MARTHA'S VINEYARD

WASTEWATER MANAGEMENT STUDY

ADDENDUM
CASE STUDIES FOR LAGOON POND AND TASHMOO POND

Prepared for:
Town of Tisbury
Town of Oak Bluffs

Prepared by:
Wright-Pierce

In Conjunction with:
Martha's Vineyard Commission

June 2011

WRIGHT-PIERCE
Engineering a Better Environment

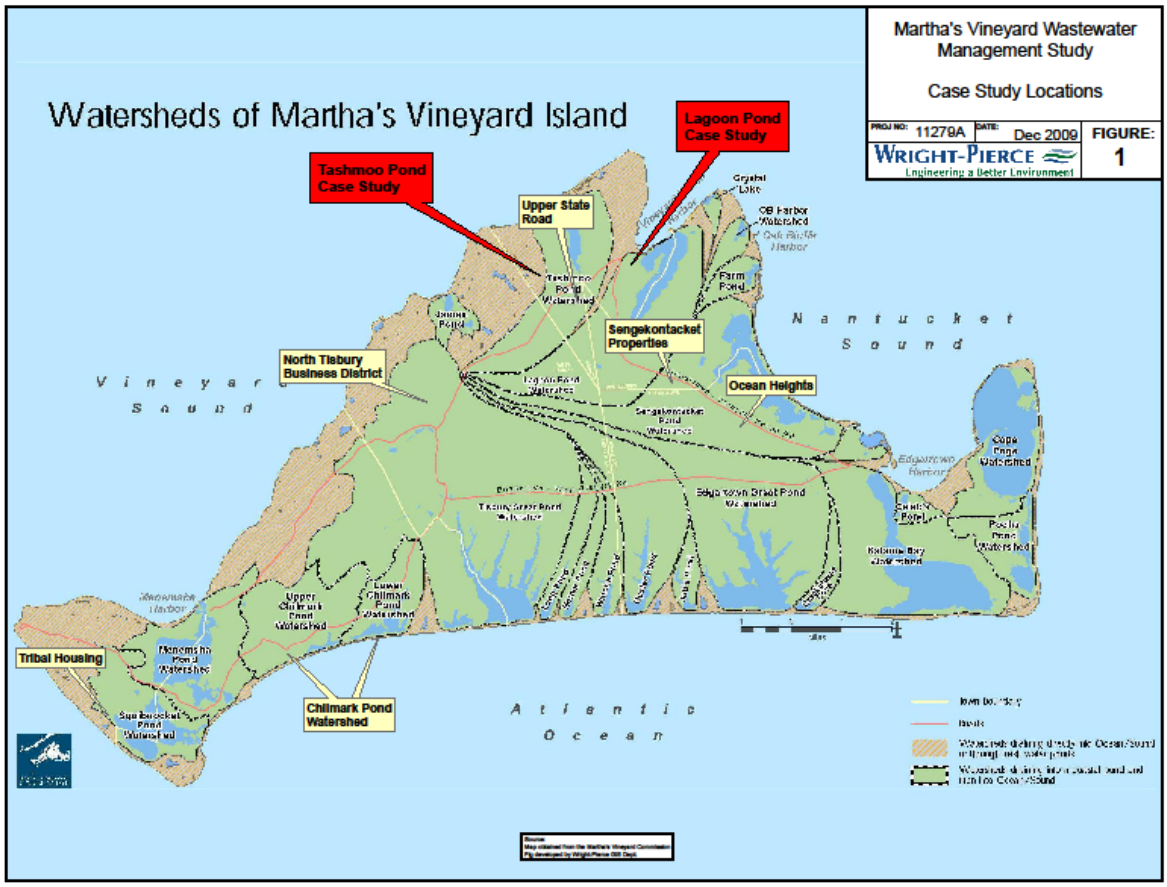
INTRODUCTION

The "Martha's Vineyard Wastewater Management Study" was completed in May 2010. The six case studies that are presented in that report have proven valuable to the Martha's Vineyard Commission and the towns. Following the completion of the May 2010 report, supplemental funding was provided by the Towns of Tisbury and Oak Bluffs to enable the completion of two additional case studies. This addendum presents the additional case studies for Lagoon Pond and Tashmoo Pond.

Most of the watersheds of nitrogen-sensitive coastal ponds on Martha's Vineyard are shared by two or more towns. These two case studies present estimates of the wastewater flows that are now discharged to the groundwater through on-site septic systems in two shared watersheds (Tashmoo Pond and Lagoon Pond) and show how much of those flows must be subject to nitrogen removal to attain water quality goals. Ranges of wastewater treatment needs are presented to help guide infrastructure planning in Tisbury, Oak Bluffs and West Tisbury.

DESCRIPTION OF STUDY AREAS

These case studies focus on the watersheds of two important coastal ponds on Martha's Vineyard: Tashmoo Pond in Tisbury and Lagoon Pond which straddles the Oak Bluffs-Tisbury town line. Figure 1 shows the location of the watersheds of these two ponds on the island. Detailed maps of the watersheds are depicted in Figures 2 and 3, showing how the watersheds cover portions of Tisbury and Oak Bluffs and extend into West Tisbury.



