National Decentralized Water Resources
Capacity Development Project

Application of a Risk-Based Approach to Community Wastewater Management

Tisbury, Massachusetts

August 2002

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Tisbury, Massachusetts

Submitted by the Town of Tisbury, Massachusetts

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National Decentralized Water Resources Capacity Development Project (NDWRCDP) Research Project

Final Report, August 2002

NDWRCDP, Washington University, Campus Box 1150
One Brookings Drive, Cupples 2, Rm. 11, St. Louis, MO 63130-4899

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CITATIONS

This report was prepared by

Stone Environmental, Inc.
58 East State Street
Montpelier, VT 05601

on behalf of the

Town of Tisbury
c/o Dennis Luttrell
51 Spring Street
Vineyard Haven, MA 02568

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West Virginia University/NRCCE Building
P.O. Box 6064
Morgantown, WV 26506-6064
Tel: (800) 624-8301

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William S. Heigis
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Michael Hoover

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Principal Investigator
Jay R. Turner, D.Sc., Washington University

Project Coordinator
Andrea L. Arenovski, Ph.D.

NDWRCDP Steering Committee:

Coalition for Alternative Wastewater Treatment
Valerie I. Nelson, Ph.D.

Consortium of Institutes for Decentralized Wastewater Treatment
Ted L. Loudon, Ph.D., P.E.
Mark Gross, Ph.D., P.E.

Electric Power Research Institute
Raymond A. Ehrhard, P.E. (Chair)
Thomas E. Yeager, P.E.

National Onsite Wastewater Recycling Association
Jean Caudill, R.S.

National Rural Electric Cooperative Association
Steven P. Lindenberg
Scott Drake, P.E.

Water Environment Federation
Vacant Seat

Water Environment Research Foundation
Jeff C. Moeller, P.E.

At-Large Members:
James F. Kreissl
Richard J. Otis, Ph.D., P.E.
Jerry Stonebridge

REPORT SUMMARY

The Town of Tisbury, Massachusetts is situated south of Cape Cod on the island of Martha's Vineyard. It provides an example of decentralized wastewater management in progress in a coastal island community with nutrient-sensitive resources, a sole source aquifer (only one aquifer available for drinking water), combined with growth concerns. The goals and key elements of their management program, coupled with the process the town has gone through, provide a case history for other communities to adapt to their own circumstances. This overview of the management program includes critical decision-making points, barriers to implementation, status of the implementation effort, and the next steps.

Tisbury is located on the northwestern tip of the island and is largely rural with a population center in the village of Vineyard Haven. Wastewater is treated onsite or in cluster systems. The town voted in October 1998 to adopt a community wastewater management plan for these decentralized systems. In July 1999, the town finalized the community wastewater management plan and made it compatible with the town's previously-planned Vineyard Haven Wastewater Project. In August 2000, the town received a grant from the National Decentralized Water Resources Capacity Development Project (NDWRCDP) to assist with implementation of the wastewater management program. Between August 2000 and July 2001, Stone Environmental, Inc. (SEI) assisted the town with program implementation. Six steps were taken to implement this program:

1. Perform a risk assessment through delineation of environmentally sensitive areas in the community, conduct nitrogen-loading studies, and develop growth projections.

2. Develop a risk-based water quality protection matrix through public workshops and information sessions.

3. Define risk-based wastewater management districts in Tisbury.

4. Install and use a computer database to track on-site system installations, upgrades, and maintenance.

5. Institute a long-term maintenance program for on-site systems. For each system, the program will include a schedule for initial inspection, regularly scheduled follow-up inspections, function checks, and pumpouts.

6. Expand availability of loans to system owners for wastewater treatment system upgrades.

SEI collected the data and performed the analyses that enabled the town to identify environmentally sensitive areas. The wastewater management districts were defined by the risk assessment/risk management approach. Tisbury's Board of Health has entered their paper on-site system permit documents into a computer database designed to facilitate the management of on-site systems, and a system for inspections and function checks of on-site systems has been set up.

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1 BACKGROUND

The Town of Tisbury is located on the northern tip of the island of Martha's Vineyard and covers 6.5 square miles. It is largely rural, with a year-round population of approximately 3,500 that increases to approximately 25,000 during the summer months. The population center is Vineyard Haven.

The entire town relies on a single groundwater aquifer for its drinking water. Approximately 75% of the town population relies on a public drinking water system, operated by Tisbury Waterworks that uses two wells that tap an unconfined sand and gravel aquifer. The remainder of town residents has individual wells tapping the same aquifer.

Wastewater treatment in Tisbury, Massachusetts has traditionally been decentralized, with on-site wastewater treatment systems (septic systems, cesspools, and mound systems) serving individual residences and businesses, plus cluster wastewater treatment systems serving small- to moderate-sized groups of homes, condominiums, or neighborhoods. There are approximately 2,400 on-site and cluster systems in town. A large cluster system serving approximately 120 homes, businesses, and institutions in the densely developed downtown portion of Tisbury, known as the village of Vineyard Haven, is currently being designed with construction planned for 2002. The highly treated effluent from the Vineyard Haven system will be pumped to two groundwater discharge soil absorption systems that were sited to minimize environmental impact. A complete description of Tisbury's recent wastewater management history is provided in *Decentralized Wastewater Management in Tisbury, Massachusetts* (Douglas, et al. 1999).

Management of decentralized systems in Tisbury has traditionally been the sole responsibility of the individual property owners. In other places where this has been the case, proper maintenance has frequently been ignored and failed systems have harmed water resources. A centralized management entity—in Tisbury's case, the municipal government—could provide the oversight both to assure that wastewater treatment systems are properly maintained over time and to protect the town's drinking water and other valuable water resources. Centralized management of decentralized systems provides the type of dependable wastewater treatment service that people typically associate with centralized wastewater collection systems and treatment plants.

The town has moved towards increased management of on-site wastewater treatment systems since 1989 when it required inspections of the systems at the time of property transfers. (This was six years before the Commonwealth of Massachusetts required time-of-transfer inspections.) Pumpouts of septic tanks have continued to be voluntary, managed only by the town requirement for a permit for each pumpout, so that the Board of Health can track pumping and manage septage.

After a Consent Order (No. 820) was entered into between the Town of Tisbury and the Commonwealth of Massachusetts’ Department of Environmental Protection that mandated the closing of the town's septage lagoons and addressed existing pollutants within the environment in excess of levels allowed under applicable regulations, the town voted in October 1998 to adopt a community wastewater management plan. In July 1999, the town finalized the community wastewater management plan (SEI, 1999) [1] and made it compatible with the town's previously planned Vineyard Haven Wastewater Project (Phase IV, Final Environmental Impact Review). In August 2000, the town received a grant from the National Decentralized Water Resources Capacity Development Project (NDWRCDP) to implement an enhanced wastewater management program. The town's overall goal has been to develop its capacity to effectively manage Title 5 wastewater treatment and disposal systems from a risk-based, watershed management perspective [Hoover, 1997; SEI, 1999—the original work plan for Tisbury (Appendix 6)]. Title 5 systems, named after the Massachusetts law of the same name, are those wastewater treatment systems treating less than 15,000 gallons/day.

The Town of Tisbury's Community Wastewater Management Plan (CWMP) was developed parallel to the Vineyard Haven cluster system solution between 1997 and 1998. It recognizes that decentralized systems will continue to be used in most areas of the town and provides for comprehensive management of the approximately 2,400 on-site systems. This represents over 95% of the wastewater users, excluding only the core of the village of Vineyard Haven.

This report describes the risk assessment and risk management program that has been used to refine the CWMP. Broadly, the improved program consists of first identifying the risks, and then proposing ways to manage those risks. The following sections show how this was done.

[1] A copy may be obtained by calling the Administrator of the Town of Tisbury, +1 508-696-4202.

2 ASSESSING THE RISKS

Broadly, risk assessment in this study consisted of two parts:

- Evaluating the nature and magnitude of the threat to Tisbury's water resources
- Assessing which water resources the townspeople considered most valuable and, therefore, most worthy of protection

The following steps were used to evaluate the nature and magnitude of the threat to Tisbury's water resources:

- Identify the significant water resources in the town
- Determine the nature of the threats to those water resources
- Delineate the watersheds for those water resources
- Determine whether present or future nutrient loads are likely to degrade the water resources, by
  - Calculating current loads and estimating future loads
  - Calculating the maximum load the resources can assimilate and still maintain the quality that the townspeople desire for them

The first step was to identify the water resources (watersheds and groundwater) in Tisbury. Seven surface watersheds and four aquifers were identified (Table 2-1).

Table 2-1
Water Resources in Tisbury

Type	Resource
Surface Watersheds	Lagoon Pond Lake Tashmoo Vineyard Haven Harbor – Inner Harbor Vineyard Haven Harbor – Outer Harbor Vineyard Sound Smith Brook Mink Meadows

Table 2-1
Water Resources in Tisbury (Cont.)

Type	Resource
Groundwater Resources (all in the same aquifer)	Zone 2 Wellhead Protection Area Interim Wellhead Protection Area Individual wells Municipal water supply

Existing water quality data were then evaluated to assess current water quality problems. Many sources of data were found. Tisbury Waterworks monitors groundwater quality at its public drinking water supply wells. The town's Board of Health collects water quality samples at the town's beaches. The Shellfish Commission samples water quality in Lagoon Pond. Tisbury Waterways Association and Martha's Vineyard Regional High School have been sampling water quality in surface waters and coastal ponds. The Martha's Vineyard Commission (MVC), the island's regional planning agency, has performed extensive field studies of the nutrient loading and nutrient limits of several of the island’s coastal ponds, including Lagoon Pond in Tisbury. Its study of the nutrient limit of Lake Tashmoo was not complete as of this writing.

These water quality sampling efforts and field studies revealed that nitrogen is the potentially limiting water quality parameter for the coastal ponds. Other types of pollution have been identified—that is, intermittent occurrences of elevated *E. coli* in the water at the inner harbor beaches appear to coincide with elevated stormwater runoff—but this study is primarily concerned with ways to limit nitrogen pollution from on-site wastewater systems.

The next step was to delineate the boundaries of these water resources by defining the areas in town where on-site systems were discharging to groundwater that flows to the community's water resources. In other words, the groundwater flow paths and groundwater divides in the town were identified. The area of groundwater contribution to drinking water supplies was defined using data available from MassGIS on the Zone 2 Wellhead Protection Area for the town’s public wells (Earth Tech, 1999). The watersheds and the areas of groundwater contribution to inland water bodies, Vineyard Haven Harbor, and Vineyard Sound were delineated using data from a variety of sources and a geographic information system (MVC, 2000, MassGIS; see Figure 2-1). The specific methods for delineating each of these areas can be found in Appendix E1 (SEI, 2001).

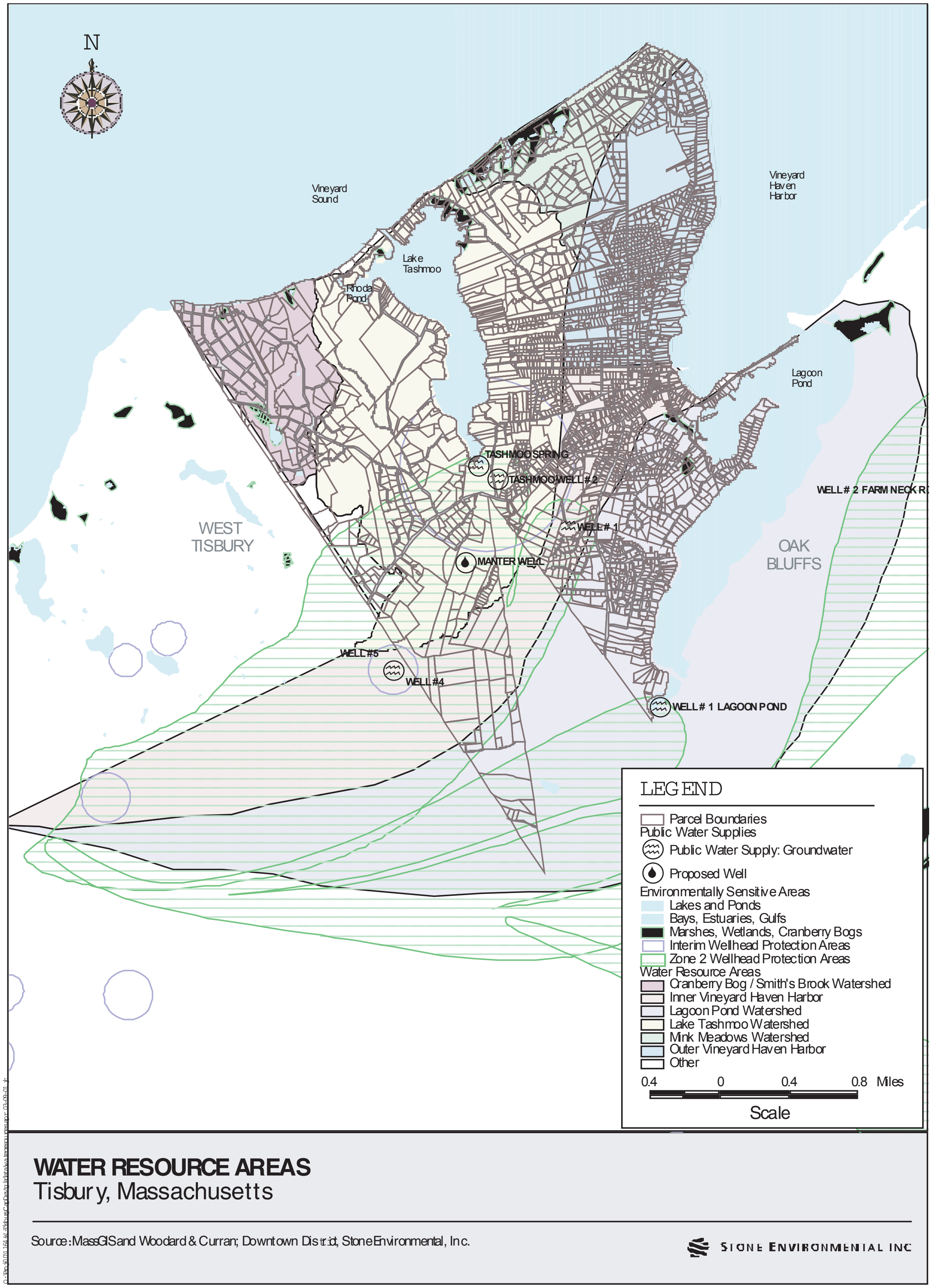

Figure 2-1
Water Resource Areas

Once the areas of contribution were established, the nitrogen loads to those water resources were evaluated. The MVC modeled nitrogen loading for Lagoon Pond. Sources that were considered included atmospheric nitrogen, stormwater runoff, lawns, agricultural uses, and septic systems (MVC, 2000). Stone Environmental, Inc. (SEI) used this computer spreadsheet model for estimating the nitrogen loading to Lake Tashmoo. In addition, SEI conducted quality control of the result by using a different model (Valiela, 1997). NLOAD, a nitrogen loading model developed by the Massachusetts Department of Environmental Protection (DEP) was used to evaluate nitrate concentrations in the public drinking water supply wells in an area known as Zone 2 (Massachusetts DEP, 1999). These surface water and groundwater nitrogen loading analyses were performed for current levels of contribution and three scenarios of future development: low, moderate, and high growth.

Policy recommendations are based on calculated nitrogen load to the watershed and recommended nitrogen loading limits. The loading limit to groundwater is determined by the 10 mg/l standard for nitrate. The loading limits to surface water are determined based on research done in nearby Buzzards Bay. There, researchers have calculated expected water quality for coastal embayments, given nitrogen loading rates, embayment dimensions, and rates at which the water is flushed—for example, replaced with water from the ocean or the land (Costa, et al., 1999). Because the embayment dimensions and rates of flushing are relatively constant, a determination of the nitrogen load gives a prediction of the water quality. Conversely, a policy decision to achieve or maintain a given level of water quality can be translated into a maximum allowable nitrogen load.

For Lagoon Pond, the MVC decided to strive for water quality in the “Outstanding Resource Waters” class. They found that the nitrogen limit consistent with achieving this water quality is roughly equivalent to the pond's current nitrogen loading (MVC, 2000).

The analysis for the Lake Tashmoo watershed will not be completed until the summer of 2002 when the MVC will quantify the nitrogen limit in Lake Tashmoo based on new field data. During this project, nitrogen loading in the Lake Tashmoo watershed was calculated for current conditions and under three growth scenarios (SEI, 2001). The draft findings for the MVC report have been released for public comment (MVC, 2002). Again, the draft nitrogen limits are based on the classification of the pond as outstanding resource waters. The nitrogen load from current, low and moderate growth scenarios are all below the lake's nitrogen limit. However, the loading from the high growth scenario exceeds the nitrogen limit for outstanding resource waters.

Knowing a water resource's nutrient load and limit is necessary but not sufficient for setting water policy. An important question remains: How valuable is this water resource? Policymakers might choose to extend a high level of protection to a valued resource that is only marginally threatened as a matter of precaution. On the other hand, a highly threatened resource that is little valued might receive little protection.

An important product of the risk-based approach to wastewater management, which incorporates both the hydrological and value-laden sides of the issue, is the groundwater and surface water protection matrix (Table 3-1). This matrix ranks the relative value and the vulnerability of each water resource to pollution. These two layers of information form the columns and rows, respectively, of the matrix.

The matrix was constructed through a community participatory process based on a methodology from Hoover (1997) and Hoover, et al. (1998). The first step was to conduct a “needs assessment” for the community. The Tisbury CWMP included most of the elements of this needs assessment and served as the basis for initial ranking of water resources in the community's watershed.

Stakeholder involvement is critical for success of decentralized wastewater management programs. The original CWMP was developed with extensive involvement of the Tisbury Wastewater Planning Commission, appointed by the Board of Selectmen. This program was adopted by Town Meeting vote in 1998. To develop the surface water and groundwater protection matrix, the project team consulted with the stakeholders listed in Table 2-2, beginning in June 1999.

Table 2-2
Stakeholders for Water Resource Management

Organization	Stakeholder
Town of Tisbury	Board of Selectmen Wastewater Planning Committee Board of Health Harbormaster Public Works Department Conservation Commission Planning and Zoning Department Shellfish Advisory Committee Fish Committee Harbor Management Committee
Community Organizations	Tisbury Waterways, Inc. Tisbury Water Works Lagoon Pond Association
Residents of Tisbury	

Table 2-2
Stakeholders for Water Resource Management (Cont)

Organization	Stakeholder
Regional Organizations	Martha's Vineyard Commission Martha's Vineyard Regional High School Martha's Vineyard Land Bank Commission Cape and Island Watershed Task Force

Near the end of the risk-based assessment in March 2001, two stakeholder meetings and a community information workshop were held to present the methodology and results of the risk assessment science and to bring the stakeholders into the judgment side of the risk assessment. Daytime meetings with invited representatives of the stakeholder organizations were followed with evening meetings for the public to solicit as wide a range of perspectives, criticism, and ideas as possible. Key outcomes of this process were consensus among the stakeholders that:

- Protecting the drinking water supply aquifer is highly important
- The shellfish industry is important to the community

Based on this consensus, the appropriate level of protection will be given to the drinking water aquifer and the waters critical to the shellfish industry.

