmark Ponds.

Fine-tuning watershed boundaries.

An important output of the MEP studies will be a set of refined watershed boundaries. Towns must have the very best determinations of the areas that are of nitrogen loading concern, as well as identification of locations for potential effluent disposal sites that do not carry the burden of retaining residual effluent nitrogen in sensitive watersheds. Recent studies in Tisbury have demonstrated how watershed boundaries can be very sensitive to modeling assumptions, and the Upper State Road case study illustrates how watershed boundaries are important in determining possible sewer areas. Groundwater modeling studies are most appropriate for areas where sewer service or effluent disposal is being considered in an area very near the watershed boundary.

CHAPTER 8 -- GUIDANCE FOR FUTURE WASTEWATER MANAGEMENT PLANNING

The evaluations and discussions presented in this report lead to several broad findings and recommendations related to planning for wastewater management on Martha's Vineyard:

1. Current wastewater generation rates are approximately 1.0 billion gallons per year Island-wide. This is an annual average of about 2,700,000 gallons per day (gpd). Approximately 89% of that wastewater is treated and disposed of in individual on-site septic systems and 11% is collected for treatment at 5 public or quasi-public wastewater facilities.
2. Approximately 71% of the Island's land area falls within the watersheds of coastal embayments, many of which are showing signs of water quality degradation related to nitrogen overloading, with septic systems being a significant source of that nitrogen.
3. Based on the Martha's Vineyard Commission's analysis of nitrogen loading and coastal pond assimilative capacity, an additional 24% of current wastewater flows should be collected and treated to address nitrogen overloading, including a small allowance for other wastewater needs not related to nitrogen control, such as water supply protection and avoidance of unsanitary conditions. The current collection needs are 2.3 times the volumes now treated at public facilities. Five watersheds account for about three-quarters of the current nitrogen control needs: Lagoon Pond, Oak Bluffs Harbor, Tisbury Great Pond, Edgartown Great Pond, and Sengekontacket Pond.
4. Studies by the Massachusetts Estuaries Project are underway that will provide more detailed information on coastal pond nitrogen loading, assimilative capacity and possible mitigating measures. While the current Commission analyses are a reasonable preliminary indication of nitrogen loads and removal needs, the MEP studies are essential to a more definitive justification for capital expenditure. Every effort should be made to allow those MEP studies to be completed as soon as possible.
5. Based on case studies presented in this report, and cost data developed on Cape Cod, Martha's Vineyard may be faced with costs ranging from \$30,000 to \$60,000 per property served by public infrastructure to control nitrogen loading. Applied to the needs assessment presented in Chapter 2, these figures indicate Island-wide capital costs of approximately \$200 million. In addition, there will be substantial annual expenses for operation and maintenance.
6. Growth projections made by Commission staff indicate the potential for major increases in wastewater volumes and associated septic nitrogen loads. Future wastewater flows could be 55% higher than current generation rates. Some towns may face an approximate doubling of current wastewater flows (Aquinnah and Chilmark). About three quarters of the Island-wide increase is expected to occur in Edgartown, Oak Bluffs and Tisbury.

7. Population growth in the watersheds of sensitive coastal ponds creates a significant environmental burden. For those watersheds with nitrogen loads exceeding the assimilative capacity of the ponds they recharge, some percentage of that current load must be removed to restore water quality. In addition, 100% of new nitrogen loads must be controlled to keep the watershed load at or below the critical loading threshold. Thus a 55% Island-wide growth, if it occurs, will essentially double the volume of wastewater that must be collected, treated and disposed of. Costs to control future nitrogen loading can be expected to equal or exceed the costs for dealing with existing needs.
8. Because wastewater management options will be driven primarily by the need to eliminate septic nitrogen loads in the watersheds of sensitive coastal embayments, the optimum solutions should be derived from a watershed-based approach and not town-by-town. Several administrative structures are available to facilitate a watershed-based approach, including County involvement, special purpose districts and town actions supported by inter-municipal agreements. If each town acts on its own, without regional cooperation, overall cost will be higher.
9. Finding suitable sites for effluent disposal is a critical planning need. The ideal sites are located outside the watersheds of sensitive embayments, outside water supply Zone IIs and near the areas from which the wastewater is to be collected and treated. Failure to find suitable sites in non-sensitive watersheds will inherently increase the volumes of wastewater to be collected, since sewered areas would need to be expanded in the receiving watersheds to offset the residual nitrogen that remains in the threatened watershed through effluent disposal. A Commission-led effort to identify the best sites is warranted, given the likelihood that sites may be beyond the boundaries of one or more town they may serve. Effluent reuse should also be seriously investigated, including golf course irrigation, because of the added nitrogen (and other contaminant) attenuation that occurs in passage through vegetative surfaces.
10. The Towns should work with the Commission to establish rational bases for sharing the cost of facilities that serve more than one town in a single watershed. The responsibility for nitrogen load reduction in a multi-town watershed can be allocated on the basis of watershed area, existing developed parcel counts or current nitrogen loads. A common Island-wide approach could be established in advance of detailed infrastructure planning to lay the groundwork for inter-town negotiations.
11. A significant portion of current and future wastewater flows is expected to occur in Edgartown, Oak Bluffs and Tisbury, in locations that are economically accessible to the existing treatment facilities in these communities. Therefore, these towns should embark on detailed planning for capacity expansions and new disposal site identification. Establishing the cost to use current reserve capacity will facilitate the implementation of new projects that could connect to the existing infrastructure.
12. In light of the apparently large growth potential in all Island towns, each town must analyze and then confirm or refine the projections made by the Commission. Where significant population growth can occur in nitrogen-sensitive watersheds, the towns will

be well served to seriously consider balancing the magnitude of the acceptable growth with the attendant costs for wastewater management. Growth management can reduce the scale of needed nitrogen controls, and drastically reduce their costs. Those cost savings must be well understood when towns consider zoning changes, land purchases, acquisition of conservation easement, nitrogen impact fees, and other measures discussed in Chapter 5.

13. Many property owners on Martha's Vineyard may seek the benefits of municipal sewer service when infrastructure expansion is proposed. Given the magnitude of wastewater management costs and the likely scarcity of suitable effluent disposal sites, each town should thoroughly address all possible needs for wastewater management (including water supply protection, sanitary needs, controlled growth, and cost and convenience issues), and then prioritize these needs. While less than 30% of wastewater now treated at public facilities comes from watersheds of nitrogen-sensitive embayments, it is unlikely that non-nitrogen needs can be afforded such preference in the future. Hard choices may be required to limit sewer service to nitrogen-sensitive areas based on cost and capacity constraints.
14. Efforts are also warranted to manage growth in areas that are now sewered. Adopting "growth-neutral" regulations and policies, and implementing "checkerboard" sewer systems, will help preserve infrastructure capacity. The towns must be mindful of the source and fate of wastewater that is collected, treated and disposed of. Growth in sewered areas of non-sensitive watersheds exacerbates water quality problems in sensitive embayments if effluent disposal sites are located in the watersheds of those embayments.

All of the Island towns will gain long-term benefit from understanding the findings and conclusions of this report and aggressively pursuing the near-term steps that are suggested.