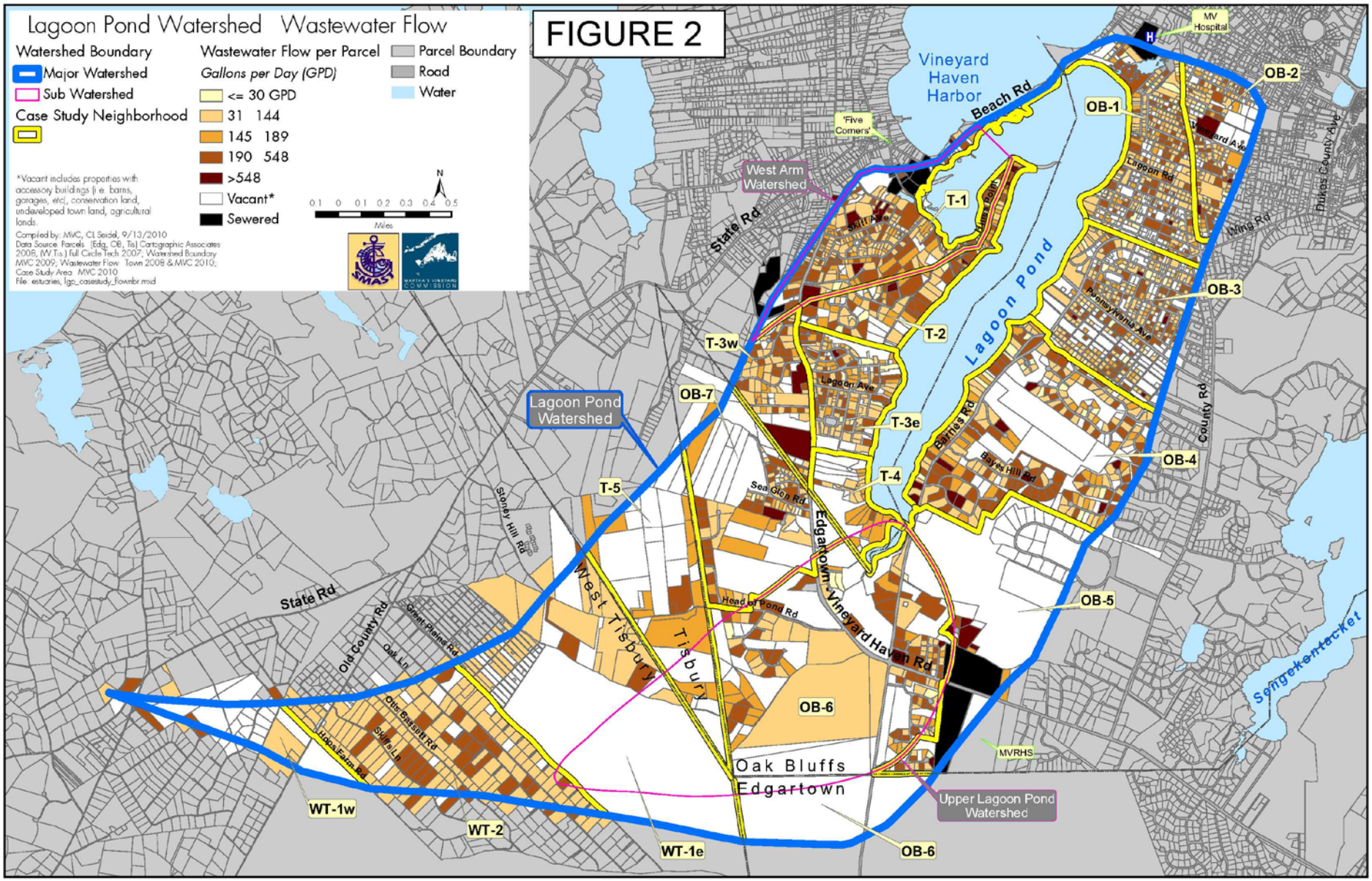
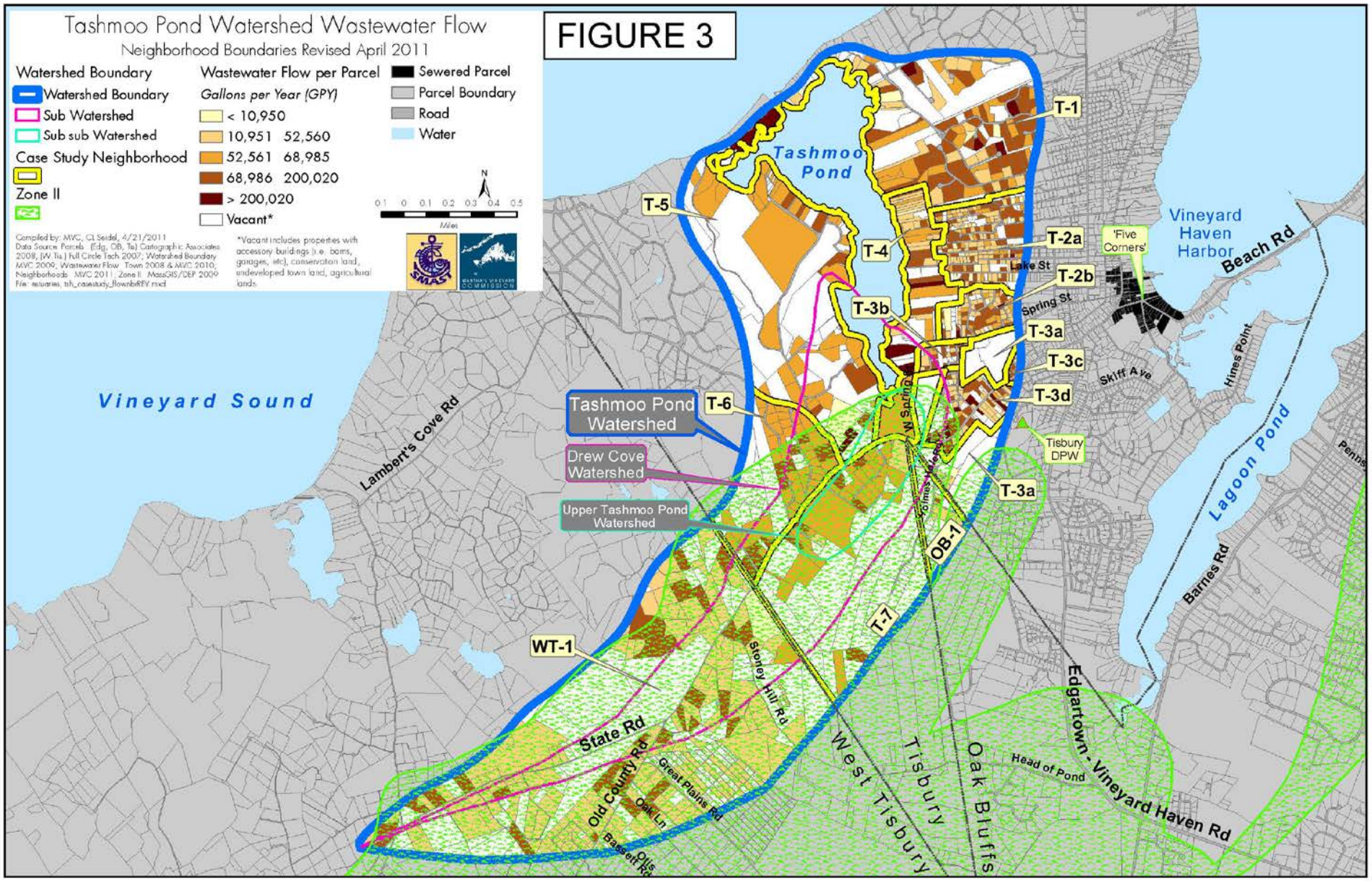


FIGURE 2
Lagoon Pond Watershed Wastewater Flow
Watershed Boundary
Major Watershed
Sub Watershed
Case Study Neighborhood
Wastewater Flow per Parcel
Gallons per Day (GPD)
<= 30 GPD
31 144
145 189
190 548
>548
Vacant*
Sewered
Parcel Boundary
Road
Water
*Vacant includes properties with accessory buildings (i.e. barns, garages, etc), conservation land, undeveloped town land, agricultural lands.
Compiled by: MVC, CL Seidel, 9/13/2010
Data Source: Parcels (Edg, OB, Tis) Cartographic Associates 2008, (W.Tis.) Full Circle Tech 2007; Watershed Boundary MVC 2009; Wastewater Flow Town 2008 & MVC 2010; Case Study Area MVC 2010
File: estuaries, lgp_casestudy_flownbr.mxd
Miles
Vineyard Haven Harbor
Beach Rd
MV Hospital
'Five Corners'
West Arm Watershed
State Rd
Lagoon Pond
Lagoon Pond Watershed
Upper Lagoon Pond Watershed
Oak Bluffs
Edgartown
West Tisbury
Tisbury
Edgartown - Vineyard Haven Rd
Sengekontacket
MVRHS
OB-1
OB-2
OB-3
OB-4
OB-5
OB-6
OB-7
T-1
T-2
T-3w
T-3e
T-4
T-5
WT-1w
WT-2
WT-1e
Lagoon Rd
Lagoon Ave
Skiff Ave
Hines Point
Pennsylvania Ave
Barnes Rd
Bayes Hill Rd
Sea Glen Rd
Head of Pond Rd
Stoney Hill Rd
Old County Rd
Great Plains Rd
Oak Ln
Otis Bassett Rd
Skiffs Ln
Hops Farm Rd
County Rd
Wing Rd
Dukes County Ave
Vineyard Ave