Once risk assessment was used to establish the value and vulnerability of water resources, the next step was to use risk management to propose appropriate levels of protection for each area.

3 MANAGING THE RISKS

The risk-based management approach exercises the greatest control over systems installed in locations that potentially threaten water resources the community highly values. Less control is assigned to those parts of the watershed that are less valued or that are not nearly as susceptible to contamination. However, in all cases, controls will be assigned to protect the health of the users of the on-site system, as well as public health in all parts of the community.

Based on the water resource areas delineation, as discussed in Chapter Two, eight wastewater management districts (WMDs) were proposed. This restructuring represents an increased sophistication in management over the three previously defined WMDs in the 1999 Wastewater Management Project (SEI, 1999). The county soil survey was used to estimate depths to seasonally high groundwater in Tisbury (USDA, 1986). Soils in Tisbury show great uniformity; approximately 95% of the town is on sandy soil with seasonally high groundwater at greater than five feet below ground surface. For this reason, a control zone is being proposed within each WMD only where groundwater is sometimes less than or equal to five feet below the surface, a situation that leads to an increased likelihood of groundwater degradation from on-site systems.

Once the WMDs were delineated according to natural boundaries, the division was modified to respect parcel boundaries so that each property fell into only one WMD. A parcel was assigned to a WMD if more than 50% of its area drained to a particular water resource area (Figure 3-1).

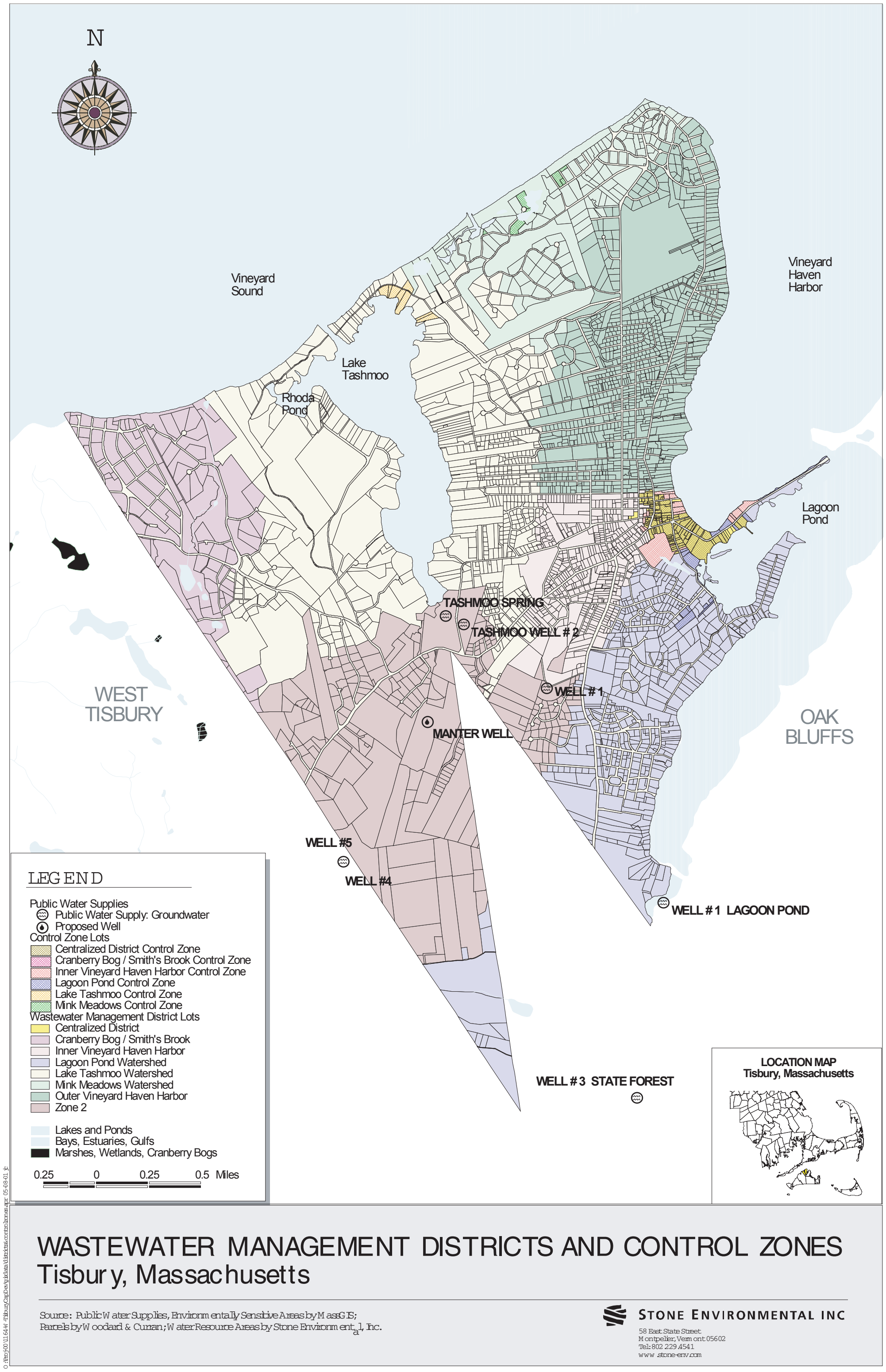

Figure 3-1
Wastewater Management Districts and Control Zones

A total of eight possible management levels (ML1 through ML8) were envisioned, and one of these was assigned to each of the WMDs and each of the control zones, based on relative risk. Each of these areas corresponds to a cell in the water quality protection matrix in Table 3-1. (Note: It is a coincidence that there are both eight wastewater management districts and eight possible management levels). Management activities, determined zone by zone, involve different frequencies of Title 5 inspections (covering everything from the tank to the leach field, plus information on who is using the system) and function checks (covering only watertightness and structural soundness of the tank and solids level). Currently, there are only two different types of management proposed. ML1–ML4, the downtown area and the wellhead protection areas, will have the same management requirements. ML5–ML8, the watersheds for the coastal ponds, outer Vineyard Haven Harbor, and Vineyard Sound, will have another set of management requirements. The management details are in Appendix E4 (SEI, 2001). The only difference between the two sets of management requirements is the frequency of function checks, which will occur at 3.5-year intervals for ML1–ML4 and at 7-year intervals for ML5–ML8.

Table 3-1
Water Quality Protection Matrix for Wastewater Management

Ranking of Environmental and Water Resource Areas →

Vulnerability to pollution ↓	Drinking Water		Surface Water						
	Public Well Head Protection Areas		Down-town district	Lagoon Pond Watershed	Lake Tashmoo Watershed	Inner Harbor	Mink Meadows	Cranberry Acres/Smith Brook	Outer Harbor
	Zone 1	Zone 2							
High (Control zone)	NDP*	ML1	ML3	ML5	ML5*	ML7	ML7	ML7	ML7
Moderate	NDP*	ML2	ML4	ML6	ML6*	ML8	ML8	ML8	ML8
Considerations Affecting Management Level	DEP requires no development	Citizens expressed need for long-term protection	Area to be served by large cluster system	Physical and modeled indications of nutrient impairment. Productive shellfishery.	Physical signs of impairment from human activities. Shellfishery. Recreational use.	Some indication of beach impairment. Older houses. Recreational use. Well flushed.	Area adjacent to beach with high GW. Marshes not used publicly. Little surrounding residential development.	No indications of impairment. Privately controlled.	Area adjacent to beach with high GW. Generally good soils. Well flushed harbor.

Notes: *NDP - No development permitted
ML - Management Level (see appropriate section of the Community Wastewater Management Plan)
If 50% of a parcel lies in a control zone, it will be subject to that level of management. This designation may change if the initial inspection reveals (or the owner proves) that the disposal area is in an adjoining lower vulnerability control zone.
* Tentative levels pending completion of nitrogen limit work by Martha's Vineyard Commission
GW = Groundwater

Management for the control zones in each WMD is, for the time being, the same as management in the rest of the WMD, except that the initial inspection is earlier. The town may decide to introduce more stringent management measures for the control zones based on new information about water quality and the systems in place. For example, in the Lagoon Pond WMD where the present nitrogen load is about the same as the nitrogen limit, the town may require advanced treatment in control zones as a way of accommodating growth without exceeding the pond's nitrogen limit (Crites and Tchobanoglous, 1998—discussion of advanced treatment technologies).

The CWMP was revised to incorporate the matrix, location of control zones, and description of control measures in each district/zone. The revised CWMP was then submitted to the Board of Health and Select Board to obtain approval for the matrix and control measures.

SEI worked with town officials, including the Board of Health's health agent, to finalize the overall management approach and to ensure that the selectmen and the Board of Health had common goals and objectives and a realistic division of responsibilities and duties. The health agent will issue the permits according to existing law and rules, using the guidance and flexibility included in the state-approved CWMP. The Board of Health will coordinate inspection and monitoring of the individual systems. In order to smooth the transition to the new management program, the Board of Health has specified that the initial inspections will be phased in over a seven-year period.

Septage treatment and disposal have been a long-term problem in Tisbury, exacerbated by the recent closing of the town's septage lagoons. Since then, all septage has been freighted by ship to the mainland. Historically, the Board of Health has issued permits for voluntary pumpouts. Under the CWMP, mandatory pumpouts will be scheduled throughout the year to better manage the volume of septage that must be transported off-island. Eventually, septage will be treated at the proposed Vineyard Haven wastewater treatment facility.

Many of the details of the CWMP have yet to be hammered out. Inspection of the systems will reveal information that will be useful in developing more detailed management requirements. The Board of Health plans to monitor future studies of water resource quality and respond with appropriate measures to modify the management plan.

Town officials are now acutely concerned with addressing the small, centralized system for wastewater management being installed in downtown Vineyard Haven. As the town moves beyond that project, the CWMP will be revised to assure sustainable wastewater management throughout the town, with adequate protection of all water resources.

4 RISK ASSESSMENT AND RISK MANAGEMENT TOOLS

Effective management of information is key to effective management of on-site systems.

GIS (Geographic Information Systems) enabled the analysis of existing and potential environmental impacts on a watershed and groundwater recharge area basis. The Town of Tisbury has purchased ArcView® and has trained Board of Health and Public Works Department staff in its use. The analyses were performed by Stone Environmental, Inc. (SEI) ArcView® GIS was used to map locations of the proposed control zones throughout the entire town of Tisbury, as shown on Figure 3-1. The vulnerability information has been shown by hatches on the parcels that are more than 50% within a high-vulnerability soil. (Due to the limited amount of soil variability in the town, there are few differences in vulnerability.)

Three different nitrogen loading models were utilized in this project. They are discussed in Chapter 2, Assessing the Risks and in Appendix E3. These computer applications are intended for use as planning tools, as a component of an overall risk-assessment program. They are generally quite easy to use, consisting of a series of spreadsheets or step-by-step on-screen instructions. Unfortunately, there is relatively little documentation for either of the spreadsheet models used for estimating nitrogen load to shallow estuaries (MVC, 2000 and Valiela, 1997). Massachusetts DEP does produce a guidance document for their NLOAD model, used for estimating nitrogen load to public water supply wells. It is available on the web at http://www.magnet.state.ma.us/dep.

The town stakeholders understand the need to effectively manage information to implement, track, and monitor the effectiveness of the town's on-site system management program, though the transition to a new system has not always proceeded smoothly. Previous Title 5 information management was accomplished by the Board of Health using a variety of methods. The Board of Health tracked septic tank and cesspool pumpouts on an Excel spreadsheet since 1995 as part of the town's septage management program. Data for time-of-transfer inspections and permits for repairs, upgrades, and new on-site systems were filed in filing cabinets. In 1999, SEI's Septic Information Management System (SIMS) wastewater management database was loaded with parcel data from the Town Assessor's office and the existing pumpout data. This system was installed on a desktop computer at the Board of Health office. This database was not used, however; instead, the historical data in the filing cabinets were still consulted.

In 2001, Tisbury's Board of Health upgraded their information management to SEI's Integrated Wastewater Information Management System (IWIMS) database. This database was designed to work more closely with the flow of information in a Board of Health office with a higher level of on-site system management. For example, pumpout and inspection scheduling, which are new tasks that the Board of Health is taking on under the management regime, were incorporated into IWIMS. Information from all of the Board of Health paper files for permits and inspection were entered into IWIMS. This database enables tracking and management to flow smoothly with a minimum of additional staff resources. SEI is working with the Board of Health to fully implement IWIMS and ensure that it is used.

The IWIMS database will be used to keep track of the location and classification of systems, operation, and maintenance schedules for all systems, and information on structures and soils at each site. The Board of Health will track system usage, locations, and inspection schedules for various types of technologies, development density in control zones, system performance data, and resource impact data. The IWIMS software can be customized for tracking these and other new types of data collected.

5 LESSONS LEARNED

The most important lessons learned are the effectiveness of making small steps toward decentralized management and the value of long-term perspective. The first draft of a CWMP was prepared in 1998. The plan was adopted at Town Meeting in 1999 along with a proposal for a large cluster system for the downtown area. The town preferred to implement a practical management plan that would gain public acceptance. The decision whether to mandate nutrient removal technologies was postponed because of the likelihood that consideration of required advanced treatment may have derailed implementation of any program improvements at this time. The town's strategy will be to revisit that issue once the new management program is effectively implemented and overall town-wide benefits of the program are evident. At that time, it will be appropriate to consider measures for water quality protection for specific watersheds.

Two public meetings were held to provide an opportunity for public participation in the development of the on-site management program. Although the discussion was very useful and productive, the turnout at these meetings was relatively small, approximately 20 people at each meeting. This may have been improved if a town resident or municipal official had taken a stronger sense of ownership to aggressively promote the project. Other communities, which have had a local "sparkplug," have had a more active public participation process. After over five years of intensive wastewater management planning, the Tisbury Wastewater Planning Committee was disbanded in 2000 and a consultant was selected to design the cluster system for the Village of Vineyard Haven. In retrospect, it may have been useful for that committee to follow through on the implementation of the on-site management program. Also, with more money allocated to public participation and public outreach, the public could have had a stronger influence in this project. In addition, the consultant should maintain a strong presence in the town to reinforce the importance of the program with local officials and the public.

With the completion of the Addendum to the CWMP, the Board of Health and Board of Selectmen are now anxious to move the program forward. Implementation of the management program described in the Addendum to the CWMP will require at least one additional staff member in the Board of Health offices. The Board of Health proposed to divide these responsibilities among the existing staff and create an administrative position for the Board. Funding for this position was proposed in the spring of 2001 as a $40,000 warrant article at Town Meeting. At that town meeting, this article was quickly tabled without discussion and therefore implementation of the management program was delayed. The tabling of the article was apparently due to a lack of understanding of the importance of this program and the benefits that the program will bring to the town. Town officials obtained ongoing funding to maintain the wastewater management program: the article for funding $50,000 was approved by voters at the April 25, 2002 town meeting. The increase in program cost is for additional public outreach as the program is implemented. This article passed because there was deliberate communication and discussion to enhance local support for implementing this initiative prior to Town Meeting.

For reference, the total town budget in fiscal year 2001 was approximately $14.2 million and is budgeted at approximately $14.6 million in fiscal year 2002.

A significant effort will be required to train septic tank pumpers to measure solids accumulation prior to pumping. We recommend that this training include materials to demonstrate that the mandatory pumping program will provide them with a steady source of customers to offset the previous practice of recommending pumping septic tank every one to three years.

After the nitrogen limits of both coastal ponds are known, the town will have to decide how to manage the nitrogen load for existing development and future growth in the Lagoon Pond watershed and possibly the Lake Tashmoo watershed. If nitrogen removal technologies are proposed as a solution for these watersheds, town officials have said they will rely on the private sector for siting, design, installation, operation, and maintenance of these systems. At that time, the private sector practitioners and Board of Health staff will need training to provide effective review, installation inspections, and oversight of these systems.

The public participation program had the following approximate cost breakdown:

Town of Tisbury: Internal Meetings

- 2001 (20 hours) $1,800
- 2002 (20 hours) $1,800

Subtotal: **$3,600**

Stone Environmental, Inc. (SEI) and Onsite Corporation (Onsite)

- Board of Health and Board of Selectmen meetings (SEI)
  - 2000 and 2001 ____________________ $5,000
- March Meetings (SEI and Onsite)
  - Preparation ________________________ $2,500
  - Meeting _________________________ $10,000
  - Travel Expenses ____________________ $1,500
- June Meeting (SEI)
  - Preparation ________________________ $1,000
  - Meeting ___________________________ $2,000
  - Travel Expenses _____________________ $300

Subtotal **$22,300**

Total Public Participation Cost_________________ **$25,900**

Remaining barriers to optimal implementation of this management program include:

- The public ownership of the process and program will diminish over time if not maintained through continued involvement of the public.
- The town has not yet trained septage pumpers to assess scum and sludge levels and pump septic tanks only if necessary. This may lead to unnecessary pumping, with consequent increased costs. Too frequent pumping may also limit the anaerobic digestion process that occurs in properly-functioning septic tanks. Also needed is a fee structure that provides pumpers with a revenue stream that is at least as great as and more reliable than the system of voluntary, irregular pumpouts.
- Designers and installers have too little experience and expertise to use innovative and alternative technologies effectively to overcome soil and site limitations (Higgins, 2001).

6 CONCLUSIONS

The Town of Tisbury has made a commitment to integrated wastewater management that includes individual and cluster decentralized systems and a small, centralized system. This project has enabled the town to implement a risk-based management program for all parcels not served by the large cluster system being designed for downtown Vineyard Haven.

7 RECOMMENDATIONS FOR FUTURE WORK

The outcomes of the project include revisions to the CWMP based on the results of the risk-assessment process and presentation of the proposed management approach to the town and public. Actions that the town has taken to maximize protection of water resources include:

- Revision of the local "Title 5 On-site System Management Regulation," effective July 1, 2002
- Funding of the program with $50,000 to pay for one additional health department employee and public outreach for implementation of this regulation per warrant article approved at April 27, 2002 Town Meeting

Recommended actions items for the town to consider in the future include:

1. Review the program effectiveness on an annual basis. Measures to be evaluated include:
    a. Inspections
        i. Total number of inspections completed
        ii. Percentage of required of inspections completed
        iii. Number of failed inspections
        iv. Percentage of upgrades required by failed inspections completed
        v. Staff and equipment resources required by inspection program
    b. Pumpouts
        i. Total number of pumpouts
        ii. Percentage of required pumpouts completed
        iii. Distribution of pumpouts over the year (by month)
        iv. Resources required by pumpout program

   c. Public Outreach

      i. Description of public outreach program

      ii. Effectiveness of public outreach tools

      iii. Resources required by public outreach program

7. When the Lake Tashmoo nitrogen limit calculations are finalized by the MVC, and the current management program is effectively implemented, revisit the risk management process to determine whether the management levels for Lake Tashmoo and Lagoon Pond watersheds are appropriate.

8. Determine whether nitrogen reduction or other advanced treatment technologies will be required in new and upgraded systems in parcels affecting vulnerable water resources.

9. Refine the nitrogen loading study to the Zone 2 Wellhead Protection Area when GIS parcel data are available for West Tisbury.