Tashmoo Pond Watershed Wastewater Flow
Neighborhood Boundaries Revised April 2011
FIGURE 3
Watershed Boundary
Watershed Boundary
Sub Watershed
Sub sub Watershed
Case Study Neighborhood
Zone II
Wastewater Flow per Parcel
Gallons per Year (GPY)
< 10,950
10,951 52,560
52,561 68,985
68,986 200,020
> 200,020
Vacant*
Sewered Parcel
Parcel Boundary
Road
Water
Miles
Compiled by: MVC, CL Seidel, 4/21/2011
Data Source: Parcels (Edg, OB, Tis) Cartographic Associates 2008, (W Tis) Full Circle Tech 2007; Watershed Boundary MVC 2009; Wastewater Flow Town 2008 & MVC 2010; Neighborhoods MVC 2011; Zone II MassGIS/DEP 2009
File: estuaries, tsh_casestudy_flownbrREV.mxd
*Vacant includes properties with accessory buildings (i.e. barns, garages, etc), conservation land, undeveloped town land, agricultural lands.
Tashmoo Pond
Vineyard Sound
Vineyard Haven Harbor
Lagoon Pond
Tashmoo Pond Watershed
Drew Cove Watershed
Upper Tashmoo Pond Watershed
T-1
T-2a
T-2b
T-3a
T-3b
T-3c
T-3d
T-4
T-5
T-6
T-7
OB-1
WT-1
'Five Corners'
Tisbury DPW
Lake St
Spring St
Skiff Ave
Beach Rd
Hines Point
Barnes Rd
Lambert's Cove Rd
W Spring
Holmes Hole Rd
Stoney Hill Rd
State Rd
Old County Rd
Great Plains Rd
Oak Ln
Bassett Rd
Olis
West Tisbury
Tisbury
Oak Bluffs
Head of Pond
Edgartown - Vineyard Haven Rd

The watershed of Tashmoo Pond covers 2,600 acres, and there are about 940 developed parcels in the watershed, of which 34% are seasonally occupied. For the Lagoon Pond watershed, there are about 2,100 developed parcels (38% seasonal) within the 3,900-acre watershed. In approximate terms, the Lagoon Pond watershed is 50% larger than the Tashmoo watershed, has twice as many developed parcels, and is somewhat more seasonal.

ESTIMATES OF CURRENT WASTEWATER FLOWS

The staff of the Martha's Vineyard Commission (MVC) has compiled land use information on these two watersheds that allows the estimation of current wastewater flows. Flow estimates are based largely on water use records for those developed parcels served by public water systems, extrapolated to cover all developed parcels. (The estimates of current wastewater flow used in these case studies are generally the same as those presented in the Wright-Pierce report entitled "Martha's Vineyard Wastewater Management Study", dated May 2010.) Tables 1 and 2 present estimates of current wastewater flows in the Tashmoo and Lagoon watersheds, respectively, with a breakdown by town.

TABLE 1. WASTEWATER FLOWS IN TASHMOO POND WATERSHED

Town	Wastewater Flows, gpd		Expected Growth, %
	Current	Future	
West Tisbury	35,600	47,400	33
Tisbury	151,900	258,200	70
Oak Bluffs	1,200	6,000	400
Total Flow	188,700	311,600	65
Sewered Flow	0		
Septic N Control			
Removal %	10	46	
Flow, gpd			
Current	18,900	18,900	
Assoc. with growth	------	122,900	
Total	18,900	141,800	

Note: Flows are reported as annual averages.

Of the 188,700 gallons of wastewater flow now generated in the Tashmoo watershed, 80% comes from developed properties in Tisbury, and most of the remainder originates in West Tisbury. None of that wastewater is conveyed to the municipal treatment facility in Tisbury; it is all disposed of through on-site septic systems.

The current wastewater flows in the Lagoon Pond watershed are 367,500 gallons per day (gpd), approximately twice that in the Tashmoo watershed. Of that total, 60% is generated in Oak Bluffs, 33% in Tisbury, and the rest in West Tisbury. At the time of the preparation of the source report, none of the Lagoon Pond wastewater was conveyed to the Oak Bluffs municipal treatment facility, and about 1,900 gpd was collected and treated at the Tisbury plant. Since

then, sewer service has been provided to several properties in Oak Bluffs, including the hospital and the YMCA.

TABLE 2. WASTEWATER FLOWS IN LAGOON POND WATERSHED

Town	Wastewater Flows, gpd Current	Wastewater Flows, gpd Future	Expected Growth, %
West Tisbury	26,300	33,400	27
Tisbury	119,900	184,600	54
Oak Bluffs	221,300	334,100	51
Total Flow	367,500	552,100	50
Sewered Flow	1,900		
Septic N Control			
Removal %	47	65	
Flow, gpd			
Current	172,700	172,700	
Assoc. with growth	------	184,600	
Total	172,700	357,300	

Note: Flows are reported as annual averages.

PROJECTED INCREASES IN WASTEWATER FLOWS

Using its Geographic Information System (GIS), the MVC has completed a build-out evaluation to predict future development and associated wastewater flows in these two watersheds. The results are shown in Tables 1 and 2. Wastewater flows in the Tashmoo watershed are projected to increase by 65% to 312,000 gpd, with most of that increase occurring in Tisbury. A 50% increase in flow is predicted for the Lagoon Pond watershed (from 367,000 to 552,000 gpd), with the Tisbury and Oak Bluffs portions of the watershed projected to grow by nearly equal percentages. (Unlike the estimates of current wastewater flow, these future projections are somewhat different from those reported in 2010. Subsequent analysis by the MVC for the Massachusetts Estuaries Project has refined the earlier growth estimates.)

NITROGEN CONTROL NEEDS

These ponds are currently overloaded (or will be soon with continued growth) with respect to nitrogen, the nutrient that limits algal growth in marine and estuarine waters. That excess nitrogen leads to undesirable algal growth and a number of negative impacts on water quality.

The draft MEP technical report for Lagoon Pond estimates that 47% of the septic nitrogen load must be removed from the watershed to restore water quality in the pond. A lower percentage removal may be successful if non-septic loads (such as fertilizer and stormwater) are reduced, or if flushing enhancements occur. For the purposes of these case studies, it is assumed that 47% of the current wastewater flow in the Lagoon Pond watershed must be subject to nitrogen removal, either on-site or through a municipal wastewater collection and treatment system.

The MEP technical report for Tashmoo Pond is under development. Studies by the MVC indicate that the Pond is now approaching or at its capacity to assimilate nitrogen. To be conservative, a 10% septic removal percentage has been used herein to better illustrate certain planning concepts.

To achieve and maintain water quality in an overloaded coastal pond, the designated percentage removal of the current load must be attained, and 100% of any new growth-related loads must be removed. This concept is demonstrated in Tables 1 and 2, which show the growth projections and the wastewater flows subject to nitrogen control under both current and future conditions.

To achieve water quality goals under current conditions in the Tashmoo watershed, only about 19,000 gpd of wastewater flow would need to be collected, treated and disposed of outside the watershed. (A somewhat higher flow would need to be treated through enhanced on-site systems to account for the residual nitrogen remaining in the watershed.) Given the large projected growth in the watershed, however, the flow subject to nitrogen removal at build-out is 142,000 gpd, over 7 times the current quantity.

Removing 47% of the current septic nitrogen load in the Lagoon Pond watershed translates to 173,000 gpd, a quantity which grows to 357,000 gpd at build-out.

The nitrogen control needs in the Lagoon Pond watershed are nearly 10 times those in the Tashmoo watershed under current conditions and 2.5 times larger at build-out.

Table 3 presents the allocation of current nitrogen control responsibility among the three towns in each watershed. This table assumes that each town is responsible for controlling nitrogen in 10% (Tashmoo) or 47% (Lagoon) of its current wastewater flow. This is but one approach for assigning responsibility and many others are possible.

TABLE 3. CURRENT NITROGEN CONTROL NEEDS BY TOWN

	Wastewater Flows Requiring Nitrogen Control, gpd		
Town	Tashmoo Pond	Lagoon Pond	**Total**
Wastewater Flow			
West Tisbury	3,600	12,400	16,000
Tisbury	15,200	56,300	71,500
Oak Bluffs	100	104,000	104,100
Total Flow	**18,900**	**172,700**	**191,600**
Percentage Responsibility			
West Tisbury	19.0%	7.2%	8.4%
Tisbury	80.4%	32.6%	37.3%
Oak Bluffs	0.5%	60.2%	54.3%
Notes:	*1. This table assumes that each town is responsible for nitrogen control in proportion to its current wastewater flow in the watershed.*		
	2. Flows are reported as annual averages.		

ADDRESSING NITROGEN CONTROL NEEDS -- LAGOON POND WATERSHED

Generic Options

While it may be a simple mathematical exercise to apportion the responsibility for nitrogen control based on current wastewater flows (as illustrated in Table 3), this approach may not lead to the least-cost control strategy. To explore this issue, this case study considers four scenarios for Lagoon Pond, as follows:

> **Option 1:** Each town would implement nitrogen controls based on its pro-rata share of current wastewater flows in the entire watershed. Tisbury, West Tisbury and Oak Bluffs would be responsible for collecting, treating and disposing of 33%, 7% and 60% respectively of the total wastewater flow, by whatever means each town determines to be in its best interests.
>
> **Option 2:** Oak Bluffs would collect, treat and dispose of all 173,000 gpd of the wastewater needing nitrogen removal. This scenario might be feasible if Oak Bluffs were better able to expand its wastewater facility, or if Tisbury found that its existing disposal sites are within sensitive watersheds (adding to the cost of control) and that new disposal sites are difficult to acquire.
>
> **Option 3:** Tisbury would sewer all of its portion of the watershed and collect 113,000 gpd of wastewater that would go to an expanded treatment plant in Tisbury. Since that would not address all of the flow needing to be treated, the remainder (60,000 gpd) would go to the Oak Bluffs plant. This scenario might be feasible if Tisbury were better able to expand its treatment facility, or if it found more acceptable disposal locations than Oak Bluffs.
>
> **Option 4:** Wastewater would be collected from the most densely developed neighborhoods near the pond, regardless of town location. Later in this memo, data are presented that can be used to determine where the most densely-developed neighborhoods are located, along with supporting land use information.

In Options 2, 3 and 4, West Tisbury would provide no nitrogen control, and the other two towns would pick up that small increment of flow. West Tisbury has no existing municipal wastewater infrastructure, and its portion of the watershed is quite distant from the pond.

The allocations of flow (totaling 173,000 gpd) handled by each town in these four scenarios are summarized as follows:

	Tisbury	Oak Bluffs	West Tisbury
Option 1--Pro-rata	56,000 gpd	104,000 gpd	13,000 gpd
Option 2--All flow to Oak Bluffs	0	173,000 gpd	0
Option 3--Maximize flow to Tisbury	113,000 gpd	60,000 gpd	0
Option 4--Sewer the densest areas	57,000 gpd	116,000 gpd	0

Town-wide Planning

These options all have different costs and non-financial considerations. Even without a detailed cost evaluation to pick the best option, this analysis is helpful to town officials to plan their possible town-wide needs.

Table 4 was prepared to illustrate how this information could be used by Oak Bluffs. It shows the current wastewater flows in four categories of watershed in Oak Bluffs:

- Watersheds of nitrogen-sensitive ponds that are shared with other towns (Lagoon, Sengekontacket and Tashmoo);
- Watersheds of nitrogen-sensitive water bodies located only in Oak Bluffs (Oak Bluffs Harbor and Farm Pond);
- Watersheds of ponds determined not to be nitrogen sensitive; and
- Watersheds with direct ocean discharge.

TABLE 4. CURRENT CONDITIONS -- OAK BLUFFS

Watershed	Current Wastewater Flow, gpd	Septic Nitrogen Control Required, %	Flow Needing Nitrogen Control, gpd
Shared watersheds of sensitive ponds			
Lagoon Pond (shared with Tisbury)	221,300	47	104,000
Sengekontacket Pond (Edgartown)	61,400	19	11,700
Tashmoo Pond (Shared with Tisbury)	1,200	10	100
Subtotal	283,900		115,800
Single-town watersheds of sensitive ponds			
Oak Bluffs Harbor	226,800	49	111,100
Farm Pond	42,100	96	40,400
Subtotal	268,900		151,500
Watersheds of non-sensitive ponds	22,600	0	0
Watersheds with ocean discharge	153,900	0	0
Total Town-wide	**729,300**	*37*	**267,300**

Note: Flows are reported as annual averages.

Reported septic nitrogen control percentages are used in Table 4 to estimate the nitrogen control needs in each category under current conditions. Town-wide, Oak Bluffs is faced with controlling about 267,000 gpd of current wastewater flow, of which about 40% is associated with its pro-rata share for Lagoon Pond. The town-wide need could be as low as 223,000 gpd if Option 3 were implemented in Lagoon Pond, or as much as 336,000 gpd with Lagoon Pond Option 2. When combined with the treatment requirements for the other watersheds in Oak

Bluffs, the four options for Lagoon Pond indicate a 15% reduction to a 25% increase over the pro-rata option for Lagoon Pond. Table 5 shows the Town-wide needs under future conditions (454,000 gpd), where the pro-rata option for Lagoon Pond (217,000 gpd) represents nearly 50% of the future town-wide need.

TABLE 5. CURRENT AND FUTURE CONDITIONS -- OAK BLUFFS

	Wastewater Flow, gpd		Septic N Control Requirement, %		Flow Needing N Control, gpd		
Watershed	Current	Growth	Current	Growth	Current	Growth	**Future Total**
Shared watersheds of sensitive ponds							
Lagoon Pond (Shared with Tisbury)	221,300		47		104,000		
		112,800		100		112,800	216,800
Sengekontacket Pond (Edgartown)	61,400		19		11,700		
		20,300		100		20,300	32,000
Tashmoo Pond (Shared with Tisbury)	1,200		10		100		
		4,900		100		4,900	5,000
Subtotal	283,900	138,000			115,800	138,000	253,800
Single-town watersheds of sensitive ponds							
Oak Bluffs Harbor	226,800		49		111,000		
		40,800		100		40,800	151,900
Farm Pond	42,100		96		40,400		
		8,000		100		8,000	48,400
Subtotal	268,900	48,800			151,500	48,800	200,300
Watersheds of non-sensitive ponds	22,300		0		0		
		3,800		0		0	0
Watersheds with ocean discharge	153,900		0		0		
		44,600		0		0	0
Total Town-wide	**729,000**	**235,200**	*37*	*100*	**267,300**	**186,800**	**454,100**

Note: Flows are reported as annual averages.

Similar town-wide needs are shown for Tisbury in Table 6 and 7, where there are no Tisbury-only sensitive watersheds and two shared watersheds. Under current conditions (Table 6), Tisbury's nitrogen control need is 72,000 gpd, 80% of which is associated with its pro-rata share of Lagoon Pond. The Town-wide need could be as low as 15,000 gpd if Lagoon Pond Option 2 is implemented and as much as 128,000 gpd with Option 3. Table 7 shows how that situation changes with the MVC-projected increase in population and wastewater flow. The nitrogen control need increases by a factor of 3.4 over current needs, nearly equally split between Tashmoo and Lagoon.

Neighborhood Analysis

If the Towns intend to extend their sewer systems to eliminate septic nitrogen loads from the Lagoon Pond watershed, there are many factors that should be considered in selecting the areas to sewer. These factors include:

TABLE 6. CURRENT CONDITIONS -- TISBURY

Watershed	Current Wastewater Flow, gpd	Septic Nitrogen Control Required, %	Flow Needing Nitrogen Control, gpd
Shared watersheds of sensitive ponds			
Lagoon Pond (shared with Oak Bluffs)	119,900	47	56,400
Tashmoo Pond (shared with Oak Bluffs)	151,900	10	15,200
Subtotal	271,800		71,600
Single-town watersheds of sensitive ponds	0		0
Watersheds of non-sensitive ponds	0		0
Watersheds with ocean discharge	295,100	0	0
Total Town-wide	**566,900**	*13*	**71,600**

Note: Flows are reported as annual averages.