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9 LIST OF ACRONYMS

CWMP	community wastewater management plan
DEP	(Massachusetts) Department of Environmental Protection
GIS	geographic information system
IWIMS	Integrated Wastewater Information Management System
ML	Management level
MVC	Martha's Vineyard Commission
NDWRCDP	National Decentralized Water Resources Capacity Development Project
NLOAD	Nitrogen loading model developed by the Massachusetts DEP
SEI	Stone Environmental, Inc.
SIMS	Septic Information Management System
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WMD	waste management district

A TITLE 5 ON-SITE SEWAGE DISPOSAL SYSTEM MANAGEMENT REGULATION IN THE TOWN OF TISBURY, MASSACHUSETTS

SECTION I. AUTHORITY

This regulation for the Management of Title 5 On-Site Sewage Disposal Systems in the Town of Tisbury, Massachusetts is adopted pursuant to: 310 CMR 15.003 and 15.301 and Section 31 of Chapter 111 of the General Laws.

SECTION II. PURPOSE

It is the purpose of this regulation to provide for the regular inspection and appropriate long-term management of all privately owned sewage treatment and disposal systems in the Town of Tisbury and to provide for the establishment of an equitable fee structure to enable the Town to carry out the purpose of the regulation. It is the further purpose of this regulation to:

1. Prevent the creation of health hazards, including surfacing sewage;

2. Prevent the contamination of groundwater, surface water, and drinking water supplies by improperly treated wastewater;

3. Ensure that all sewage treatment and disposal facilities are managed in a manner that promotes sanitary and healthful conditions and provides for the long-term operation of these systems.

SECTION III. APPLICABILITY

1. All privately owned sewage treatment and disposal systems shall be managed under the guidance of this regulation.

2. When any other applicable regulation, bylaw, ordinance, or statute differs from this regulation, the stricter provisions shall apply.

SECTION IV. WASTEWATER MANAGEMENT DISTRICTS AND CONTROL ZONES

1. Purpose

It is the purpose of this Subsection to provide for the establishment and revision of Wastewater Management Districts and Control Zones within which the Town may apply specific standards for the selection, siting, construction, operation, and maintenance of sewage treatment and disposal systems, in order to achieve the purposes of this regulation in a manner consistent with the unique physical and environmental conditions present in the Town of Tisbury.

2. Establishment

   a. The Board of Health hereby establishes Town of Tisbury Wastewater Management Districts (hereinafter CWMDs) coincident with watershed and wellhead protection area boundaries of the Town of Tisbury, within which all treatment and disposal systems are subject to the provisions of this regulation. The designation and delineation of the WMDs is set forth in the Community Wastewater Management Plan (CWMP) section of the Town's Phase IV Wastewater Facilities Plan – Final EIR dated August, 1999, Revised ________, 2001.

   b. The Board of Health hereby establishes Town of Tisbury Control Zones (hereinafter CZs) coincident with areas of high seasonal groundwater levels within the Town of Tisbury, within which all wastewater treatment and disposal systems are subject to the provisions of this regulation.

   c. The Board of Health shall have the authority to establish additional Control Zones within the Town of Tisbury within which additional standards for the design, construction, operation and/or maintenance of wastewater treatment and disposal systems may be applied.

   d. The Board of Health may establish Control Zones upon finding that a specific geographic area within the Town of Tisbury has unique environmental and/or physical features which require measures above and beyond the standard provisions of this regulation in order to accomplish the purposes set forth in Section I above.

   e. The Board of Health hereby establishes a schedule of Risk Classification as the basis for frequency of system re-inspections based on initial inspection, function check, and performance history. Each system shall be assigned by the Board of Health or its designated agent to a risk classification in accordance with this schedule which is included in Section VI, 4b.

3. Hearing Required; Public Notice

Prior to establishment of a Control Zone, the Board of Health shall hold at least one (1) public hearing on the proposed designation of a Control Zone. At least 21 days prior to the public hearing, the Board of Health shall publish a notice in a paper of general circulation. At least 21 days prior to the public hearing, the Board of Health shall send a copy of the same public notice by first class mail to all property owners of current record within the proposed Control Zone. A map clearly showing the boundaries of the proposed Control Zone shall be made available for public inspection at Tisbury Town Offices, during regular business hours, at least 21 days prior to the public hearing.

4. Provisions for Control Zones

The Board of Health may adopt for a Control Zone such regulations as are directly required to accomplish the purposes of this regulation, including but not limited to:

a. Additional standards for the siting and design of on-site sewage disposal systems directly related to the protection of public health and water quality;

b. Provisions for the use and management of advanced treatment units and innovative/alternative on-site systems;

c. Standards for connection to off-site disposal systems.

SECTION V. SUPPLEMENTAL STANDARDS FOR THE USE OF ADVANCED OR INNOVATIVE/ALTERNATIVE TREATMENT AND DISPOSAL SYSTEMS

1. Advanced or innovative/alternative sewage treatment and disposal systems typically utilize components that require additional inspection, operation and maintenance requirements to ensure that they are sustainable solutions for individual and cluster systems. As used herein, advanced or innovative/alternative systems shall mean alternative systems, as defined in 310 CMR 15.002.

2. The Disposal System Construction Permit Application for these systems shall indicate the inspection and operation and maintenance requirements for these systems. The Town will require maintenance contracts or operating permits for all advanced treatment or innovative/alternative systems.

3. The Operation and Maintenance of these systems shall be performed by the entity specified in the permit. If the operator changes, a notice identifying the new operator must be filed with the Board of Health.

SECTION VI. MANAGEMENT WITHIN WASTEWATER MANAGEMENT DISTRICTS AND CONTROL ZONES

1. Purpose

It is the purpose of this section to outline the management requirements within the Town of Tisbury Wastewater Management Districts and Control Zones. In addition, details on management requirements of each WMD and CZ can be found in the CWMP.

2. Town-Wide Standards for Operation

It shall be illegal to knowingly cause or allow to be discharged into the system any volatile or inflammable liquids, any toxic or radioactive wastes, paints, or any significant quantities of fats, waxes, solvents, oils, acids, alkalis, or solids or other inappropriate material to the proper functioning of a sewage treatment and disposal system. “Significant” shall mean amounts more than minor amounts incidental to normal residential household and home kitchen operation.

3. Initial Inspection

The purpose of the initial inspection is to establish an inventory and baseline of knowledge about all privately owned sewage treatment and disposal systems in Tisbury. The initial inspection also serves as a guide for subsequent management requirements including frequency of function checks and estimated pumpout intervals.

All privately owned sewage treatment and disposal systems shall be inspected following Title 5 of the State Environmental Code inspection guidelines, within seven years of the adoption of this regulation. Systems that have received a Title 5 inspection within seven years prior to the scheduled inspection date, and have not had repairs, except as a condition of a passing inspection, shall be exempt from this initial inspection requirement.

Scheduling of these inspections shall be coordinated by the Board of Health. An authorized agent of the Board and a party responsible for operation and maintenance of the system shall be present during the inspection.

Innovative/Alternative (I/A) and other mechanized systems often have operation and maintenance requirements specified by the system supplier or designer. Inspections necessitated by the particular type of system shall not be construed as an acceptable alternative to the requirements of this section.

4. Periodic Function Checks and Inspections

All privately owned sewage treatment and disposal systems shall be assessed on a regular basis to ensure their proper functioning and to protect water resources and the public health in accordance with the Risk Classification Schedule.

a. Function Checks – Every system will receive function checks at least as frequently as the schedule defined in the CWMP. The primary purpose of the function check is to determine the need for pumping the septic tank by measuring the accumulation of solids (sludge and scum). At the same time, the inspector shall investigate the tank for soundness and watertightness. In addition, a visual inspection of the disposal area will be made to identify obvious signs of leaching failure.

   The Board of Health has the authority to alter the function check schedule based on the results of the initial inspection or historical trends.

b. Inspections – Based on the schedule defined in the CWMP, but at least every seven years, every system will receive a Title 5 inspection. During this inspection, all components of the system will be assessed for proper functioning and structural integrity. In addition, data relating to the recommended periodic maintenance such as pumpout intervals will be confirmed.

The Board of Health has the authority to alter the periodic inspection schedule based on the results of the initial inspection, historical trends and/or the following risk classification schedule:

Risk Classification Schedule

Risk Class	System Performance Criteria	Inspection Frequency
I	Failed systems that require pumping more frequently than four times per year	annually
II	Chronically failing septic systems that require pumping and cleaning more than twice per year	annually
III	Non-Title V systems	every 2 years
IV	Title V septic systems that have required pumpout, cleaning or repair more frequently than once every three years. All systems in Shore Zone (less then 100 feet from shore). Advanced treatment systems. Innovative/ Alternative systems.	every 3 years
V	Title V septic systems that have required pumpout or cleaning more frequently than once every five years. Systems with variances and/or marginally adequate for current site use.	every 5 years
VI	Title V Septic Systems that have required pumpout or cleaning less frequently than once every five years. Systems adequate for site use.	every 7 years

5. Pumpouts and Interim Maintenance

Through the use of a computerized database and a review of historical trends, the Board of Health will establish a minimum pumpout interval for every system that contains a primary settling septic tank or cesspool. The Board may also establish such other interim maintenance measures as it determines necessary to carry out the purpose of this regulation.

The Board may alter the minimum pumpout and other maintenance intervals based on the results of the initial inspection or function checks.

6. Reporting Requirements

Results of all inspections, function checks, and pumpouts shall be duly recorded and filed at the Board of Health office. For all reporting, only forms authorized by the Board of Health for such use will be acceptable.

Reports for all maintenance tasks shall be submitted to the Board of Health within seven days of the activity, unless otherwise provided by special written condition by the Board.

SECTION VII. FEE STRUCTURE

The Board of Health shall establish and publish a fee schedule relative to the activities required to implement this regulation, including, but not limited to: permit fees, recording fees, enforcement fees, violation or noncompliance fees, and reporting fees.

SECTION VIII. PROPERTY OWNERS LOAN PROGRAM

The Board of Health shall provide for the use of its Betterment Program for the repair, replacement or upgrade of failed sewage disposal systems to carry out the purpose of this regulation. The Betterment Program is described in the document entitled "______________________" dated ____________ on file with the Board of Health.

SECTION IX. ENFORCEMENT

This regulation may be enforced by the Board of Health and its authorized agents. Violation of this regulation shall be subject to a penalty of up to $300.00. Each day during which a violation exists shall be considered a separate offense.

SECTION X. DEFINITIONS

Except where the context requires otherwise, terms used in this regulation shall have the same meaning set forth in Title 5 of the State Environmental Code, 310 CMR 15.00.

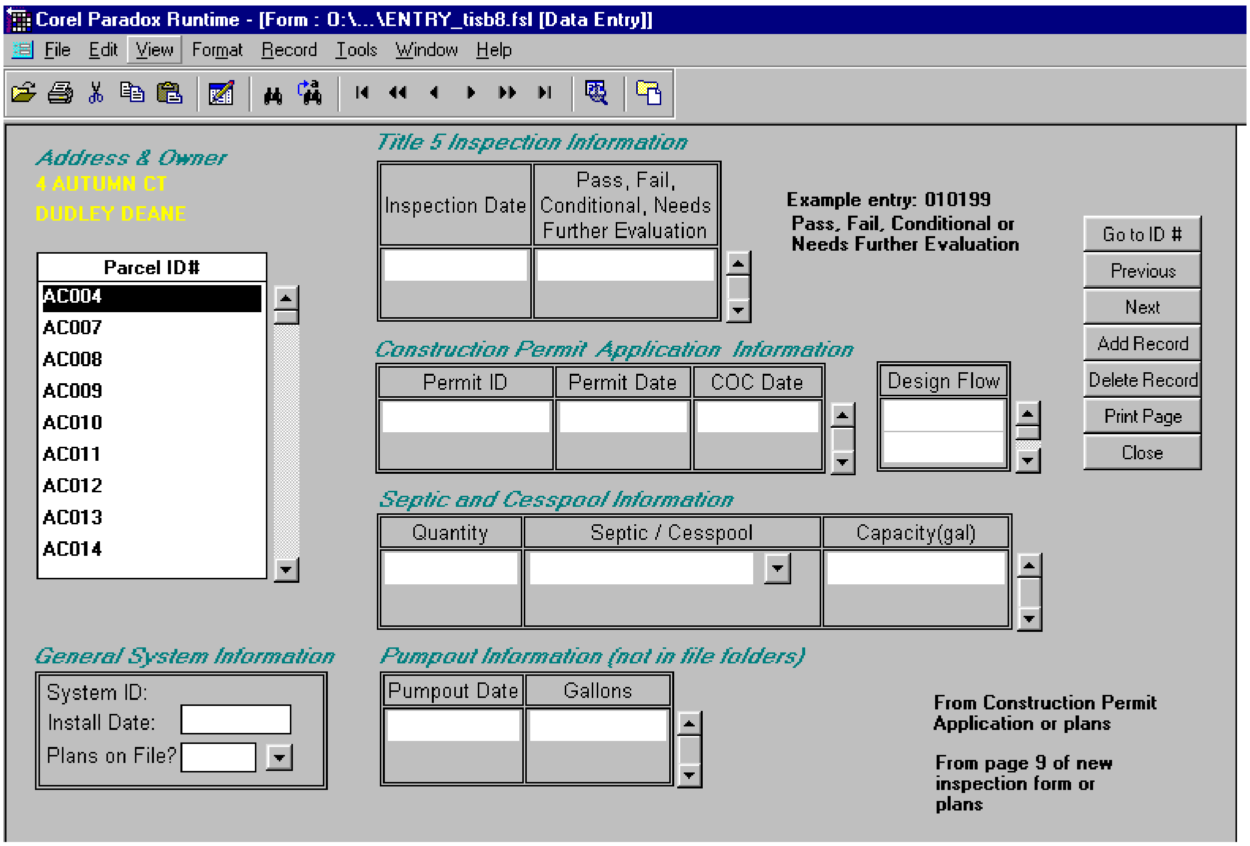
SECTION XI. SEVERABILITY

Should any provision of this regulation be declared to be invalid or inapplicable to any circumstance, that invalidity or inapplicability will not affect the enforceability of any other provision of the regulation or its application to any other circumstance.

SECTION XII. EFFECTIVE DATE

This regulation shall become effective July 1, 2002.

B DATA ENTRY FORM



C ADHERENCE TO QUALITY ASSURANCE PROJECT PLAN

This project was conducted in accordance with an approved Quality Assurance Project Plan (QAPP). This project is considered a “secondary data” project. As indicated in the QAPP, much of the data was received from other organizations such as consultants, local governmental organizations, and state agencies. Data that were gathered from these third parties were archived and cataloged per the QAPP. Data from the Tisbury assessor were used as the basis for the nutrient loading and buildout calculations. It was important that a high level of correlation exist between the assessor parcel ID numbers in the Geographic Information Systems (GIS) parcel polygon IDs. Stone Environmental, Inc. (SEI) has made the Tisbury assessor and its parcel mapping subcontractor Cartographic Associates aware of inconsistencies between the two sets of data. Approximately 10% of the GIS parcel polygons did not have matching IDs in the assessor data; therefore they were not included in the nutrient loading calculations.

The secondary data were used by SEI to develop buildout (growth) scenarios and were used in computer models to develop nutrient load estimates. Any calculations that were developed by SEI staff for buildout calculations were independently confirmed by other staff members. Also, calculations that were embedded in several of the nitrogen loading model spreadsheets were confirmed by SEI staff. In addition, assumptions and inputs to the computer models were discussed with the model developers before they were used and reported in the project. The Valiela model was intended for use as a comparative analysis for the Martha’s Vineyard Commission (MVC) model. When SEI applied the recommended correction factor (82%) to the MVC model results, they were within 3% of the loading predicted by the Valiela model. This confirmation of the correction factor recommended by Valiela suggests that other analyses conducted by the MVC on other Martha’s Vineyard coastal ponds should be revisited, considering that the MVC work is being used to establish growth management and septic design and siting policies.

The researchers believe that appropriate quality control procedures were followed to ensure that the results of this project can be used by the Town of Tisbury in establishing wastewater management policies for the majority of the town that will not be serviced by the community sewer system.

D ADDENDUM TO THE COMMUNITY WASTEWATER MANAGEMENT PLAN

SEI # 00-1164-W

June 12, 2002

Prepared for:

Town of Tisbury
c/o Dennis Luttrell
51 Spring Street
Vineyard Haven, MA 02568
Telephone: 508-696-4200
Fax: 508-693-5876

Prepared by:

Stone Environmental, Inc.
58 East State Street
Montpelier, VT 05601 USA
Phone: 802-229-4541
Fax: 802-229-5417
E-Mail: sei@stone-env.com

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1. Risk Assessment/Risk Management Process

The Town of Tisbury voted in October 1998 to implement a community wastewater management plan (CWMP). This plan was finalized for compatibility with the Vineyard Haven Wastewater Project and described by Stone Environmental, Inc. (SEI, 1999b).

SEI's description of the CWMP described the risk assessment/risk management (RA/RM) process developed by Michael Hoover [Hoover, 1997; SEI, 1999—the original workplan for Tisbury (Appendix 6)]. In August 2000, the town received a grant from the National Decentralized Water Resources Capacity Development Project (NDWRCDP) to conduct the process described. Stone Environmental, Inc. was contracted to assist the town with this effort to better understand the risks posed by on-site wastewater systems to important water resources around town. During the course of the project, the RA/RM process was modified and refined to better meet the needs of the town. Included in this addendum is a revised description of the RA/RM process as it was conducted in Tisbury.

The point of departure for the RA/RM process has been a long-term, continued use of on-site systems in most areas of the town. The major goals for the process have been to:

- Assess the risks by evaluating the environmentally sensitive areas in the town and prioritizing protection of critical resources
- Manage the risks by defining the controls to be established in order to protect water quality and public health

The six steps used in the program included:

1. Perform a risk assessment through delineation of environmentally sensitive areas in the community, including nitrogen-loading studies and growth projections.
2. Develop a risk-based water quality matrix through public workshops and information sessions.
3. Define risk-based wastewater management districts in Tisbury.
4. Install and use a computer database to track on-site system installations, upgrades, and maintenance.
5. Institute a long-term maintenance program for on-site systems. For each system, the program will include a schedule for initial inspection, regularly scheduled follow-up inspections, function checks, and pumpouts.
6. Expand availability of loans to system owners for wastewater treatment system upgrades.

As new data become available, or periodically, the town might wish to go through the process again, in part or in whole, to improve the management of on-site systems. If the town chooses to revisit the process in the future, several steps could be eliminated, such as delineation of water resource areas and determination of soils vulnerability.

2. Assessing the Risks

Broadly, risk assessment in this study consisted of two parts: 1) evaluating the nature and magnitude of the threat to Tisbury's water resources, and 2) assessing which water resources the townspeople considered most valuable and, therefore, most worthy of protection.