TABLE 7. CURRENT AND FUTURE CONDITIONS -- TISBURY

Watershed	Wastewater Flow, gpd		Septic N Control Requirement, %		Flow Needing N Control, gpd		
	Current	Growth	Current	Growth	Current	Growth	**Future Total**
Shared watersheds of sensitive ponds							
Lagoon Pond (Shared with Oak Bluffs)	119,900		47		56,400		
		64,700		100		64,700	121,100
Tashmoo Pond (Shared with Oak Bluffs)	151,900		10		15,200		
		106,300		100		106,300	121,500
Subtotal	271,800	171,000			71,600	171,000	242,600
Single-town watersheds of sensitive ponds	0				0		0
Watersheds of non-sensitive ponds	0				0		0
Watersheds with ocean discharge	295,100		0		0		
		120,900		0		0	0
Total Town-wide	**566,900**	**291,900**	*13*	*100*	**71,600**	**171,000**	**242,600**

Note: Flows are reported as annual averages.

Proximity to the pond. Eliminating near-shore septic systems will result in faster water quality improvement.

Location along length of pond. The West Arm is the area of the pond most threatened by nitrogen overloading. Nitrogen loads in the Upper Lagoon Pond watershed pass through a freshwater segment where some natural nitrogen removal occurs, so this portion of the watershed has less need for sewering.

Density of development. Sewer costs are directly proportional to the length of collection piping, and more densely developed neighborhoods cost less to sewer than those with large lots or with many vacant lots.

Nature of land use. Preference may be given to commercial parcels because their wastewater flows are often higher. Zoning should also be considered.

Proximity to existing sewer system. Lower transport costs favor neighborhoods closer to the existing sewer system in either town.

Development within water supply recharge areas. Long-term protection of the water supply may be enhanced by elimination of septic systems from recharge areas.

Recent expenditures in upgrading Title 5 systems. From a fairness perspective, towns may wish to defer providing public sewers in neighborhoods where a large number of residents have recently upgraded outdated septic systems or installed individual denitrifying systems.

To start to address these factors, the MVC GIS database was used to assemble land use data on 16 neighborhoods in the Lagoon Pond watershed; 7 in Oak Bluffs, 6 in Tisbury and 3 in West Tisbury. All of the land use information is presented in Appendix A, and the most important data are summarized in Table 8. (Note that the wastewater flows and derivative statistics in Appendix A are based on recent MVC studies in support of the Massachusetts Estuaries Project, and the flows differ somewhat from those reported elsewhere in this memo.)

Table 8 illustrates one sewering scenario based on serving the three most densely developed neighborhoods in Oak Bluffs (OB-1, OB-2 and OB-3) and two of the most densely developed neighborhoods in Tisbury (TL-1 and TL-3E). Neighborhoods OB-1 and TL-1 are closest to the existing sewer systems, have commercial flows, and are located near the most threatened segments of Lagoon Pond. As shown in Table 8, these neighborhoods should cost the least to sewer because of their relatively high density, as measured by the road length per developed parcel.

Data from the MVC indicates that Neighborhoods TL-1 and TL-3E generate 71,000 gpd of wastewater in Tisbury, and Neighborhoods OB-1, OB-2 and OB-3 generate 117,000 gpd in Oak Bluffs. These 5 neighborhoods generate 188,000 gpd, or 9% more than the current nitrogen control need. If the towns choose to collect only the precise flow associated with the current need (173,000 gpd), they could avoid the portions of these neighborhoods with predominately seasonal residences, or they could defer connecting those properties that have recently upgraded their on-site systems. It is important to note that there is some degree of uncertainty associated with the predicted 47% septic removal percentage, and that projected growth in the watershed could require the collection of over twice the initial flow.

ALLOCATING COSTS FOR NITROGEN CONTROL -- LAGOON POND WATERSHED

The four options listed above should be evaluated to determine which is the least-cost approach for controlling septic nitrogen loading in the Lagoon Pond watershed. That evaluation may lead to other options with even lower cost. Regardless of the cost of the option selected, the responsibility for those costs should be the subject of separate discussions. Simply stated, <u>the town building the infrastructure need not be the sole source of the capital expenditures</u>. For example, if the cost analysis indicated that Tisbury should sewer more than its pro-rata share of the Lagoon Pond watershed, some of the cost should be borne by West Tisbury and Oak Bluffs.

TABLE 8. LAND USE DATA FOR NEIGHBORHOODS IN LAGOON POND WATERSHED

Neigh-borhood	Distance to Pond, miles	Number of Developed Parcels	Percent Yr-round Parcels	Development Density, rd.ft./parcel	No. Devel. Parcels in Zone IIs	Annual Avg. Wastewater Flow, gpd
Neighborhoods that could be Connected to Sewer for Current Conditions						
OB-1	0.11	293	56%	105	57	40,200
OB-2	0.39	175	58%	78	71	26,500
OB-3	0.31	343	59%	98	210	50,700
TL-1	0.18	263	71%	91	3	49,500
TL-3E	0.20	139	67%	115	0	21,600
Subtotal		1,213			341	188,500
Average	0.24		62%	97		
Neighborhoods that could Remain on Septic						
OB-4	0.36	222	47%	125	79	44,700
OB-5	0.51	21	71%	298	15	8,600
OB-6	0.57	119	73%	275	95	21,700
OB-7	0.52	79	72%	147	21	13,300
TL-2	0.15	84	58%	102	0	16,700
TL-3W	0.50	79	73%	126	55	17,600
TL-4	0.08	20	50%	141	2	2,600
TL-5	0.98	16	75%	310	16	5,500
WT-1E	1.49	35	57%	341	35	5,300
WT-1W	2.88	11	82%	108	10	2,100
WT-2	2.19	169	67%	87	169	27,200
Subtotal		855			497	165,300
Average	0.93		66%	187		
Total		2,068			838	353,800

Notes: *1. See Figure 2 for locations of neighborhoods.*
2. "Distance to Pond" is measured from centroid of neighborhood area.

Table 9 presents land use and demographic statistics that could form the basis for a fair allocation of costs, regardless of where the infrastructure is built. In terms of percentage shares for Oak Bluffs, Tisbury and West Tisbury, "watershed area" would indicate a "56%-22%-22%" split. "Current wastewater flow" would indicate an allocation of "60%-33%-7%". "Length of shoreline" would lead to a "40%-60%-0%" distribution. No one of these statistics is the best one, but this list provides a useful basis for negotiations among the towns.

TABLE 9. POTENTIAL BASES FOR COST ALLOCATION IN LAGOON POND WATERSHED

	Oak Bluffs	Tisbury	West Tisbury	Watershed-wide
Distrbution of:				
Watershed area	56.5%	21.5%	21.9%	100%
Currently developed parcels	60.5%	29.1%	10.4%	100%
Potential for future buildings	68.7%	27.2%	4.0%	100%
Vacant land area	60.8%	14.7%	24.6%	100%
Current wastewater flow	60.2%	32.6%	7.2%	100%
Current wastewater N load	60.2%	32.6%	7.2%	100%
Assessed property values	53.0%	31.9%	15.1%	100%
Road miles	62.4%	26.5%	11.1%	100%
Length of shoreline	40.0%	60.0%	0.0%	100%

	Oak Bluffs	Tisbury	West Tisbury	Watershed-wide
Other indicators				
Year-round properties, % of total	59	68	67	62
Development density, road-ft/lot	125	110	130	121
Development density, acre/lot	1.77	1.41	4.01	1.9
Average distance to pond, miles	0.40	0.35	2.19	
Percent of parcels on town water	97	93	0	86
Percentage of devel. lots in Zone II	44	13	99	59
Wastewater flow, gpd/lot	164	189	161	171
Wastewater N load, lb/yr/lot	13.1	15	12.8	13.6

ADDRESSING NITROGEN CONTROL NEEDS -- TASHMOO POND WATERSHED

About 80% of the nitrogen control need in the Tashmoo watershed falls to Tisbury. This case study explores the sensitivity of the flow estimates to the assumed degree of growth in the watershed, and presents statistics on Tisbury neighborhoods in the watershed as a tool for planning control measures.