The following steps were used to evaluate the nature and magnitude of the threat to Tisbury's water resources:

1. Identify the significant water resources in the town
2. Determine the nature of the threats to these water resources
3. Delineate the watersheds for those water resources
4. Determine whether present or future nutrient loads are likely to degrade the water resources, by
   a. Calculating the current loads and estimating future loads
   b. Calculating the maximum load the resources can assimilate and still maintain the quality that the townspeople desire for them

The first step was to identify the water resources (watersheds and groundwater) in Tisbury. Seven surface watersheds and four aquifers were identified (Table D-1).

Table D-1
Water Resources in Tisbury

Type	Resource
Surface Watersheds	Lagoon Pond
	Lake Tashmoo
	Vineyard Haven Harbor – Inner Harbor
	Vineyard Haven Harbor – Outer Harbor
	Vineyard Sound
	Smith Brook
	Mink Meadows
Groundwater Resources (all in the same aquifer)	Zone 2 Wellhead Protection Area
	Interim Wellhead Protection Area
	Individual wells
	Municipal water supply

Existing water quality data were then evaluated to assess current water quality problems. Many sources of data were found. Tisbury Waterworks monitors groundwater quality at their public drinking water supply wells. The town's Board of Health collects water quality samples at the town's beaches. The Shellfish Commission samples water quality in Lagoon Pond. Tisbury Waterways Association and Martha's Vineyard Regional High School have been sampling water quality in surface waters and coastal ponds. The Martha's Vineyard Commission (MVC), the island's regional planning agency, has performed extensive field studies of the nutrient loading and nutrient limits of several of the island's coastal ponds, including Lagoon Pond in Tisbury. Their study of the nutrient limit of Lake Tashmoo was not complete as of this writing.

These water quality sampling efforts and field studies revealed that nitrogen is the potentially limiting water quality parameter for the coastal ponds. Other types of pollution have been identified—that is, intermittent occurrences of elevated *E. coli* in the water at the inner harbor beaches appear to coincide with elevated stormwater runoff—but this study is primarily concerned with ways to limit nitrogen pollution from on-site wastewater systems.

The next step was to delineate the boundaries of these water resources by defining the areas in town where on-site systems were discharging to groundwater that flows to the community's water resources Figure D-1. In other words, the groundwater flow paths and groundwater divides in the town were identified. The area of groundwater contribution to drinking water supplies was defined using data available from MassGIS on the Zone 2 Wellhead Protection Area (WHPA) for the town's public wells. The watersheds and the areas of groundwater contribution to inland water bodies, Vineyard Haven Harbor, and Vineyard Sound, were delineated using data from a variety of sources and a geographic information system (MVC, 2000, MassGIS; see Figure D-1, Water Resource Areas). The specific methods for delineating each of these areas can be found in Appendix E1.

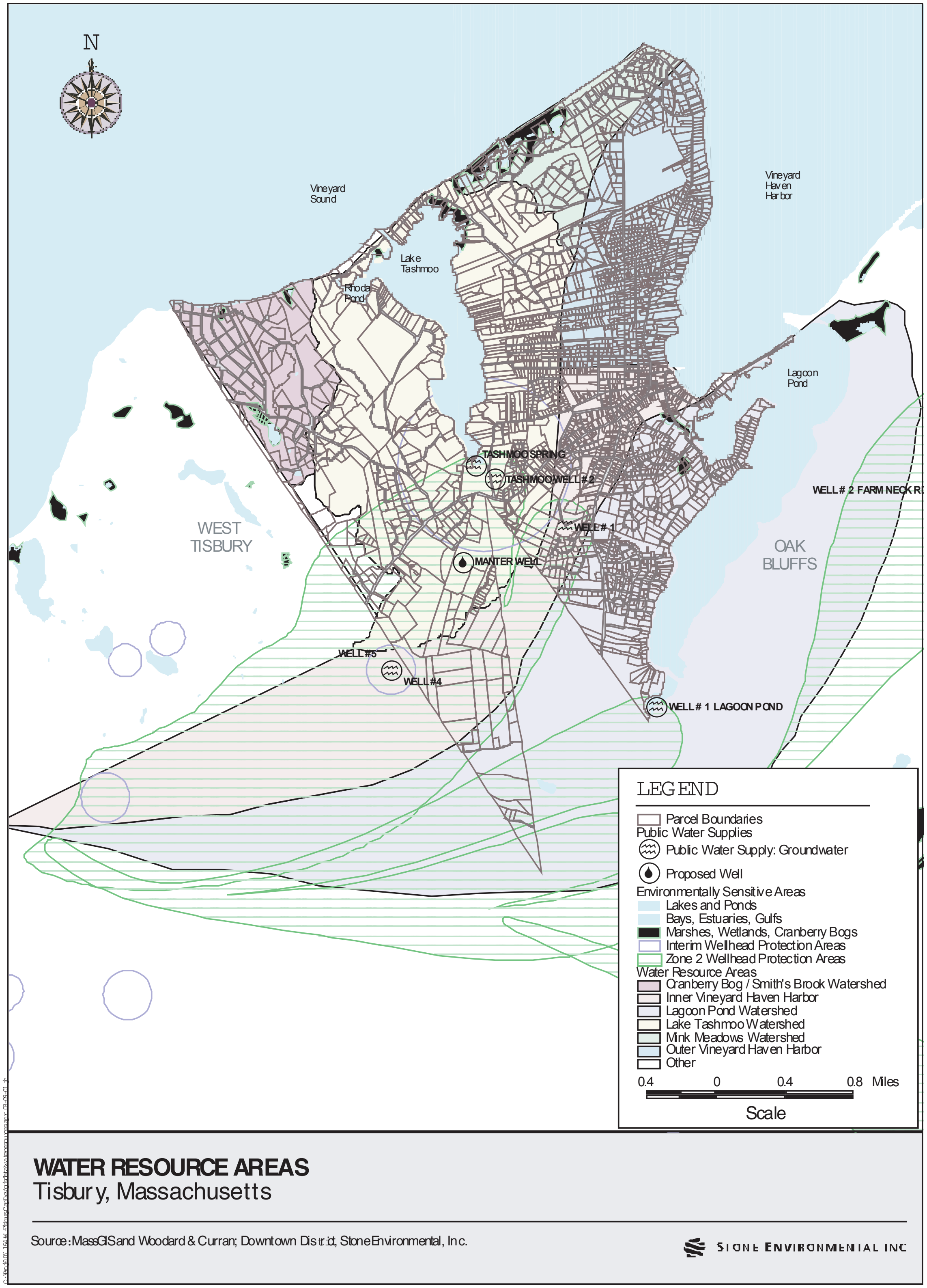


Figure D-1
Water Resource Areas

Once the areas of contribution were established, the nitrogen loads to those water resources were evaluated. The MVC modeled nitrogen loading for Lagoon Pond. Sources that were considered included atmospheric nitrogen, stormwater runoff, lawns, agricultural uses, as well as septic systems (MVC, 2000). SEI used this computer spreadsheet model for estimating the nitrogen loading to Lake Tashmoo. In addition, SEI conducted quality control of the result by using a different model (Valiela, 1997). NLOAD, a nitrogen loading model developed by the Massachusetts Department of Environmental Protection (DEP) was used to evaluate nitrate concentrations in the public drinking water supply wells in an area known as Zone 2. (Massachusetts DEP, 1999). These surface water and groundwater nitrogen-loading analyses were performed for current levels of contribution and three scenarios of future development: low, moderate, and high growth.

Policy recommendations are based on calculated nitrogen load to the watershed and recommended nitrogen-loading limits. The loading limit to groundwater is determined by the 10 mg/l standard for nitrate. The loading limits to surface water are determined based on research done in nearby Buzzards Bay. There, researchers have calculated expected water quality for coastal embayments, given nitrogen loading rates, embayment dimensions, and rates at which the water is flushed (for example, replaced with water from the ocean or the land) (Costa, et al., 1999). Because the embayment dimensions and rates of flushing are relatively constant, then a determination of the nitrogen load gives a prediction of the water quality. Conversely, a policy decision to achieve or maintain a given level of water quality can be translated into a maximum allowable nitrogen load.

For Lagoon Pond, the MVC decided to strive for water quality in the “Outstanding Resource Waters “ class. They found that the nitrogen limit consistent with achieving this water quality is roughly equivalent to the pond's current nitrogen loading (MVC, 2000).

The MVC is quantifying the nitrogen limit in Lake Tashmoo based on new field data. The analysis for the Lake Tashmoo watershed was released as a draft at the end of this project (MVC, 2002). During this project, nitrogen loading in the Lake Tashmoo watershed was calculated for current conditions and under three growth scenarios (SEI, 2001). The draft nitrogen limits are based on the classification of the pond as outstanding resource waters. The nitrogen load from current-, low-, and moderate-growth scenarios are all below the lake's nitrogen limit. However, the loading from the high-growth scenario exceeds the nitrogen limit for outstanding resource waters.

Knowing a water resource's nutrient load and limit is necessary but not sufficient for setting water policy. An important question remains: How valuable is this water resource? Policymakers might choose to extend a high level of protection to a valued resource that is only marginally threatened as a matter of precaution. On the other hand, a highly threatened resource that is little valued might receive little protection.

An important product of the risk-based approach to wastewater management, which incorporates both the hydrological and value-laden sides of the issue, is the groundwater and surface water protection matrix (Table D-2). This matrix ranks the relative value and the vulnerability of each water resource to pollution. These two layers of information form the columns and rows, respectively, of the matrix.

The matrix was constructed through a community-participatory process based on a methodology from Hoover (1997) and Hoover, et al. (1998). The first step was to conduct a needs assessment for the community. The Tisbury CWMP included most of the elements of this needs assessment and served as the basis for initial ranking of water resources in the community's watershed.

Table D-2
Proposed Water Quality Protection Matrix for Wastewater Management

Ranking of Environmental and Water Resource Areas →

Vulnerability to pollution ↓	Drinking Water		Surface Water						
	Public Well Head Protection Areas		Down-town district	Lagoon Pond Watershed	Lake Tashmoo Watershed	Inner Harbor	Mink Meadows	Cranberry Acres/Smith Brook	Outer Harbor
	Zone 1	Zone 2							
High (Control zone)	NDP*	ML1	ML3	ML5	ML5*	ML7	ML7	ML7	ML7
Moderate	NDP*	ML2	ML4	ML6	ML6*	ML8	ML8	ML8	ML8
Considerations Affecting Management Level	DEP requires no development	Citizens expressed need for long-term protection	Area to be served by large cluster system	Physical and modeled indications of nutrient impairment. Productive shellfishery.	Physical signs of impairment from human activities. Shellfishery. Recreational use.	Some indication of beach impairment. Older houses. Recreational use. Well flushed.	Area adjacent to beach with high GW. Marshes not used publicly. Little surrounding residential development.	No indications of impairment. Privately controlled.	Area adjacent to beach with high GW. Generally good soils. Well flushed harbor.

Notes: *NDP - No development permitted
ML - Management Level (see appropriate section of the Community Wastewater Management Plan)
If 50% of a parcel lies in a control zone, it will be subject to that level of management. This designation may change if the initial inspection reveals (or the owner proves) that the disposal area is in an adjoining lower vulnerability control zone.
* Tentative levels pending completion of nitrogen limit work by Martha's Vineyard Commission
GW = Groundwater

Stakeholder involvement is critical for success of decentralized wastewater management programs. The original CWMP was developed with extensive involvement of the Tisbury Wastewater Planning Commission, appointed by the Board of Selectmen. This program was adopted by Town Meeting vote in 1998. To develop the surface water and groundwater protection matrix, the project team consulted with the stakeholders listed in Table D-3, beginning in June 1999.

Table D-3
Stakeholders for Water Resource Management

Town of Tisbury	Board of Selectmen
	Wastewater Planning Committee
	Board of Health
	Harbormaster
	Public Works Department

Table D-3
Stakeholders for Water Resource Management (Cont.)

Town of Tisbury (Cont.)	Conservation Commission
	Planning and Zoning Department
	Shellfish Advisory Committee
	Fish Committee
	Harbor Management Committee
Community Organizations	Tisbury Waterways, Inc.
	Tisbury Water Works
	Lagoon Pond Association
Residents of Tisbury	
Regional Organizations	Martha's Vineyard Commission
	Martha's Vineyard Regional High School
	Martha's Vineyard Land Bank Commission
	Cape and Island Watershed Task Force

Near the end of the risk-based assessment in March 2001, two stakeholder meetings and a community information workshop were held to present the methodology and results of the risk assessment science and to bring the stakeholders into the judgment side of the risk assessment. Daytime meetings with invited representatives of the stakeholder organizations were followed with evening meetings for the public to solicit as wide a range of perspectives, criticism, and ideas as possible. Key outcomes of this process were consensus among the stakeholders that:

1. Protecting the drinking water supply aquifer is highly important
2. The shellfish industry is important to the community

Based on this consensus, the appropriate level of protection will be given to the drinking water aquifer and the waters critical to the shellfish industry.

Once risk assessment was used to establish the value and vulnerability of water resources, the next step was to use risk management to propose appropriate levels of protection for each area.

3. Managing the Risks

The risk-based management approach exercises the greatest control over systems installed in locations that potentially threaten water resources the community highly values. Less control is assigned to those parts of the watershed that are less valued or that are not nearly as susceptible to contamination. However, in all cases, controls will be assigned to protect the health of the users of the on-site system, as well as public health in all parts of the community.

Based on the water resource areas delineation, as discussed above, eight wastewater management districts (WMDs) were proposed. This represents an increased sophistication in management over the three previously defined WMDs in the 1999 Wastewater Management Project (SEI, 1999). The county soil survey was used to estimate depths to seasonally high groundwater in Tisbury (USDA, 1986). Soils in Tisbury show great uniformity; approximately 95% of the town is on sandy soils with a seasonal high groundwater at greater than five feet below ground surface. For this reason, a control zone is being proposed within each wastewater management district only where groundwater is sometimes less than or equal to five feet below the surface, a situation that leads to an increased likelihood of groundwater degradation from on-site systems.

Once the WMDs were delineated according to natural boundaries, the division was modified to respect parcel boundaries, so that each property fell into only one WMD. A parcel was assigned to a WMD if more than 50% of its area drained to a particular water resource area Figure D-2.

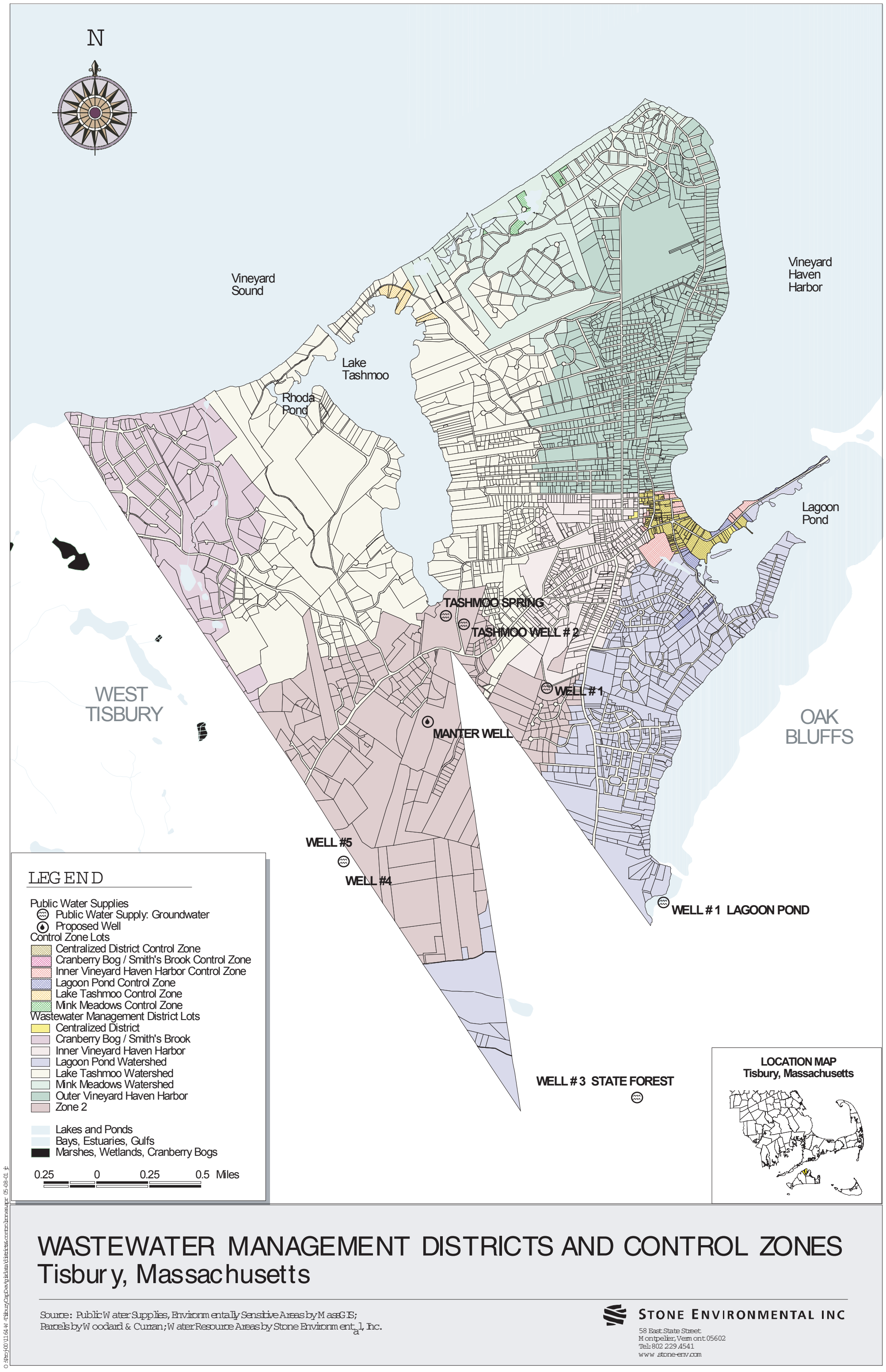


Figure D-2
Wastewater Management Districts and Control Zones

A total of eight possible management levels (ML1 through ML8) were envisioned and one of these was assigned to each of the WMDs and each of the control zones, based on relative risk. Each of these areas corresponds to a cell in the water quality protection matrix, Table D-2. (Note: It is a coincidence that there are both eight wastewater management districts and eight possible management levels). Management activities, determined zone by zone, involve different frequencies of Title 5 inspections (covering everything from the tank to the leach field, plus information on who is using the system) and function checks (covering only watertightness and structural soundness of the tank, plus solids level). At present, there are only two different types of management proposed; ML1–ML4 are identical, as are ML5–ML8. The management details are in Appendix E4.

Management for the control zones in each WMD is, for the time being, the same as management in the rest of the WMD, except that the initial inspection is earlier. The town may decide to introduce more stringent management measures for the control zones, based on new information about water quality and the systems in place. For example, in the Lagoon Pond WMD, where the present nitrogen load is about the same as the nitrogen limit, the town may require advanced treatment in control zones as a way of accommodating growth without exceeding the pond's nitrogen limit (Crites and Tchobanoglous, 1998).

The CWMP was revised to incorporate the matrix, location of control zones, and description of control measures in each district/zone. The revised CWMP was then submitted to the Board of Health and Select Board to obtain approval for the matrix and control measures.