Impacts of Growth on Wastewater Control Needs

The current nitrogen control needs in the Tisbury portion of the Tashmoo watershed are as follows for three levels of future growth:

No growth	15,000 gpd
35% growth (50% of MVC projection)	68,000 gpd
70% growth (100% of MVC projection)	121,000 gpd

Compared to Tables 6 and 7, it is clear that the assumed level of growth in the Tashmoo watershed is very important in determining the Tisbury overall need. If growth in the Tisbury portion of the Tashmoo watershed is only one-half of that projected by the MVC, then Tisbury's future nitrogen control need (for both Tashmoo and Lagoon) would be 22% less.

Neighborhood Land Use Data

The MVC GIS database was used to assemble land use data on 13 neighborhoods in the Tashmoo Pond watershed; 11 in Tisbury, 1 in Oak Bluffs and 1 in West Tisbury. All of the land use information is presented in Appendix B, and the most important data are summarized in Table 10. (Note that the wastewater flows and derivative statistics in Appendix B are based on recent MVC studies in support of the Massachusetts Estuaries Project, and the flows differ somewhat from those reported elsewhere in this memo.)

Table 10 illustrates one sewering scenario based on serving Neighborhood T-3D. This small Tisbury neighborhood was selected because it has adequate current wastewater flow to address the assumed 10% nitrogen control need, it is one of the most densely developed neighborhoods, and it is close to the Tisbury wastewater treatment plant. Although it is not as close to Tashmoo Pond as some of the other neighborhoods, it has a high percentage of commercial flow, and some of the developed parcels are located in a Zone II.

The current nitrogen control needs are modest, but they increase significantly with the growth projected for the watershed. Table 10 highlights five other neighborhoods in the Tashmoo Pond watershed that could be candidates for sewering should that projected growth occur. Neighborhoods T-2A, T-2B, T-3B and T-3C are all close to the treatment plant and all have quite high development density. The current flow in these neighborhoods is over 50,000 gpd, nearly three times that of Neighborhood T-3D. A detailed analysis of build-out potential in these neighborhoods should be conducted to confirm their appropriateness for future sewering.

TABLE 10. LAND USE DATA FOR NEIGHBORHOODS IN TASHMOO POND WATERSHED

Neigh-borhood	Distance to Pond, miles	Number of Developed Parcels	Percent Yr-round Parcels	Develop. Density, rd.ft./parcel	No. Devel. Parcels in Zone IIs	No. Devel. Commercial Parcels	Annual Avg. Wastewater Flow, gpd
Neighborhoods that could be Connected to Sewer for Current Conditions							
T-3D	0.31	89	73%	93	25	22	18,700
Subtotal		89			25	22	18,700
Average	0.31		73%	93			
Neighborhoods that could Remain on Septic							
T-1	0.32	105	40%	202	0	0	27,700
T-2A	0.35	202	65%	**80**	0	4	32,900
T-2B	0.31	76	74%	**90**	0	1	12,600
T-3A	0.35	7	100%	1048	18	0	400
T-3B	0.18	28	71%	**79**	0	1	4,500
T-3C	0.49	16	75%	**63**	0	0	2,700
T-4	0.03	37	57%	144	1	0	6,800
T-5	0.20	48	40%	539	11	0	17,500
T-6	0.63	48	73%	160	57	1	8,200
T-7	0.78	35	77%	291	80	3	6,100
OB-1	0.60	9	89%	241	24		1,400
WT-1	1.86	244	74%	197	443		39,100
Subtotal		855			634		159,900
Average	0.51		70%	261			
Total		944			659		178,600

Notes:
1. See Figure 3 for locations of neighborhoods.
2. "Distance to Pond" is measured from centroid of neighborhood area.
*3. Neighborhoods in **bold** are candidates for sewers to address future nitrogen overloading based on high development density (<100 feet/parcel) or proximity to planned new connector road.*
4. 60% of flow in Neighborhood T- 3D is commercial.

The southerly portion of Neighborhood T-3A in the Tashmoo watershed is the location of a planned new road that will extend from State Road to the Edgartown-Vineyard Haven Road to address traffic congestion and to develop smart growth possibilities in both Neighborhood T-3A and other adjoining areas. While this area has no substantial nitrogen loading at this time, it is viewed as a future growth area requiring sewage collection and treatment.

SIZING BASIS FOR MUNICIPAL INFRASTRUCTURE

All of the flow estimates presented herein are expressed as annual averages. Wastewater infrastructure must be sized to handle the summer peak flows associated with those annual averages. At the Oak Bluffs treatment facility, the highest daily flows are typically 2.7 times the annual average, compared with 2.0 in Tisbury and 2.6 in Edgartown.

Tisbury

The Tisbury wastewater facility is sized for a summer peak flow of 104,000 gpd. Over the past few years, it has received an annual average of approximately 37,000 gpd and a summer peak of about 70,000 gpd. From the figures reported in Table 7, one can illustrate the magnitude of the additional capacity needs in Tisbury, assuming that public sewers are used to allow the abandonment of septic systems and the elimination of the nitrogen load they contribute to the groundwater:

	Tashmoo Only	Tashmoo and Lagoon
Current needs	30,000 gpd	140,000 gpd
Future needs with 35% growth	140,000 gpd	310,000 gpd
Future needs with 70% growth	240,000 gpd	480,000 gpd

There is approximately 30,000 gpd of unused capacity in the existing Tisbury wastewater treatment facility, but it is largely committed to existing properties outside the Tashmoo watershed. Therefore, a treatment plant expansion is needed to accommodate all of the summer peak flows shown above.

Oak Bluffs

In Oak Bluffs, the public wastewater treatment facility is sized for 320,000 gpd (the effluent disposal facility is permitted for 370,000 gpd) and in recent years it has received annual average flows of about 80,000 to 90,000 gpd and summer peaks of 220,000 to 240,000 gpd. (The unused capacity might be sufficient for Option 3.) Converting the annual average flows reported in Tables 4 and 5 to summer peak flows results in the following capacity needs:

Current conditions (pro-rata shares)	720,000 gpd
Future conditions	1,220,000 gpd

These capacity needs are 2 to 3 times the current capacity at the Oak Bluffs plant.

Other Considerations

All of the wastewater flow figures presented above relate to the quantities of wastewater that need to be subject to nitrogen removal. Many towns choose to provide public sewers for other reasons, such as economic development, resolving unsanitary conditions or water supply protection. Should Oak Bluffs or Tisbury identify such other needs, then the associated flows should be added to those presented above.

The flow estimates presume that wastewater could be collected, treated to remove nitrogen, and discharged at sites outside the watershed with nutrient overloading. If disposal sites are within nitrogen-sensitive watersheds, then these flow estimates must be increased to account for the effluent nitrogen that is discharged back into the watershed. This correction would also be needed for on-site denitrification systems, which typically remove only 50% to 60% of the nitrogen they receive.

In Tables 4, 5, 6 and 7, town-wide needs are presented for Oak Bluffs and Tisbury assuming that nitrogen overloading is addressed by the elimination of septic systems. To the extent that other nitrogen control approaches are employed, less wastewater would need to be collected and treated. This would be the case if the towns were successful in reducing lawn, garden and golf course fertilization, for example, in the nitrogen-sensitive watersheds. In Oak Bluffs, the possibility of enhancing flushing of Farm Pond by culvert modifications would reduce the wastewater flows presented here.