SEI worked with town officials, including the Board of Health's health agent, to finalize the overall management approach and to ensure that the selectmen and the Board of Health have common goals and objectives and a realistic division of responsibilities and duties. The health agent will issue the permits according to existing law and rules, using the guidance and flexibility included in the state-approved CWMP. The Board of Health will coordinate inspection and monitoring of the individual systems. In order to smooth the transition to the new management program, the Board of Health has specified that the initial inspections will be phased in over a seven-year period.

Septage treatment and disposal have been a long-term problem in Tisbury, exacerbated by the recent closing of the town's septage lagoons. Since then, most septage has been freighted by ship to the mainland. Some septage is accepted at the Edgartown Wastewater Treatment Plant. Historically, the Board of Health has issued permits for voluntary pumpouts. Under the CWMP, mandatory pumpouts will be scheduled throughout the year to better manage the volume of septage that must be transported off-island. Eventually, septage will be treated at the proposed Vineyard Haven wastewater treatment facility.

Inspection of the systems will reveal information that will be useful in developing more detailed management requirements. The Board of Health plans to monitor future studies of water resource quality and respond with appropriate measures to modify the management plan.

Town officials are now acutely concerned with addressing the small, centralized systems for wastewater management being installed in downtown Vineyard Haven. As the town moves beyond that project, the CWMP will be revised to assure sustainable wastewater management throughout the town, with adequate protection of all water resources.

4. Staffing and Responsibilities

Decentralized wastewater management can be accomplished within a wide spectrum of management structures. In Tisbury, the Board of Health will maintain responsibility for program administration and rely on local professionals to carry out most of the inspection, operation and maintenance, site evaluation, and design work. The Board of Health staff currently focuses on permitting, reviewing design, tracking pumpouts and inspections, and performing construction inspections. The many additional tasks to be coordinated or performed by the Board of Health will create a demand for additional staff. These tasks include:

- Developing and implementing training programs for local professionals to ensure high quality and consistent design, installation, and maintenance of systems
- Being present during all initial inspections in order to develop a complete inventory of all systems and confirm data entered from historical records
- Managing the database tracking system
  - Developing, producing and sending notifications for inspections, function checks, septic tank pumpouts, and repairs
  - Producing system summary sheets so that data in IWIMS can be confirmed during the initial inspections
  - Entering data as they come in from inspectors and pumpers
  - Tracking system owners' compliance with required management tasks
  - Working with the Tisbury assessor to improve the assessor's data
  - Updating the database periodically with new data from the Tisbury assessor
- Developing and producing reports so that the program may be continuously assessed

On-site wastewater professionals in the community will be contracted by system owners to perform the following tasks:

- Initial and periodic Title 5 inspections (everything from the tank to the drainfield, plus information about who is using the system)
- Function checks (simple checks of sludge and scum levels, septic tank robustness and watertightness, and surface inspection of the drainfield area)
- Site evaluations for upgrades and new systems
- System specification and design for repairs, upgrades, and new systems
- Installation of new systems, repairs, and upgrades
- Septic tank or cesspool pumping

In connection with these tasks, the professionals will be required by the town to submit timely reports and coordinate all permit gathering and field work with the homeowner.

It will be the town's responsibility to oversee the quality of the professionals that are carrying out the daily implementation of the Program. We recommend that the Board of Health make an initial assessment of the qualifications and training needs of local professionals, and then coordinate regular training for site evaluators, designers, inspectors, and pumpers. Training may be performed by hired professionals, town staff, or members of the regulatory community, depending on the needs of the training session. We expect that the town will require that professionals who wish to participate actively in the management program submit verification of training that the town deems necessary.

5. Recommendations

The outcomes of the project include revisions to the CWMP based on the results of the risk-assessment process and presentation of the proposed management approach to the town and public. Actions that the town has taken to maximize protection of water resources include:

- Revised the local "Title 5 On-site System Management Regulation," effective July 1, 2002
- Funded the program with $50,000 to pay for one additional health department employee and public outreach for implementation of this regulation per warrant article approved at April 27, 2002 Town Meeting

Recommended actions items for the town to consider in the future include:

1. Review the program effectiveness on an annual basis. Measures to be evaluated include:
   a. Inspections
      i. Total number of inspections completed
      ii. Percentage of required of inspections completed
      iii. Number of failed inspections
      iv. Percentage of upgrades required by failed inspections completed
      v. Resources required by inspection program
   b. Pumpouts
      i. Total number of pumpouts
      ii. Percentage of required pumpouts completed
      iii. Distribution of pumpouts over the year (by month)
      iv. Resources required by pumpout program
   c. Public Outreach
      i. Description of public outreach program
      ii. Effectiveness of public outreach tools
      iii. Resources required by public outreach program
2. When the Lake Tashmoo nitrogen limit calculations are finalized by the MVC, and the current management program is effectively implemented, revisit the risk management process to determine whether the management levels for Lake Tashmoo and Lagoon Pond watersheds are appropriate.

3. Determine whether nitrogen reduction or other advanced treatment technologies will be required in new and upgraded systems in parcels affecting vulnerable water resources.

4. Refine the nitrogen-loading study to the Zone 2 WHPA when GIS parcel data are available for West Tisbury.

Appendix D1: Delineating Water Resource Areas and Wastewater Management Districts

The risk-based approach required definition of watersheds and groundwater recharge areas in order to develop wastewater management districts. The original wastewater management districts (WMD) were organized around the proposed large cluster service area (WMD1), the existing District of Critical Planning Concern (WMD2) and the rest of town (WMD3). One of the goals of the National Decentralized Water Resources Capacity Development Project (NDWRCDP) in funding this work was to redefine the WMDs based on the environmental sensitivity of water resources. The Town of Tisbury was therefore divided into seven water resources areas (Figure D-1). This resulted in eight wastewater management districts, including the downtown with centralized service.

The extent of the area of the watersheds in Tisbury are difficult to define precisely because the ponds are fed primarily by groundwater. Therefore, the groundwater flow divide better represents the areas where septic systems are contributing contaminants to the surface waters. Groundwater flow data was used where available, supplemented by surface topography where necessary.

Lagoon Pond

The Lagoon Pond watershed was delineated by the Martha's Vineyard Commission (MVC, 2000). This delineation, available from a paper map, was digitized by Stone Environmental, Inc. (SEI).

Lake Tashmoo

The Lake Tashmoo watershed was delineated by SEI based on the United States Geologic Survey (USGS) 7.5-minute series topographic quadrangles for Tisbury, downloaded from the MassGIS website (http://www.state.ma.us/mgis/). These quadrangles were plotted and the watershed boundary was manually delineated. This boundary was quality controlled by SEI and all necessary changes were drawn. This hand-delineated boundary was then digitized on screen. The boundary east of Lake Tashmoo was modified based on a groundwater contour map produced by Earth Tech. These groundwater contours were created based on a number of subsurface borings that were previously conducted in this area (SEI, 1999a). These data were determined to be the most accurate representation of groundwater levels on the east side of the lake. Because there were no groundwater contours available for the west side of the lake, the USGS surface contours were used to define the watershed boundary.

For comparison and quality control purposes, the watershed was then delineated using the Center for Research in Water Resources (CRWR) Watershed Delineator in ArcView(r) (Spatial Analyst and CRWR Vector Extensions). Data from the 1:25,000 USGS Digital Elevation Model (DEM) were downloaded for the Vineyard Haven and Edgartown quadrangles. The DEMs were merged together and then processed using HecPrepro, which is documented at http://www.ce.utexas.edu/prof/maidment/giswr98/ex298/prepro.htm#attributes.

The hand-delineated watershed boundary was then quality controlled by comparing it to the DEM generated boundary. The two watershed boundaries were compared, along with the groundwater contours for the east side of Lake Tashmoo and the town boundaries. The hand-delineated boundary was changed in one section (east of Lake Tashmoo) to more closely resemble the DEM-generated boundary. To be conservative and include as much as possible, the southernmost extent of the hand-delineated watershed was used instead of the DEM-generated boundary. The DEM watershed was approximately 1,666 acres as compared to the hand-delineated watershed, which was 2,091 acres—about a 20% difference. The two boundaries differed near depressions. The hand-delineated boundary avoided these depressions by going around the outside of the depressions where necessary. However, the DEM-generated boundary apparently avoided depressions by delineating to the inside of them. This would account for differences between the two boundaries in several sections of the watershed, notably on the southern end and northeastern corner.

A map showing the DEM-generated boundary and the manually-delineated boundary was then sent to several state and local officials and the MVC for further comments. As a result, the northeast corner of the watershed boundary was modified to exclude several small ponds that are located to the northeast of Lake Tashmoo. These changes based on suggestions by Bill Wilcox of the MVC.

Other Water Resource Areas

All other water resource areas were delineated using surface topography and natural features from the USGS map, groundwater contours from Earth Tech, and boundaries created by previously-delineated watersheds. These include Cranberry Bog/Smith Brook, Mink Meadows, Outer Vineyard Haven Harbor, and Inner Vineyard Haven Harbor.

Wellhead Protection Area

The Zone 2 WHPA was acquired in Arcview GIS format from MassGIS. A single Zone 2 forms the protection area for three wells in Tisbury: the Tashmoo well, the Sanborn well, and the Manter well. The Manter well currently is not in service.

Wastewater Management Districts

The water resource areas define geographical areas, but do not identify which parcels are in each wastewater management district. In order to assign each parcel a district code, SEI used the GIS system to identify those parcels that had at least 50% of their area inside each resource area (Figure D-2). This information was added to the customized septic management database so the Board of Health will be able to prioritize maintenance tasks such as inspections by water resource area.

The following wastewater management districts were created:

- Large cluster service area
- Zone 2 WHPA

- Lagoon Pond
- Lake Tashmoo
- Inner Vineyard Haven Harbor
- Outer Vineyard Haven Harbor
- Mink Meadows
- Cranberry Bog/Smith Brook

Control Zones

Control zones are areas within each wastewater management district that warrant a higher level of management or stricter siting criteria due to the higher vulnerability of the soils in that area. High vulnerability soils are defined as those with a shallow depth to groundwater, extremely coarse texture, or shallow depth to bedrock. Any of these conditions could lead to incomplete treatment of wastewater and inadequate protection of water resources. Specifically, the removal of nitrogen and pathogens could be limited.

In general, the soils in Tisbury are very conducive to wastewater disposal. They tend to be deep, unsaturated sands, which are very effective at accepting wastewater. There are pockets around town, however, with shallow sands, peats, or mucks. These soils are more restrictive for siting septic systems because designs have to account for site limitations. SEI digitized all the soils in Tisbury with a groundwater depth of less than five feet, according to the soil survey for Dukes County (USDA, 1986). Mass GIS is in the process of digitizing the entire soil survey for Dukes County, but the data were not available at this time. Table D1-1 shows the soil series that were included in the high vulnerability category.

Table D1-1
High Vulnerability Soils

Soil Mapping Unit Code	Full Name, Description, and Limitations
Be	Berryland loamy sand, very poorly drained, high water table
Fs	Freetown and Swansea mucks, very poorly drained, high water table
Ke	Kjel loamy coarse sand, seasonally high water table
Pa	Pawcatauck and Matunuck mucky peats, very poorly drained, daily tidal flooding
Pg	Pits, sand and gravel, generally not suitable for development

Table D1-1
High Vulnerability Soils (Cont.)

Soil Mapping Unit Code	Full Name, Description, and Limitations
Ta	Tisbury very fine sandy loam, seasonally high water table
Ur	Urban land, generally paved, would require further investigation

After the high vulnerability soils were digitized, SEI used the GIS system to identify those parcels that had at least 50% of their area within those soils areas. These parcels were also coded in the database as being within a control zone in their respective districts. The wastewater management districts and control zones are displayed on Figure D-2. Also, the districts are included in Table D-2 in relative order of protection priority. Because the majority of Tisbury soils are of moderate vulnerability, most systems will be managed under those guidelines. Only a handful will fall under the stricter criteria of high vulnerability.

The differences among management levels are identified in Appendix E4. Descriptions of the management tasks (inspections and function checks) can be found on pages 21–25 of the town's Wastewater Management Program (SEI, 1999b). The roles and responsibilities necessary to implement this management program are described in Appendix E4 of this addendum. One of the goals of the initial inspections is to confirm the soil conditions on each site. The data from NRCS is considered “planning level” with an expected accuracy down to about three acres. Therefore it is necessary to confirm the site conditions before finalizing the control zones.

Appendix D2: Growth Scenarios

As explained in Appendix E1, one goal of the NDWRCDP in funding this work was to redefine the WMDs based on the environmental sensitivity of water resources. Another goal was to help the town understand the potential environmental impact from septic systems today and into the future. The nitrogen load modeling is described in Appendix E3. One of the inputs to these models is the number of residential and commercial establishments contributing nitrogen to the particular water resource. SEI analyzed the current data and conducted a growth analysis in two of the water resource areas as part of this effort. Because the Lagoon Pond watershed was the focus of earlier work by the MVC (2000), SEI focused on the Lake Tashmoo area and the Zone 2 WHPA.

Lake Tashmoo Watershed Growth Analysis

Three growth trajectories were projected for the Lake Tashmoo watershed, based on the current land use and the zoning regulations for towns within the watershed(Table D2-1, Tisbury and Oak Bluffs Zoning Districts in Lake Tashmoo Watershed). The data for the Lake Tashmoo growth scenarios were compiled from the Tisbury and Oak Bluffs assessor offices.

Table D2-1
Tisbury and Oak Bluffs Zoning Districts in Lake Tashmoo Watershed

TISBURY

- B-2 District:
    i. Minimum lot size for commercial uses = 0 acres (used 0.10 acres in high-growth calculations)
    ii. Minimum lot size for residential uses = 0.23 acres
    iii. Minimum lot size for multi-unit = 0.46 acres
- R-10 District:
    i. Minimum lot size = 0.23 acres
    ii. Single-family dwellings, agriculture, home business, and municipal uses permitted
    iii. Guesthouses permitted if lot is 25% greater than minimum lot size requirement
    iv. Multiple-family dwellings approved by special permit provided the lot is no smaller than the minimum lot size requirement
- R-20 District
    i. Minimum lot size = 0.46 acres
    ii. Permitted uses same as R-10 district
- R-3A District:
    i. Minimum lot size = 3 acres
    ii. No guesthouses permitted
- R-50 District:
    i. Minimum lot size = 1.15 acres
    ii. Permitted uses same as R-10 district

OAK BLUFFS

- R-3 District:
    i. Minimum lot size = 1.38 acres

Initial Assumptions

The primary fields from the assessor's databases used for the analysis were property type class codes and zoning codes. The complete list of property type class codes is available from the Massachusetts Department of Revenue, Division of Local Services.

The following codes were considered unbuildable land: 3800, 7160, 7170, 1320, 3920, and 7180. These codes refer to undevelopable land, golf courses, and agricultural land. Based on discussions with planning committees, we assumed that no conversion of farmland for residential or commercial development would occur. (Farmland is considered a valuable landscape component for the town's tourist industry.) It was also assumed that 10% of the buildable area will be built out as roads for the high-growth scenario, 7% for moderate growth, and 5% for low growth.

Residential Growth

The current number of residential units and commercial units was determined based on the property class codes in the town assessor's data. The data showed number of bedrooms per parcel. We found an average of three bedrooms on parcels with a single family (code 1010), which we assumed was the average for all the parcels. Growth projections were made in terms of residential units, so we converted to residential units by dividing the number of bedrooms on that parcel by three.

In various class codes, some of the parcels had no bedroom data. In that case, they were assigned a number of residential units based on the class code. Those without bedroom data on parcels with codes 0101, 1010, and 1021 received a value of 1 residential unit. Those without bedroom data on parcels with codes 1040, 1060, and 1090 (typically multi-family buildings or multi-building parcels) were assigned 1.333, 0, and 2 residential units, respectively. All other parcels with no bedroom data were determined to be non-residential from the class codes and were therefore not considered in residential growth scenarios. The following codes were considered residential: 0101, 0104, 0109, 1010, 1014, 1021, 1030, 1040, 1090, 1091, 1110, 1211, 1300, 9020, and 9080.

Guesthouses—individual structures for rental to guests—are typical in tourist destination towns like Tisbury and were, therefore, considered potentially significant contributors of wastewater. The number of guesthouses were determined from parcels with the property type class codes 1090 and 1091. According to the Tisbury assessor, these parcels are considered to have guesthouses. The current number of guesthouses was determined to be 44. This number does not include guesthouses in the Oak Bluffs portion of the watershed due to lack of data pertaining to Oak Bluffs parcels. One guesthouse was considered to be one residential unit (equivalent to one single-family dwelling).

For the moderate-growth scenario, it was calculated that there could be 142 additional guesthouses based on the parcels with the class code of 1010 that had an area 25% greater than the minimum lot size required by the Tisbury zoning regulations. Therefore, 142 projected plus the existing 44 guesthouses result in 186 guesthouses in the moderate-growth scenario. Half of the 142 (or 71) plus the 44 existing (resulting in 115) was used for the number of guesthouses in the low-growth scenario. By the nature of the assumptions in the high-growth scenario, there was no difference between the way guesthouses and single-family dwellings were considered.

The MVC previously reported the occupancy rates for seasonal and year-round dwellings in Tisbury and Oak Bluffs (MVC, 2000). In Tisbury, each year-round dwelling was determined to be occupied by 2.33 persons per house for 365 days a year, with an additional 2.33 guests per house for 25 days a year. It was also found that 30% of the dwellings are seasonally occupied by 4.77 persons/house for 75 days a year and by 2.33 persons per house for an additional 30 days of shoulder seasons. This means that there would be 428 person-days per year for seasonal dwellings and 909 person-days per year for year-round dwellings. These numbers vary slightly for Oak Bluffs at 426 person-days per year for seasonal dwellings and 881 person-days per year for year-round dwellings. Assessor information about the Oak Bluffs parcels in the watershed was limited, and it was assumed that there were no guesthouses on these parcels.

Commercial Growth

Because each commercial building would have a different flow rate depending on its use, the various commercial parcels were separated into the following categories based on land use codes:

- Offices: 3400, 0340, 0342 and parcels with codes 9020, 9030, 9050 that also had an assessed building value
- Stores: 3220, 3240, and 3130
- Warehouses: 3160
- Restaurants: 3260
- Outdoor facilities: 3880
- Churches: 9060
- Unknown commercial: 0315, 0316, 0321, 0322, 0326, and 0361

The number of commercial units assumes one building of that commercial type per parcel. In cases where a parcel had two commercial land use codes (that is, a parcel with the land use codes for both an office and a store), it would be counted twice (as containing one office and one store).

Growth Projections for Residential and Commercial Areas

In the high-growth scenario, maximum growth was determined based on minimum lot size requirements for each district; current parcel boundaries were ignored. So for all the buildable land in that district, a future potential number of parcels was determined based on the minimum lot size. This scenario is unlikely, but represents the maximum development possible under the current zoning regulations.

In the moderate-growth scenario, it was assumed that all subdividable parcels will only be subdivided once. It was also assumed that half the vacant parcels in each district would be built on. In the town of Tisbury, it was assumed that vacant parcels in the B-2 district would be built out as commercial properties and vacant parcels in all the other districts would become residential, with a single-family dwelling. Vacant parcels in Oak Bluffs were also assumed to be built out as residential, with single-family dwellings.

In the low-growth scenario, it was assumed that only half of the subdividable parcels will be subdivided once. For the vacant land, it was assumed that one quarter of the vacant parcels in each zone would be built on. Again, vacant parcels in the B-2 district of Tisbury were assumed to become commercial, whereas vacant parcels in all other Tisbury districts, as well as vacant parcels in Oak Bluffs, were assumed to become residential.

The results of the high-, moderate- and low-growth scenarios are summarized in Table D2-2, Summary of Growth Scenarios for Lake Tashmoo Watershed.

Table D2-2
Summary of Growth Scenarios for Lake Tashmoo Watershed

Land Use	Current # Units	High Growth Total # Future Units	Moderate Growth Total # Future Units	Low Growth Total # Future Units
Residential	484.7	1152.5	614.0	549.3
Office	25.0	98.9	43.0	34.0
Store	19.0	112.1	43.5	31.3
Warehouse	10.0	54.1	23.0	18.0
Restaurant	1.0	5.9	2.0	1.5
Outdoor Facilities	1.0	5.9	2.0	1.5
Churches	2.0	4.3	3.0	2.5
Unknown Commercial	23.0	75.3	30.0	26.5

A detailed report on the units in the growth scenarios is in Table D2-4–Table D2-6.

Zone 2 WHPA Growth Analysis

Because Zone 2 includes land in three towns, it was necessary to obtain assessor data and digital parcel data where possible for these towns. Oak Bluffs and Tisbury parcel and assessor data had previously been obtained for the Lake Tashmoo growth analysis, but there was no digital parcel data available for the West Tisbury section of Zone 2. Because this section made up the greatest area of Zone 2 (1,599 acres), it could not be ignored. Therefore, SEI digitized buildings and roads from the digital orthophotos (available from MassGIS). The results of digitizing showed the current number of buildings to be 368, but it is not known whether these buildings are commercial or residential. These were assumed to be residential (single family) because this area is within a rural district of the town.

The current number of residential and commercial units in Tisbury and Oak Bluffs were determined based on the assessor data. However, land use data for some Oak Bluffs parcels were not available from the assessor’s data. In these cases, digital orthophotos (downloaded from MassGIS) or the surrounding Tisbury parcels were used to determine whether the parcels were residential or vacant. All parcels with no assessors data that were considered residential were assigned one residential unit. The number of residential units for parcels (in Tisbury and Oak Bluffs) with assessor data was then calculated by dividing the number of bedrooms by three. This is assuming a 2.33 persons/unit occupancy rate and 3 bedrooms per unit. Those parcels in Tisbury that had residential property type class codes but did not have a number of bedrooms assigned were manually given a number of residential units. One residential unit was assigned to parcels with the following codes: 0101, 0109, 0111, and 0110. Parcels with the code 1040 were given 1.333 residential units and parcels with the codes 1090 were assumed to have two residential units. Parcels with the code 1090 or 1091 were identified as having a guesthouse. The results showed 15 guesthouses.

The DEP model requires that the number of residential units be separated into single-family and multi-family categories. For residential parcels in Tisbury, the following property type class codes were selected for each of these categories:

- Single-family: 0101, 0104, 0109, 0111, 1010, 1090, and 1091
- Multi-family: 9080, 1110, and 1040

All residential parcels in Oak Bluffs were considered single family because the code was 1010.

The commercial parcels in Tisbury were separated into the following commercial types based on the property type class codes:

- Office: 3400, 9030 (with no assessed building value), 0340, and 0342
- Store: 3130 and 3220
- Warehouse: 3160
- Restaurant: 3260
- Truck terminal: 3140
- Church: 9060
- Unknown commercial: 0316, 0317, 0322, 0326, 0332, and 0361

There was only one commercial parcel in Oak Bluffs, which was a warehouse (code 3160). West Tisbury was assumed to have no commercial buildings.

There was no farmland in the Tisbury section of Zone 2, and all vacant lots were identified based on the class code. Parcels with the codes 9020, 9030, or 9050, were investigated to determine if there was an assessed building value. Those with no assessed building value were considered vacant land. All parcels in Oak Bluffs that were not residential or commercial were determined to be vacant. Because parcel and assessor's data were not available for West Tisbury, it was not possible to determine the amount of vacant land. It was assumed that West Tisbury has no vacant land.

The area of the roads within the West Tisbury portion of the study area was determined by assuming that all digitized roads were 50 feet wide, including right of way, by placing a 25-foot buffer on either side of the line coverage created by SEI. The total road area was calculated to be 105 acres. The buildable land in West Tisbury was then calculated by subtracting this road area from the area of Zone 2 within West Tisbury. It was assumed that 10% of the buildable area in each town would be developed as roads in the high-growth scenario.

Growth Projections for Residential and Commercial Areas

A high-growth scenario was projected from GIS parcel data and assessor data. Again, this ignored current parcel boundaries and estimated maximum growth based on the minimum lot size requirements for each district within each town.

In the high-growth scenario, the formula of Buildable area/[(Fraction of Res * MinLotsize for Res) + (Fraction of Comm* MinLotsize for Comm)] resulted in negative numbers for West Tisbury and Oak Bluffs growth. This meant that no further growth could occur. The spreadsheet was modified so that the number of future units equaled the current number of units in these towns. Also, 10% of the buildable area was subtracted for roads. The results of the high-growth scenario were then entered into the DEP model to determine nitrogen load (after growth) in Zone 2.

Table D2-3 summarizes the results of the high-growth scenario. Moderate- and low-growth scenarios were not calculated for the Zone 2 study area.

A detailed report on the units in the high-growth scenarios is in Table D2-7.

Table D2-3
Summary of High-Growth Scenario for Zone 2 WHPA

Land Use	Current # Units	High Growth Total # Future Units
Single-family residential	499.0	701.1
Multi-family residential	28.3	115.0
Commercial	43.0	211.1

Table D2-4
Low-Growth Scenario for Parcels in the Lake Tashmoo Watershed

Residential and Commercial

Town	Zone	Comm Bldg Type	# Subdividable Parcels	# Parcels to be Subdivided*	Current Units	Total Units at Low Growth
Tisbury	B-2	Residential	0	0	18.3	18.3
		Office	11	6	12.0	17.5
		Store	18	9	19.0	28.0
		Warehouse	8	4	9.0	13.0
		Restaurant	1	1	1.0	1.5
		Outdoor facil.	1	1	1.0	1.5
		Church	0	0	0.0	0.0
		Unknown comm	6	3	7.0	10.0
		Totals	45	23	49.0	71.5
Tisbury	R-10	Residential	33	17	204.7	218.8
		Office	3	2	4.0	5.5
		Store	0	0	0.0	0.0
		Warehouse	0	0	0.0	0.0
		Restaurant	0	0	0.0	0.0
		Outdoor facil.	0	0	0.0	0.0
		Church	1	1	1.0	1.5
		Unknown comm	1	1	5.0	5.5
		Totals	5	3	10.0	12.5
Tisbury	R-20	Residential	0	0	0.0	0.0
		Office	0	0	0.0	0.0
		Store	0	0	0.0	0.0
		Warehouse	0	0	0.0	0.0
		Restaurant	0	0	0.0	0.0

Table D2-4
Low-Growth Scenario for Parcels in the Lake Tashmoo Watershed (Cont.)

Residential and Commercial (Cont.)

Town	Zone	Comm Bldg Type	# Subdividable Parcels	# Parcels to be Subdivided*	Current Units	Total Units at Low Growth
Tisbury	R-20	Outdoor facil.	0	0	0.0	0.0
		Church	0	0	0.0	0.0
		Unknown comm	0	0	0.0	0.0
		Totals	0	0	0.0	0.0
Tisbury	R-3A	Residential	10	5	101.3	106.7
		Office	1	1	4.0	4.5
		Store	0	0	0.0	0.0
		Warehouse	2	1	3.0	4.0
		Restaurant	0	0	0.0	0.0
		Outdoor facil.	0	0	0.0	0.0
		Church	0	0	1.0	1.0
		Unknown comm	0	0	6.0	6.0
		Totals	3	2	14.0	15.5
Tisbury	R-50	Residential	28	14	151.0	163.5
		Office	3	2	5.0	6.5
		Store	0	0	0.0	0.0
		Warehouse	0	0	0.0	0.0
		Restaurant	0	0	0.0	0.0
		Outdoor facil.	0	0	0.0	0.0
		Church	0	0	0.0	0.0
		Unknown comm	0	0	5.0	5.0
		Totals	3	2	10.0	11.5

Table D2-4
Low-Growth Scenario for Parcels in the Lake Tashmoo Watershed (Cont.)

Residential and Commercial (Cont.)

Town	Zone	Comm Bldg Type	# Subdividable Parcels	# Parcels to be Subdivided*	Current Units	Total Units at Low Growth
Oak Bluffs	R-3	Residential	3	2	9.3	11.0
		Warehouse	0	0	1.0	1.0
		Totals	0	0	1.0	1.0

Vacant

Town	Zone	Current # Vac Parcels	*Tot Res Units at Low Growth	*Tot Comm Units at Low Growth
Tisbury	B-2	13	0.0	3.3
	R-10	23	5.8	0.0
	R-20	2	0.5	0.0
	R-3A	24	6.0	0.0
	R-50	57	14.3	0.0
Oak Bluffs	R-3	18	4.5	0.0
		Total units	31.0	3.3

* Assumes that vacant parcels in the B-2 district will become commercial and those in the other zones will become residential with a single family dwelling (1 Res Unit)

Note: Assume that 1/4 of the vacant lots will be built-on

Table D2-5
Moderate-Growth Scenario for Parcels in the Lake Tashmoo Watershed

Residential and Commercial

Town	Zone	Comm Bldg Type	# Subdividable Parcels	CurrentU nits	*Total Units at Mod Growth
Tisbury	B-2	Residential	0	18.3	18.3
		Office	11	12.0	23.0
		Store	18	19.0	37.0
		Warehouse	8	9.0	17.0
		Restaurant	1	1.0	2.0
		Outdoor facil.	1	1.0	2.0
		Church	0	0.0	0.0
		Unknown comm	6	7.0	13.0
		Totals	45	49.0	94.0
Tisbury	R-10	Residential	33	204.7	233.0
		Office	3	4.0	7.0
		Store	0	0.0	0.0
		Warehouse	0	0.0	0.0
		Restaurant	0	0.0	0.0
		Outdoor facil.	0	0.0	0.0
		Church	1	1.0	2.0
		Unknown comm	1	5.0	6.0
		Totals	5	10.0	15.0
Tisbury	R-20	Residential	0	0.0	0.0
		Office	0	0.0	0.0
		Store	0	0.0	0.0
		Warehouse	0	0.0	0.0

Table D2-5
Moderate-Growth Scenario for Parcels in the Lake Tashmoo Watershed (Cont.)

Residential and Commercial (Cont.)

Town	Zone	Comm Bldg Type	# Subdividable Parcels	CurrentU nits	*Total Units at Mod Growth
Tisbury	R-20	Restaurant	0	0.0	0.0
		Outdoor facil.	0	0.0	0.0
		Church	0	0.0	0.0
		Unknown comm	0	0.0	0.0
		Totals	0	0.0	0.0
Tisbury	R-3A	Residential	10	101.3	112.0
		Office	1	4.0	5.0
		Store	0	0.0	0.0
		Warehouse	2	3.0	5.0
		Restaurant	0	0.0	0.0
		Outdoor facil.	0	0.0	0.0
		Church	0	1.0	1.0
		Unknown comm	0	6.0	6.0
		Totals	3	14.0	17.0
Tisbury	R-50	Residential	28	151.0	176.0
		Office	3	5.0	8.0
		Store	0	0.0	0.0
		Warehouse	0	0.0	0.0
		Restaurant	0	0.0	0.0
		Outdoor facil.	0	0.0	0.0
		Church	0	0.0	0.0
		Unknown comm	0	5.0	5.0
		Totals	3	10.0	13.0

Table D2-5
Moderate-Growth Scenario for Parcels in the Lake Tashmoo Watershed (Cont.)

Residential and Commercial (Cont.)

Town	Zone	Comm Bldg Type	# Subdividable Parcels	CurrentUnits	*Total Units at Mod Growth
Oak Bluffs	R-3	Residential	3	9.3	12.7
		Warehouse	0	1.0	1.0
		Totals	0	1.0	1.0

* Assumes lots that can be subdivided can only be subdivided once

Multiply the current # bedrooms by two on lots that are subdividable based on minimum lot size, then recalculate the number of units for each parcel by dividing that number by three. All unsubdividable lots are assumed to maintain current number of bedrooms.

Vacant

Town	Zone	Current # Vac Parcels	*Total Res Units at Mod Growth	*Total Comm Units at Mod Growth
Tisbury	B-2	13	0.0	6.5
	R-10	23	11.5	0.0
	R-20	2	1.0	0.0
	R-3A	24	12.0	0.0
	R-50	57	28.5	0.0
Oak Bluffs	R-3	18	9.0	0.0
		Total units	62.0	6.5

* Assumes that vacant parcels in the B-2 district will become commercial and those in the other zones will become residential with a single family dwelling (1 Res Unit)

Note: For moderate growth, assume that half the vacant parcels will be built on

Table D2-6
High-Growth Scenario for Parcels in the Lake Tashmoo Watershed

			Existing				*Future*	
Town	**Zoning District**	**Landuse**	**Current # of Units**	**Fraction of Total Units**	**Buildable Land (acres)**	**Min Lot Size (ac/struct)**	**Additional Units**	**Total Units**
Tisbury	B-2	Residential	18.3	27.2%	na	0.23	89.9	108.2
		Office	12.0	17.8%	na	0.10	58.8	70.8
		Store	19.0	28.2%	na	0.10	93.1	112.1
		Warehouse	9.0	13.4%	na	0.10	44.1	53.1
		Restaurant	1.0	1.5%	na	0.10	4.9	5.9
		Outdoor facil.	1.0	1.5%	na	0.10	4.9	5.9
		Church	0.0	0.0%	na	0.10	0.0	0.0
		Unknown comm	7.0	10.4%	na	0.10	34.3	41.3
		Totals	67.3	100.0%	53.8	na	330.1	397.4
Tisbury	R-10	Residential	204.7	95.3%	na	0.23	331.8	536.5
		Office	4.0	1.9%	na	0.23	6.5	10.5
		Store	0.0	0.0%	na	0.23	0.0	0.0
		Warehouse	0.0	0.0%	na	0.23	0.0	0.0
		Restaurant	0.0	0.0%	na	0.23	0.0	0.0
		Outdoor facil.	0.0	0.0%	na	0.23	0.0	0.0
		Church	1.0	0.5%	na	0.23	1.6	2.6
		Unknown comm	5.0	2.3%	na	0.23	8.1	13.1
		Totals	214.7	100.0%	129.4	na	348.1	562.7
Tisbury	R-20	Residential	0.0	0.0%	na	0.46	0.0	0.0
		Office	0.0	0.0%	na	0.46	0.0	0.0
		Store	0.0	0.0%	na	0.46	0.0	0.0
		Warehouse	0.0	0.0%	na	0.46	0.0	0.0
		Restaurant	0.0	0.0%	na	0.46	0.0	0.0

Table D2-6
High-Growth Scenario for Parcels in the Lake Tashmoo Watershed (Cont.)

			Existing				*Future*	
Town	**Zoning District**	**Landuse**	**Current # of Units**	**Fraction of Total Units**	**Buildable Land (acres)**	**Min Lot Size (ac/struct)**	**Additional Units**	**Total Units**
Tisbury	R-20	Outdoor facil.	0.0	0.0%	na	0.46	0.0	0.0
		Church	0.0	0.0%	na	0.46	0.0	0.0
		Unknown comm	0.0	0.0%	na	0.46	0.0	0.0
		Totals	0.0	0.0%	16.7	na	0.0	0.0
Tisbury	R-3A	Residential	101.3	90.2%	na	3.00	66.7	168.1
		Office	4.0	3.6%	na	3.00	2.6	6.6
		Store	0.0	0.0%	na	3.00	0.0	0.0
		Warehouse	0.0	0.0%	na	3.00	0.0	0.0
		Restaurant	0.0	0.0%	na	3.00	0.0	0.0
		Outdoor facil.	0.0	0.0%	na	3.00	0.0	0.0
		Church	1.0	0.9%	na	3.00	0.7	1.7
		Unknown comm	6.0	5.3%	na	3.00	4.0	10.0
		Totals	112.3	100.0%	558.9	na	74.0	186.3
Tisbury	R-50	Residential	151.0	93.8%	na	1.15	179.3	330.3
		Office	5.0	3.1%	na	1.15	5.9	10.9
		Store	0.0	0.0%	na	1.15	0.0	0.0
		Warehouse	0.0	0.0%	na	1.15	0.0	0.0
		Restaurant	0.0	0.0%	na	1.15	0.0	0.0
		Outdoor facil.	0.0	0.0%	na	1.15	0.0	0.0
		Church	0.0	0.0%	na	1.15	0.0	0.0
		Unknown comm	5.0	3.1%	na	1.15	5.9	10.9
		Totals	161.0	100.0%	405.0	na	191.2	352.2

Table D2-6
High-Growth Scenario for Parcels in the Lake Tashmoo Watershed (Cont.)

			Existing				*Future*	
Town	**Zoning District**	**Landuse**	**Current # of Units**	**Fraction of Total Units**	**Buildable Land (acres)**	**Min Lot Size (ac/struct)**	**Additional Units**	**Total Units**
Oak Bluffs	R-3	Residential	9.3	90.3%	na	1.38	0.0	9.3
		Warehouse	1.0	9.7%	na	1.38	0.0	1.0
		Totals	10.3	100.0%	31.3	na	0.0	10.3

Assumed minimum lot size of 0.1 acres for commercial use in the B-2 district based on building size of 0.04 acres

na = not applicable

Table D2-7
High-Growth Scenario for the Zone 2 WHPA: Tashmoo, Sandborn, and Manter Wells

			Existing				*Future*	
Town	**Zoning District**	**Landuse**	**Current # of units**	**Fraction of Total units**	**Buildable Land (acres)**	**Min Lot Size (ac/struct)**	**Additional Units**	**Total Units**
Tisbury	B-2	Single-family	0.0	0.0%	na	0.23	0.0	0.0
		Multi-family	9.0	32.1%	na	0.23	60.5	69.5
		Office	5.0	17.9%	na	0.10	33.6	38.6
		Store	8.0	28.6%	na	0.10	53.8	61.8
		Warehouse	4.0	14.3%	na	0.10	26.9	30.9
		Restaurant	1.0	3.6%	na	0.10	6.7	7.7
		Truck terminal	0.0	0.0%	na	0.10	0.0	0.0
		Church	0.0	0.0%	na	0.10	0.0	0.0
		Unknown comm	1.0	3.6%	na	0.10	6.7	7.7
		Totals	28.0	100.0%	30.7	na	188.2	216.2

Table D2-7
High-Growth Scenario for the Zone 2 WHPA: Tashmoo, Sandborn, and Manter Wells (Cont.)