SEWERS VERSUS ON-SITE TREATMENT SYSTEMS

Tables 1 and 2 document the volumes of wastewater that should be subject to nitrogen control, assuming that fertilizer or stormwater controls are not implemented. There are two fundamental approaches to reducing nitrogen loads from a septic system: 1) adding an on-site treatment system property-by-property; or 2) eliminating the septic system by connecting properties to a municipal sewer system. An important factor with the sewering option is the cost of the sewer system, which can be greater than the cost of the treatment and disposal steps. While costly, the sewer system allows the wastewater to be removed from the watershed. Since the on-site option involves no change in the location of the discharge and does not remove all of the wastewater nitrogen, on-site systems remove less nitrogen from the watershed than do sewered options. As a result, more homes must be retro-fitted with on-site systems than would be connected to a sewer system, if that system leads to an outside-the-watershed disposal facility.

This evaluation has focused on traditional municipal sewers to reduce watershed nitrogen loads because the fewest number of parcels would be involved. Each town must undertake a cost-benefit evaluation to weigh the cost of the solution with the amount of nitrogen that is removed from the watershed. By focusing on alternatives that include municipal systems, these case studies are not intended to conclude that sewering options are the only ones available.

APPENDICES

APPENDIX A--LAND USE DATA FOR LAGOON POND WATERSHED

Part 1

Neigh-Hood ID #	Existing Developed Parcels			Existing Percent Yr-round	Future # of bldgs	Roadway Miles				Develop. Density, Rd-ft per lot	Neigh-Hood Area, acres	Develop. Density, acre/lot	Existing Flows and Nitrogen Loads					
													Wastewater Flow, gpd ann.avg.			Wastewater N Load, lb/yr		
	Yr-round	Seasonal	Total			Public	Private	Total	% public				Yr-round	Seasonal	Total	Yr-round	Seasonal	Total
OB-1	165	128	293	56%	125	5.81	0.00	5.81	100%	105	207.5	0.71	26,593	13,561	40,155	2,127	1,084	3,211
OB-2	101	74	175	58%	117	2.58	0.00	2.58	100%	78	110.6	0.63	20,000	6,549	26,549	1,599	524	2,123
OB-3	204	139	343	59%	188	6.30	0.04	6.34	99%	98	236.4	0.69	35,119	15,598	50,717	2,808	1,247	4,056
OB-4	105	117	222	47%	84	3.76	1.50	5.26	72%	125	395.7	1.78	26,056	18,658	44,713	2,084	1,492	3,575
OB-5	15	6	21	71%	32	0.97	0.21	1.18	82%	298	311.9	14.85	7,656	989	8,646	612	79	691
OB-6	87	32	119	73%	39	3.72	2.47	6.19	60%	275	702.3	5.90	17,350	4,327	21,677	1,387	346	1,733
OB-7	57	22	79	72%	97	2.20	0.00	2.20	100%	147	253.7	3.21	10,836	2,424	13,259	866	194	1,060
TL-1	186	77	263	71%	110	4.54	0.00	4.54	100%	91	208.6	0.79	35,234	14,283	49,517	2,750	1,142	3,892
TL-2	49	35	84	58%	27	1.63	0.00	1.63	100%	102	114.2	1.36	9,281	7,381	16,662	742	590	1,332
TL-3E	93	46	139	67%	23	3.03	0.00	3.03	100%	115	119.4	0.86	16,179	5,466	21,645	1,294	437	1,731
TL-3W	58	21	79	73%	63	1.88	0.00	1.88	100%	126	99.8	1.26	15,637	1,958	17,595	1,250	157	1,407
TL-4	10	10	20	50%	27	0.53	0.00	0.53	100%	141	64.7	3.24	1,434	1,153	2,587	115	92	207
TL-5	12	4	16	75%	20	0.94	0.00	0.94	100%	310	238.4	14.90	4,890	630	5,521	391	50	441
WT-1E	20	15	35	57%	18	2.26	0.00	2.26	100%	341	483.4	13.81	3,084	2,262	5,347	236	181	417
WT-1W	9	2	11	82%	15	0.22	0.00	0.22	100%	108	85.2	7.74	1,661	390	2,051	133	31	164
WT-2	114	55	169	67%	8	2.20	0.59	2.79	79%	87	293.1	1.73	18,216	8,942	27,159	1,446	715	2,161
ST--OB	734	518	1,252	59%	682	25.35	4.23	29.57	86%	125	2,218.1	1.77	143,609	62,106	205,715	11,484	4,966	16,450
ST--T	408	193	601	68%	270	12.55	0.00	12.55	100%	110	845.2	1.41	82,656	30,870	113,526	6,542	2,469	9,010
ST--WT	143	72	215	67%	41	4.68	0.59	5.28	89%	130	861.6	4.01	22,962	11,595	34,556	1,815	927	2,742
Total	1285	783	2,068	62%	993	42.58	4.82	47.40	90%	121	3,924.9	1.90	249,226	104,571	353,797	19,840	8,362	28,202
	62.1%	*37.9%*				*89.8%*	*10.2%*						*70.4%*	*29.6%*		*70.3%*	*29.7%*	
	yr-round	*seasonal*				*public*	*private*						*yr-round*	*seasonal*		*yr-round*	*seasonal*	

LAGOON POND *27-Jun-11*

APPENDIX A--LAND USE DATA FOR LAGOON POND WATERSHED

Part 2

Neigh-Hood ID #	Growth Potential, %	Distance to Pond, miles	Vacant Land		Number Parcels Sewered	Number of Parcels on Town Water			Number of Parcels in Zone II			Total Number of Parcels	Wwr Flow per lot, gpd ann.avg.			Wastewater N Load per lot, lb/yr		
			Parcels	Acres		Yr-Round	Seas.	Total	Develop.	Vacant	Total		Yr-round	Seasonal	Total	Yr-round	Seasonal	Total
OB-1	43%	0.11	168	48.6	1	167	123	290	57	36	93	293	161	106	137	12.9	8.5	11.0
OB-2	67%	0.39	69	35.6	0	100	74	174	71	16	87	175	198	88	152	15.8	7.1	12.1
OB-3	55%	0.31	153	73.8	0	199	137	336	210	110	320	343	172	112	148	13.8	9.0	11.8
OB-4	38%	0.36	48	149.0	0	102	117	219	79	23	102	222	248	159	201	19.8	12.8	16.1
OB-5	152%	0.51	36	297.8	2	17	6	23	15	18	33	21	510	165	412	40.8	13.2	32.9
OB-6	33%	0.57	37	312.7	0	75	30	105	95	36	131	119	199	135	182	15.9	10.8	14.6
OB-7	123%	0.52	35	186.3	0	51	22	73	21	19	40	79	190	110	168	15.2	8.8	13.4
TL-1	42%	0.18	43	22.7	14	185	77	262	3	4	7	263	189	185	188	14.8	14.8	14.8
TL-2	32%	0.15	24	19.5	0	44	33	77	0	0	0	84	189	211	198	15.1	16.9	15.9
TL-3E	17%	0.20	34	25.6	0	89	44	133	0	0	0	139	174	119	156	13.9	9.5	12.5
TL-3W	80%	0.50	16	15.0	0	55	21	76	55	6	61	79	270	93	223	21.6	7.5	17.8
TL-4	135%	0.08	10	18.8	0	6	5	11	2	3	5	20	143	115	129	11.5	9.2	10.3
TL-5	125%	0.98	27	164.5	0	0	0	0	16	27	43	16	408	158	345	32.6	12.6	27.6
WT-1E	51%	1.49	44	357.7	0	0	0	0	35	44	79	35	154	151	153	11.8	12.1	11.9
WT-1W	136%	2.88	21	67.2	0	0	0	0	10	21	31	11	185	195	186	14.8	15.6	14.9
WT-2	5%	2.19	24	21.3	0	0	0	0	169	23	192	169	160	163	161	12.7	13.0	12.8
ST--OB	54%	0.40	546	1,103.7	3	711	509	1220	548	258	806	1,252	196	120	164	15.6	9.6	13.1
ST--T	45%	0.35	154	266.1	14	379	180	559	76	40	116	601	203	160	189	16.0	12.8	15.0
ST--WT	19%	2.19	89	446.1	0	0	0	0	214	88	302	215	161	161	161	12.7	12.9	12.8
Total	48%		789	1,815.9	17	1090	689	1779	838	386	1224	2,068	194	134	171	15.4	10.7	13.6
					1.4%	*61.3%*	*38.7%*	*86.0%*	*68.5%*	*31.5%*	*59.2%*							
					of all lots	*yr-round*	*seasonal*	*of all lots*	*devel.*	*vacant*	*of all lots*							