			Existing				*Future*	
Town	**Zoning District**	**Landuse**	**Current # of units**	**Fraction of Total units**	**Buildable Land (acres)**	**Min Lot Size (ac/struct)**	**Additional Units**	**Total Units**
Tisbury	R-10	Single-family	3.7	78.6%	na	0.23	30.7	34.4
		Multi-family	0.0	0.0%	na	0.23	0.0	0.0
		Office	1.0	21.4%	na	0.23	8.4	9.4
		Store	0.0	0.0%	na	0.23	0.0	0.0
		Warehouse	0.0	0.0%	na	0.23	0.0	0.0
		Restaurant	0.0	0.0%	na	0.23	0.0	0.0
		Truck terminal	0.0	0.0%	na	0.23	0.0	0.0
		Church	0.0	0.0%	na	0.23	0.0	0.0
		Unknown comm	0.0	0.0%	na	0.23	0.0	0.0
		Totals	4.7	100.0%	10.1	na	39.1	43.7
Tisbury	R-20	Single-family	44.0	68.8%	na	0.46	53.0	97.0
		Multi-family	12.0	18.7%	na	0.46	14.5	26.5
		Office	0.0	0.0%	na	0.46	0.0	0.0
		Store	0.0	0.0%	na	0.46	0.0	0.0
		Warehouse	0.0	0.0%	na	0.46	0.0	0.0
		Restaurant	0.0	0.0%	na	0.46	0.0	0.0
		Truck terminal	1.0	1.6%	na	0.46	1.2	2.2
		Church	0.0	0.0%	na	0.46	0.0	0.0
		Unknown comm	7.0	10.9%	na	0.46	8.4	15.4
		Totals	64.0	100.0%	64.9	na	77.1	141.1

Table D2-7
High-Growth Scenario for the Zone 2 WHPA: Tashmoo, Sandborn, and Manter Wells (Cont.)

Town	Zoning District	Landuse	Existing: Current # of units	Existing: Fraction of Total units	Existing: Buildable Land (acres)	Existing: Min Lot Size (ac/struct)	Future: Additional Units	Future: Total Units
Tisbury	R-3A	Single-family	42.3	75.6%	na	3.00	63.2	105.6
		Multi-family	4.7	8.3%	na	3.00	7.0	11.6
		Office	2.0	3.6%	na	3.00	3.0	5.0
		Store	0.0	0.0%	na	3.00	0.0	0.0
		Warehouse	0.0	0.0%	na	3.00	0.0	0.0
		Restaurant	0.0	0.0%	na	3.00	0.0	0.0
		Truck terminal	0.0	0.0%	na	3.00	0.0	0.0
		Church	1.0	1.8%	na	3.00	1.5	2.5
		Unknown comm	6.0	10.7%	na	3.00	9.0	15.0
		Totals	56.0	100.0%	418.9	na	83.6	139.6
Tisbury	R-50	Single-family	30.7	80.0%	na	1.15	55.1	85.8
		Multi-family	2.7	7.0%	na	1.15	4.8	7.5
		Office	2.0	5.2%	na	1.15	3.6	5.6
		Store	0.0	0.0%	na	1.15	0.0	0.0
		Warehouse	0.0	0.0%	na	1.15	0.0	0.0
		Restaurant	0.0	0.0%	na	1.15	0.0	0.0
		Truck terminal	0.0	0.0%	na	1.15	0.0	0.0
		Church	0.0	0.0%	na	1.15	0.0	0.0
		Unknown comm	3.0	7.8%	na	1.15	5.4	8.4
		Totals	38.3	100.0%	123.3	na	68.9	107.2

Table D2-7
High Growth Scenario for the Zone 2 WHPA: Tashmoo, Sandborn, and Manter Wells (Cont.)

			Existing				*Future*	
Town	**Zoning District**	**Landuse**	**Current # of Units**	**Fraction of Total Units**	**Buildable Land (acres)**	**Min Lot Size (ac/struct)**	**Additional Units**	**Total Units**
Oak Bluffs	R-3	Single-family	10.3	91.2%	na	1.38	0.0	10.3
		Multi-family	0.0	0.0%	na	1.38	0.0	0.0
		Warehouse	1.0	8.8%	na	1.38	0.0	1.0
		Totals	11.3	100.0%	104.9	na	0.0	11.3
West Tisbury	RU	Single-family	368.0	100.0%	na	3.00	0.0	368.0
		Totals	368.0	100.0%	1344.3	na	0.0	368.0

For commercial use in Tisbury's B-2 district, assume minimum lot size of 0.1 acres because assumed building size is 0.04 acres

na = not applicable

Assumes all area in West Tisbury is currently residential

Buildable area in West Tisbury determined by subtracting the road area from the entire area of the Zone 2 in West Tisbury

Appendix D3: Nitrogen Load Modeling

In coastal environments, nitrogen is often the limiting nutrient for algae growth. Excessive nitrogen input can lead rapidly to algae growth, which lowers the available oxygen and inhibits plant and animal growth in the water body. It is therefore important to understand where the nitrogen comes from and what ability the water body has to absorb or buffer that input.

Two nutrient loading models were considered for determining nitrogen loads into Lake Tashmoo: the MVC model (MVC, 2000) and the Valiela model (Valiela, et al., 1997). Both of these approaches use Excel spreadsheets developed to model nitrogen loading to shallow estuaries. A third model, NLOAD, was used for the Zone 2 analysis, because it is more appropriate for modeling impacts at a single extraction point, such as a municipal well. NLOAD is available from the Massachusetts DEP.

The modeling was conducted for current conditions and three growth scenarios in the Lake Tashmoo watershed. An additional study was being conducted by the MVC at the time of this writing to establish the nitrogen limit to the lake. When the results are available from that work, it would be appropriate for the town to revisit the recommendations in this report for this wastewater management district.

In the Zone 2 WHPA, the modeling was conducted for current conditions and a high-growth scenario. This gave an indication of whether the maximum contaminant level for nitrogen would be exceeded based on the most extreme circumstances. It should be noted, however, that because of a lack of available data for the West Tisbury area, it would be prudent to run the analysis again when more data are available.

Nitrogen Load Estimates for the Lake Tashmoo Watershed

MVC Model

This nutrient loading model determines nitrogen load to a surface water body, based on the following categories of inputs:

- Residential wastewater
- Commercial wastewater
- Rainfall and runoff
- Lawn fertilizing
- Agriculture, forestry, and recreational uses

To develop these inputs, SEI analyzed available GIS and assessor data.

Residential Wastewater

Wastewater is typically one of the larger contributors of nitrogen to water. In Tisbury, most of the wastewater comes from residences, which tend to have low- to moderate-strength wastewater, treated in on-site systems.

The per capita nitrogen load for Lake Tashmoo was assumed to be the same as that of Lagoon Pond (MVC, 2000). This was 0.0062 kg N/person/day, calculated from 35 mg/l nitrogen and 48 gal/person/day.

The results of the residential wastewater load for parcels in the Lake Tashmoo watershed were as follows:

- Existing 2,500 kg N/yr
- High growth 5,500 kg N/yr
- Moderate growth 3,800 kg N/yr
- Low growth 3,100 kg N/yr

Commercial Wastewater

As described above, the commercial land use types were separated in each zone, so that a different flow rate could be assigned to each. According to Title 5, design flows for offices and stores are based on building area, but building area was not recorded at the assessor's office. Therefore, building areas for offices and stores were calculated as the median of the building sizes for offices and stores in the Lagoon Pond watershed. Only those buildings in Vineyard Haven were used in the calculation of the median. The resulting median office building size was 1,914 sq ft and the median store size was 2,293 sq ft. These building sizes were verified by the Town of Tisbury as being probable building sizes for offices and stores in Tisbury.

Flow rates for offices and stores were calculated, based on Title 5, at 0.075 gallons per day per square foot of building (gpd/sq ft bldg) for offices and 0.05 gpd/sq ft bldg for stores. For warehouses, the flow rate was based on 15 gpd per person and 2 persons per warehouse. Flow rate for restaurants was based on 35 gpd per seat and the rate for churches was assumed to be 100 gpd per church, based on the figures the MVC used in a study of Tisbury Great Pond (MVC, 2000). Where the specific use of a commercial building was not known, the average rate from stores and warehouses (72 gpd per building) was used to estimate flow rates.

In the moderate- and low-growth scenarios, that vacant land in the B-2 district that was assumed to be converted to commercial was assigned the same flow rate as stores.

The following list shows the nitrogen load from commercial properties for each of the growth scenarios using 35 mg/l as the nitrogen concentration:

- Existing 510 kg N/yr
- High-growth 2,400 kg N/yr

- Moderate-growth 950 kg N/yr
- Low-growth 740 kg N/yr

Rainfall and Runoff

The amount of nitrogen in rain and snowfall was determined to be 13.9 kg/ha after discussions with the MVC (2001). Given that the area of Lake Tashmoo is 108.3 ha, the total nitrogen from rainfall directly on the pond surface was calculated to be 1510 kg N/yr. This number was assumed to remain constant for all growth scenarios.

The average annual precipitation for Tisbury was determined to be 46.9 inches per year based on discussions with the MVC (2001). The amount of nitrate in rainfall discharged through groundwater was 0.05 mg/l (MVC, 2000). Using the non-paved surface in the watershed, the current amount of nitrogen from groundwater recharge was calculated to be 360 kg N/yr. For the high-, moderate-, and low-growth scenarios, this was determined to be 330, 340, and 350 kg respectively. Numbers vary slightly due to the reduction of land area devoted to roads in each scenario: 10% for high, 7% for moderate, and 5% for low.

The amount of nitrate in rainfall discharged through runoff was 1.5 mg/l (MVC, 2000). Using the paved surface in the watershed, the current amount of nitrogen from runoff was determined to be 560 kg N/yr. After growth, this number was expected to increase to
620 kg N/yr for high growth, 600 kg N/yr for moderate growth, and 590 kg N/yr for low growth.

Therefore the total nitrogen through rain and runoff was estimated as:

- Existing 2,400 kg N/yr
- High-growth 2,500 kg N/yr
- Moderate-growth 2,400 kg N/yr
- Low-growth 2,400 kg N/yr

Lawns

Based on a GIS analysis, the total area of all residential parcels in the watershed was determined to be 650.5 acres. It was assumed that 5% of this total area would be lawns. A fertilizer application rate of 1.5 lb/1,000 sq ft/yr was used in determining load from lawns. This number was averaged from the rates used by the MVC in the Lagoon Pond report (2000). A percent leaching loss of 25% was also used in this case, as used by the MVC.

The total nitrogen load from lawns could be calculated by multiplying the number of residential units by the lawn size per unit by the fertilizer application rate by the percent loss due to leaching.

The resulting list shows the total nitrogen load from lawns for all growth projections.

- Existing 240 kg N/yr
- High-growth 570 kg N/yr
- Moderate-growth 300 kg N/yr
- Low-growth 270 kg N/yr

Agriculture, Forestry, and Recreational Land

All farmland, forested area, and golf course area were considered unbuildable for this study. This accounts for only 81 acres of land in the entire Lake Tashmoo watershed. Based on property type class codes, the farmland was divided into four main categories: Golf course, tillable forage, productive woodlot, and pasture. The fertilizer application rate used for the golf course area was 171 kg/ha/yr , the default value for the Valiela (1997) model. It was assumed that the loss due to leaching would be equal to 25% (the same as lawns). Tillable forage and pasture were given the same fertilizer rates and leaching loss values based on conversations with the MVC (2001). This rate was 18 kg/acre/yr, with a leaching loss of 33%. The productive woodlot was assumed to have no fertilizer applied and no leaching loss.

The total nitrogen load for agriculture land use in the watershed was calculated as 630 kg N/yr. This would remain constant for all growth scenarios.

Summary of Results From the MVC Model

The following list summarizes the total nitrogen load in the Lake Tashmoo watershed at present and in three different growth projections:

- Existing 6,300 kg/yr
- Low-growth 7,200 kg/yr
- Moderate-growth 8,100 kg/yr
- High-growth 12,000 kg/yr

More detailed information about these scenarios is found in Table D3-1–Table D3-7.

Valiela Model

The reason for running this model was to compare two approaches to the same question. As SEI progressed in this effort, it became apparent that the two approaches had some significant differences, both on inputs and calculation methods. These differences are documented in a paper by Jennifer Bowen (2001). Nonetheless, the model was run for current conditions in the Lake Tashmoo watershed.

Default values in the Valiela model were changed to more closely match input values used in the MVC model. This would allow for better comparisons to be made between the models. The following changes were made after a discussion with Jennifer Bowen, a colleague of the model developer Ivan Valiela (Bowen, 2001):

- Changed “lawn size” to 0.03 ha/house instead of 0.05 ha. Lawn size is the average area of grass on a parcel.
- Changed “precip” to 1191 mm from 1130 mm. Precip is the total rain and snowfall for the year.
- Changed “fert to lawn” to 73.24 kg/ha/yr from 122.33 kg/ha/yr. Fert to lawn is the average amount of fertilizer applied to grassed areas.
- Changed “other” to 44.48 kg/ha/yr from 136.0 kg/ha/yr (this number was used for agricultural uses other than cranberries)

The results of this model were significantly different from the MVC model. At current development conditions, the Valiela model estimated the nitrogen load at about 3,500 kg/yr, while the estimate of 6,300 kg/yr from the MVC model was 80% higher. It was beyond the scope of this project to investigate all the reasons for the difference. Based on a calibration of many models on a single watershed followed by sampling, Bowen and Valiela believe their model more accurately represents reality (Bowen, 2001). They suggest a correction factor of -43% be applied to the MVC model to make the results comparable. If this correction factor was applied, the resulting load from the MVC model would be 3600 kg/yr, only 3% higher than the Valiela model gives.

General Conclusions

The total nitrogen load to the Lake Tashmoo watershed based on the existing land use is approximately 3,500 to 6,300 kg/yr. According to the MVC model, almost half (3,000 kg) is from residential and commercial wastewater. This is substantially less than the load estimated in the Lagoon Pond watershed (17,000 kg/yr). This result would be expected because of the substantial commercial and residential development in the Lagoon Pond area. The preliminary nitrogen limit has been released as a draft for public comment by the MVC: 9,119 kg N/yr for outstanding resource waters. The nitrogen load from current, low- and moderate-growth scenarios are all below the pond's preliminary nitrogen limit. However, the loading from the high-growth scenario exceeds the preliminary nitrogen limit. There is subjective information from local interest groups that the lake is subject to transformative processes, such as sedimentation, damage to bottoms from dragging boat anchorlines, and docks and other shoreline features. Whether or not nitrogen has adversely affected the lake is not known.

An eelgrass mapping project was conducted from 1995–1996 (MVC, 1997). At that time, the eelgrass was considered healthy and generally abundant, except in areas that were subject to heavy boat traffic. Eelgrass is considered an indicator species that will react quickly to an external stress such as elevated nitrogen levels. One recommendation of the report was to determine the tidal flushing of the pond and prepare an estimate of the pond's nutrient loading limits and nutrient load from human activities in the watershed. In this project, we have estimated the load. At the time of this writing, the limit determination was underway by the MVC.

Nitrogen Load Estimates for the Zone 2 WHPA

The DEP NLOAD was used to determine nitrogen load in the Zone 2 WHPA (Figure D3-1 DEP NLOAD Model Results). This Zone 2 area includes the Tashmoo, Sanborn, and Manter wells and extends into Tisbury, Oak Bluffs, and West Tisbury.

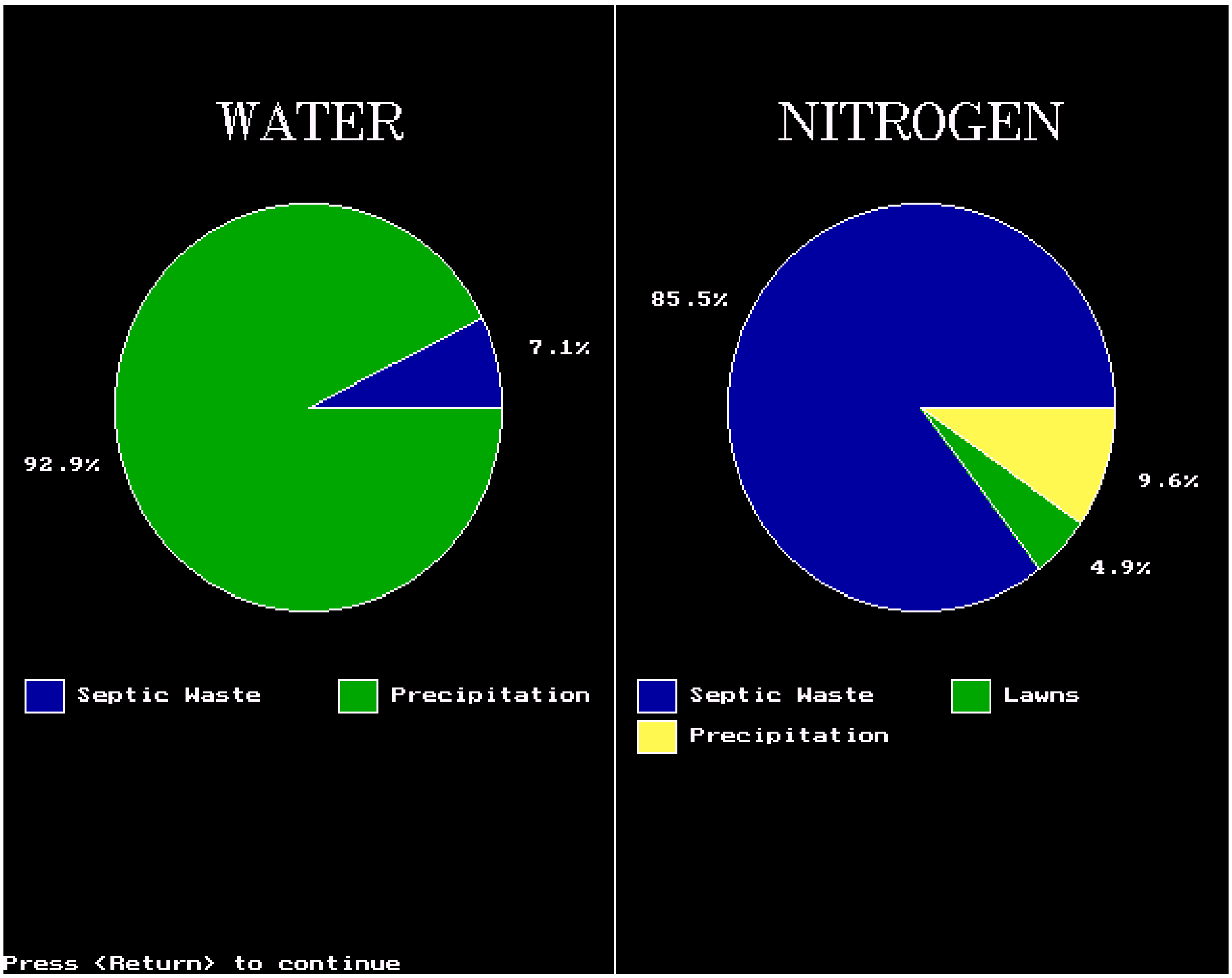


Figure D3-1
DEP NLOAD Model Results: Sources of Water and Nitrogen to Groundwater in the High-Growth Scenario for the Zone 2 WHPA

DEP NLOAD

This model is not intended to be used for regulatory purposes, but rather to give an indication to the user of the potential impact to the water supply. It is primarily a planning tool and a way to determine whether further, detailed investigation is warranted.