Growth potential = Future buildings/total developed parcels

APPENDIX B--LAND USE DATA FOR TASHMOO POND WATERSHED

Part 1

Neigh-Hood ID #	Existing Developed Parcels			Existing Percent	Future # of	Roadway Miles				Develop. Density, Rd-ft per lot	Neigh-Hood Area, acres	Develop. Density, acre/ lot	Existing Flows and Nitrogen Loads					
													Wastewater Flow, gpd ann.avg.			Wastewater N Load, lb/yr		
	Yr-round	Seasonal	Total	Yr-round	bldgs	Public	Private	Total	% public				Yr-round	Seasonal	Total	Yr-round	Seasonal	Total
T-1	42	63	105	40%	54	1.95	2.07	4.02	49%	202	317.2	3.02	10,493	17,215	27,708	839	1,377	2,216
T-2A	132	70	202	65%	59	3.04	0.03	3.07	99%	80	95.9	0.47	25,234	7,654	32,888	2,018	613	2,631
T-2B	56	20	76	74%	37	1.30	0.00	1.3	100%	90	42.9	0.56	10,346	2,222	12,568	827	179	1,006
T-3A	7	0	7	100%	45	1.39	0.00	1.39	100%	1048	17.0	2.43	409	0	409	33	0	33
T-3B	20	8	28	71%	10	0.42	0.00	0.42	100%	79	59.4	2.12	3,214	1,263	4,477	258	101	359
T-3C	12	4	16	75%	2	0.19	0.00	0.19	100%	63	5.5	0.34	2,374	367	2,741	190	29	219
T-3D	65	24	89	73%	83	1.57	0.00	1.57	100%	93	96.1	1.08	13,612	5,120	18,732	1,089	410	1,499
T-4	21	16	37	57%	20	0.82	0.19	1.01	81%	144	116.3	3.14	3,256	3,576	6,832	260	1,142	1,402
T-5	19	29	48	40%	40	0.62	4.28	4.9	13%	539	427.1	8.90	3,167	14,308	17,475	253	590	843
T-6	35	13	48	73%	34	0.75	0.70	1.45	52%	160	155.6	3.24	5,740	2,440	8,180	459	437	896
T-7	27	8	35	77%	13	1.92	0.01	1.93	99%	291	342.3	9.78	4,739	1,325	6,064	379	157	536
OB-1	8	1	9	89%	8	0.41	0.00	0.41	100%	241	43.1	4.79	1,214	139	1,353	97	50	147
WT-1	180	64	244	74%	90	8.70	0.42	9.12	95%	197	934.5	3.83	28,876	10,238	39,114	2,309	181	2,490
ST--T	436	255	691	63%	397	13.97	7.28	21.25	66%	162	1,675.3	2.42	82,584	55,490	138,074	6,605	5,035	11,640
ST--OB	8	1	9	89%	8	0.41	0.00	0.41	100%	241	43.1	4.79	1,214	139	1,353	97	50	147
ST--WT	180	64	244	74%	90	8.70	0.42	9.12	95%	197	934.5	3.83	28,876	10,238	39,114	2,309	181	2,490
Total	624	320	944	66%	495	23.08	7.70	30.78	75%	172	2,652.9	2.81	112,674	65,867	178,541	9,011	5,266	14,277
	66.1%	*33.9%*				*75.0%*	*25.0%*						*63.1%*	*36.9%*		*63.1%*	*36.9%*	
	yr-round	*seasonal*				*public*	*private*						*yr-round*	*seasonal*		*yr-round*	*seasonal*	

APPENDIX B---LAND USE DATA FOR TASHMOO POND WATERSHED

Part 2

Neigh-Hood ID #	Growth Potential, %	Distance to Pond, miles	Vacant Land		Number Parcels Sewered	Number of Developed Parcels on Town Water			Number of Parcels in Zone II			Total Number of Parcels	Wwr Flow per lot, gpd ann.avg.			Wastewater N Load per lot, lb/yr		
			Parcels	Acres		Yr-Round	Seas.	Total	Develop.	Vacant	Total		Yr-round	Seasonal	Total	Yr-round	Seasonal	Total
T-1	51%	0.32	44	80.8	0	37	55	92	0	0	0	105	250	273	264	20.0	21.9	21.1
T-2A	29%	0.35	37	14.0	0	129	65	194	0	0	0	202	191	109	163	15.3	8.8	13.0
T-2B	49%	0.31	15	6.0	0	56	20	76	0	0	0	76	185	111	165	14.8	9.0	13.2
T-3A	643%	0.35	18	69.0	0	7	0	7	4	14	18	7	58	---	58	4.7	---	4.7
T-3B	36%	0.18	7	3.0	0	17	8	25	0	0	0	28	161	158	160	12.9	12.6	12.8
T-3C	13%	0.49	2	0.0	0	18	5	23	0	0	0	16	198	92	171	15.8	7.3	13.7
T-3D	93%	0.31	20	10.0	0	61	25	86	20	5	25	89	209	213	210	16.8	17.1	16.8
T-4	54%	0.03	15	27.9	0	15	14	29	1	0	1	37	155	224	185	12.4	71.4	37.9
T-5	83%	0.20	38	203.7	0	4	3	7	5	6	11	48	167	493	364	13.3	20.4	17.6
T-6	71%	0.63	20	60.0	0	0	0	0	39	18	57	48	164	188	170	13.1	33.6	18.7
T-7	37%	0.78	43	218.0	0	1	0	1	37	43	80	35	176	166	173	14.0	19.6	15.3
OB-1	89%	0.60	15	33.1	0	0	0	0	9	15	24	9	152	139	150	12.1	50.4	16.4
WT-1	37%	1.86	179	320.9	0	0	0	0	264	179	443	244	160	160	160	12.8	2.8	10.2
ST--T	57%	2.31	259	692.4	0	345	195	540	106	86	192	691	189	218	200	15.1	19.7	16.8
ST--OB	89%	2.24	15	33.1	0	0	0	0	9	15	24	9	152	139	150	12.1	50.4	16.4
ST--WT	37%	1.86	179	320.9	0	0	0	0	264	179	443	244	160	160	160	12.8	2.8	10.2
Total	52%		453	1,046.4	0	345	195	540	379	280	659	944	181	206	189	14.4	16.5	15.1
						63.9%	*36.1%*	*57.2%*	*57.5%*	*42.5%*	*69.8%*							
						yr-round	*seasonal*	*of all lots*	*devel.*	*vacant*	*of all lots*							

Growth potential = Future buildings/total developed parcels

TASHMOO POND *11-May-11*