Residential

The current numbers of single-family and multi-family houses were used as input to the DEP model. The average occupancy rate used was 2.33 persons per unit, with the amount of nitrogen waste per person at 5.9 lb/person/year (the default value in the model). The lawn area used was 3,000 sq ft (as previously calculated in the Lake Tashmoo nutrient loading analysis). The amount of lawn fertilizer used was 1.5 lb N/1,000 sq ft/year, with a leaching rate of 25%. Again, this was equivalent to numbers used in the Lake Tashmoo nutrient loading analysis.

Commercial

Based on a GIS analysis, the total land area under commercial development was determined to be 95 acres. Tisbury Waterworks supplied the number of gallons per year of water usage for commercial parcels within the Tisbury portion of the Zone 2 study area. The average usage for these parcels was calculated to be 231 gal/day. With 43 commercial units in Zone 2, this translated into 9,930 gal/day (used as input into the DEP model).

Agriculture and Other Nitrogen Sources

There was no farmland found in the Tisbury or Oak Bluffs portion of Zone 2. It was assumed that there was also no farmland in West Tisbury. Therefore, no inputs were necessary in the corresponding section of the DEP model.

Hydrologic Data

The total area of Zone 2 is 2521 acres. The total DEP-approved pumping rate is 3.26 million gallons/day based on the pumping rates for the Tashmoo well (708,480 gpd), the Sanborn well (826,560 gpd), and the Manter well (1.728 mgd). Model default values of 0.05 mg/l and 0.3 mg/l were used for surface and precipitation nitrogen concentrations, respectively.

Future Development

The number of single-family residential houses was 701, based on the results of the high-growth analysis. The number of multi-family units was 115. The high-growth scenario suggested that the number of commercial units would increase to 211 units, giving 48,800 gal/day based on 231 gal/day for commercial units. No low- or moderate-growth scenario analysis was performed.

DEP Model Results

The DEP model, NLOAD, estimated that the nitrogen concentration for the Zone 2 WHPA would be 1.2 mg/l (ppm) based on current conditions and 2.9 mg/l at maximum growth. The Tisbury Water Works reports water quality sampling results in their newsletter “Tisbury Water Works.” The table below shows that the nitrate concentrations have remained very low since 1998, and below the amount predicted by the DEP model.

Table D3-1
Sampling Results for Nitrate—Tisbury Water Works

Sampling Date	Results	Below MCL*
1/98	0.14 ppm	Yes
1/99	0.42 ppm	Yes
1/00	0.95 ppm	Yes
1/01	0.90 ppm	Yes
*MCL—Maximum contaminant level (10 ppm for nitrate)		

The model estimated that 85% of the nitrogen flowing into the watershed was from wastewater. Precipitation and lawn fertilizers accounted for the other 15%. The model also estimated that 93% of the water flowing into the watershed was from precipitation, with only 7% from wastewater. More detailed information about nitrogen loading for the Zone 2 WHPA at the high-growth scenario is found in Table D3-9

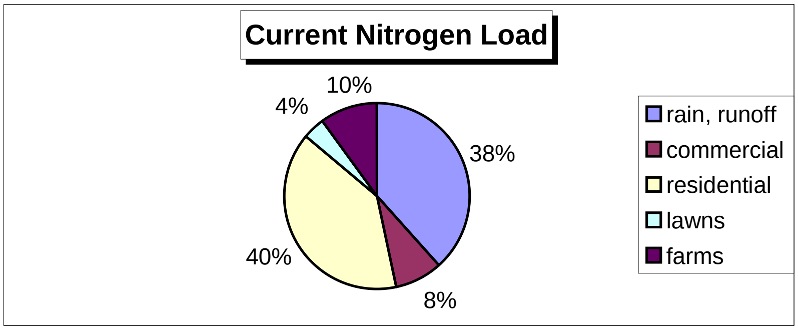
Nutrient Loading in Other Water Resource Areas

The MVC conducted a study of nitrogen loading and limits for Lagoon Pond (MVC, 2000). They concluded that the current load exceeds the calculated limit for this pond. There are several variables and assumptions that make this analysis quite conservative, particularly the use of Title 5-specified flows in the calculation of nitrogen loads. The MVC computer model also does not take into consideration possible nitrogen removal mechanisms in the subsoil environment. However, based on water quality sampling and calculated loads, Lagoon Pond is being negatively affected by nitrogen. The largest source of nitrogen in this watershed is septic systems, so the commission recommended several management approaches for addressing this source. Tisbury has an opportunity to play an active and cooperative role in addressing nitrogen loading to Lagoon Pond, through implementation of this management plan, including increased use of nitrogen-removing advanced on-site treatment systems in both new and existing structures.

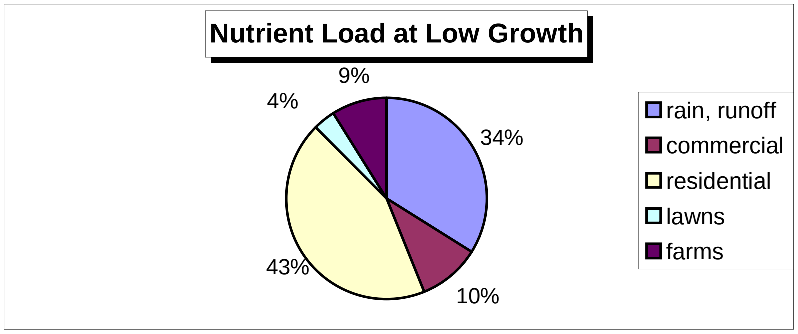
Other water resource areas were not assessed for nutrient loading or limits.

Table D3-2
Nitrogen Load Estimates for Three Growth Scenarios in the Lake Tashmoo Watershed

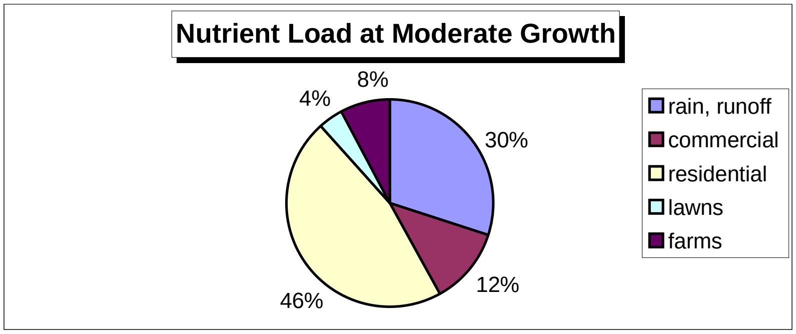
Source	kg N/year
rain, runoff	2,433.1
commercial	513.7
residential	2,505.4
lawns	241.0
farms	633.2
total:	**6,326.5**



Source	kg N/year
rain, runoff	2,443.0
commercial	735.5
residential	3,148.4
lawns	273.1
farms	633.2
total:	**7,233.3**



Source	kg N/year
rain, runoff	2,447.0
commercial	953.0
residential	3,791.3
lawns	305.3
farms	633.2
total:	**8,129.9**



Source	kg N/year
rain, runoff	2,452.9
commercial	2,440.1
residential	5,461.8
lawns	573.0
farms	633.2
total:	**11,561.0**

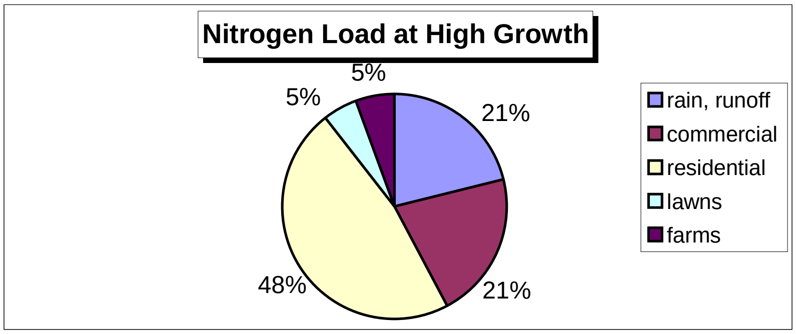
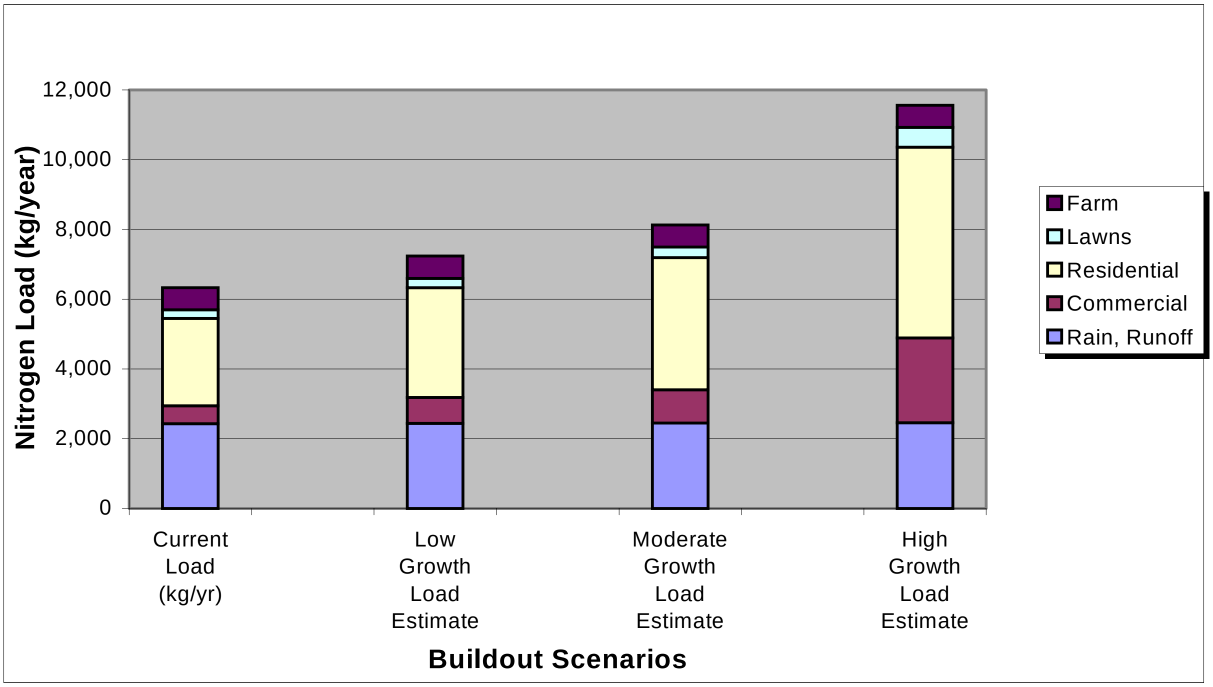


Table D3-3
Nitrogen Load Estimate for Three Growth Scenarios in the Lake Tashmoo Watershed



	Rain, Runoff	Commercial	Residential	Lawns	Farm	Total N Load (kg/yr)
Current Load (kg/yr)	2,433.1	513.7	2,505.4	241.0	633.2	6,326.5
Low Growth Load Estimate	2,443.0	735.5	3,148.4	273.1	633.2	7,233.3
Moderate Growth Load Estimate	2,447.0	953.0	3,791.3	305.3	633.2	8,129.9
High Growth Load Estimate	2,452.9	2,440.1	5,461.8	573.0	633.2	11,561.0

Table D3-4
Nitrogen Load Estimates from Precipitation in the Lake Tashmoo Watershed

Direct Precipitation on the Pond Surface

*Nitrogen in Rainfall (kg/hect)	Area of Lake Tashmoo (acres)	Conversion Factor (hect to acres)	Total Nitrogen (kg N/yr)
13.9	267.6	2.47	1,505.9

Through Groundwater Recharge

Growth Scenario	Non-Paved Area in Wshd (m2)	*Aver Annual Rainfall (inches)	Conversion Factor (inches to m)	Rainfall * Area (m3)	Nitrate in rainfall discharged through groundwater (mg/L)	Conversion Factor (L to m3)	Conversion Factor (kg to mg)
Existing	6,120,595.4	46.9	0.0254	7,291,220.4	0.05	1,000.0	1,000,000.0
High	5,508,535.8	46.9	0.0254	6,562,098.4	0.05	1,000.0	1,000,000.0
Moderate	5,692,153.7	46.9	0.0254	6,780,835.0	0.05	1,000.0	1,000,000.0
Low	5,814,565.6	46.9	0.0254	6,926,659.4	0.05	1,000.0	1,000,000.0

Through Runoff

Growth Scenario	Paved Area in Wshd (m2)	*Aver Annual Rainfall (inches)	Conversion Factor (inches to m)	Rainfall * Area (m3)	Nitrate in rainfall discharged through runoff (mg/L)	Conversion Factor (L to m3)	Conversion Factor (kg to mg)
Existing	314,867.5	46.9	0.0254	375,089.0	1.5	1,000.0	1,000,000.0
High	346,354.2	46.9	0.0254	412,597.9	1.5	1,000.0	1,000,000.0
Moderate	336,908.2	46.9	0.0254	401,345.3	1.5	1,000.0	1,000,000.0
Low	330,610.9	46.9	0.0254	393,843.5	1.5	1,000.0	1,000,000.0

**As discussed with the Martha's Vineyard Commission on 02/15/01*

SUMMARY

Growth Scenario	Total N Load from Precip (kg N/yr)
Existing	2,433.1
High	2,452.9
Moderate	2,447.0
Low	2,443.0

Table D3-5
Commercial Wastewater Flow and Nitrogen Load Estimates in the Lake Tashmoo Watershed

Comm.	*Assumed	Assumed flow	GPD	*Existing*		*High Growth*		*Moderate Growth*		*Low Growth*	
Bldg Type	bldg sqft	gpd/sq ft bldg	for Bldg	# units	Total gpd**	# units	Total gpd**	# units	Total gpd**	# units	Total gpd**
office	1,914.0	0.075	143.6	25.0	3,588.8	98.9	14,195.2	43.0	6,172.7	34.0	4,880.7
store	2,293.0	0.050	114.7	19.0	2,178.4	112.1	12,857.5	37.0	4,242.1	28.0	3,210.2
warehouse			30.0	10.0	300.0	54.1	1,623.6	23.0	690.0	18.0	540.0
restaurant			2,100.0	1.0	2,100.0	5.9	12,395.0	2.0	4,200.0	1.5	3,150.0
outdoor facil.			600.0	1.0	600.0	5.9	3,541.4	2.0	1,200.0	1.5	900.0
churches			100.0	2.0	200.0	4.3	428.0	3.0	300.0	2.5	250.0
unkwn comm			72.0	23.0	1,656.0	75.3	5,422.6	30.0	2,160.0	26.5	1,908.0
conver. vacant***			114.7	na	na	na	na	6.5	745.2	3.3	372.6
			Total GPD		10,623.1		50,463.4		19,709.9		15,211.5

na = not applicable
**Determined from median of those bldgs listed in MVC report*
***Assuming one bldg of that type on each parcel*
****Vacant parcels in the B-2 district assumed to be build-out as stores*
warehouse - assume 15 gal/day/person and 2 persons/warehouse
restaurant flow - based on 35 gpd/seat and the restaurant has 60 seats
unknown commercial flow - average of gpd from stores and warehouses

Commercial Nitrogen Load Estimate in the Lake Tashmoo Watershed

Growth Scenario	Total Flow (gpd)	Nitrogen Concentration (mg / L)	Conversion Factor (days/yr)	Conversion Factor (L/gal)	Conversion Factor (kg/mg)	Total Nitrogen Load (kg/yr)
Existing	10,623.1	35.0	365.0	0.2642	1,000,000.0	513.7
High	50,463.4	35.0	365.0	0.2642	1,000,000.0	2,440.1
Moderate	19,709.9	35.0	365.0	0.2642	1,000,000.0	953.0
Low	15,211.5	35.0	365.0	0.2642	1,000,000.0	735.5

Table D3-6
Residential Nitrogen Load Estimates from Septic Systems in the Lake Tashmoo Watershed

Growth Scenario		# Res Units	# Guesthouse units	Total # units	Occp. Rate (person-days/year)	Septic Load (kg/person/year of Nitrogen)	ResidentialLoad (kg N/yr)
Existing	Seasonal	145.4	13.2	158.6	427.65	0.0062	420.5
	Year-Round	339.3	30.8	370.1	908.70	0.0062	2084.9
	Totals	484.7	44.0	528.7			2505.4
High	Seasonal	345.7	0.0	345.7	427.65	0.0062	916.7
	Year-Round	806.7	0.0	806.7	908.70	0.0062	4545.1
	Totals	1152.5	0.0	1152.5			5461.8
Moderate	Seasonal	184.2	55.8	240.0	427.65	0.0062	636.3
	Year-Round	429.8	130.2	560.0	908.70	0.0062	3155.0
	Totals	614.0	186.0	800.0			3791.3
Low	Seasonal	164.8	34.5	199.3	427.65	0.0062	528.4
	Year-Round	384.5	80.5	465.0	908.70	0.0062	2620.0
	Totals	549.3	115.0	664.3			3148.4

1 guesthouse = I unit

* Number of parcels with a 1010 code that could potentially have a guesthouse based on a lot size with 25% greater area than the Min lot size requirement plus the existing guesthouses

** Half the parcels with 1010 code that have a lot size 25% greater than the minimum requirement plus the existing guesthouses

Table D3-7
Nitrogen Load Estimates from Lawns in the Lake Tashmoo Watershed

Determination of Lawn Size

*Total Area Res Parcels (acres)	*Total Area Res parcels (sq ft)	% of Total Area That is Lawn	Area of Lawn (sq ft)	Lawn Size per Unit (sq ft/unit)	Average Lot Size (sq ft)
650.5	28,334,124.7	5.0%	1,416,706.2	2,923.1	58,461.1

** Area of parcels that have a number of Res. Units > 0*

Nitrogen Load Estimates from Lawns

Growth Scenario	# Res Units	Lawn Size per Unit (sq ft/unit)	**Fert. Appl. Rate (lb/1000 sq ft/yr)	Fert. Appl. Rate (lb/unit/yr)	Total Fert. Appl. in Res Area (lb/yr)	% N Loss due to Leaching	Total N (lbs/yr)	Total N (kg/yr)
Exisitng	484.7	2,923.1	1.5	4.4	2,125.1	25.0%	531.3	241.0
High	1,152.5	2,923.1	1.5	4.4	5,053.1	25.0%	1,263.3	573.0
Moderate	614.0	2,923.1	1.5	4.4	2,692.1	25.0%	673.0	305.3
Low	549.3	2,923.1	1.5	4.4	2,408.6	25.0%	602.1	273.1

*** Averaged from Martha's Vineyard Commission report*

Table D3-8
Nitrogen Load Estimates for Agricultural, Forestry, and Recreational Uses in the Lake Tashmoo Watershed

Landuse code	Farm Type	Area (acres)	Fert. Appl. Rate Per Year (kg/acre/yr)	% Loss due to Leaching	Total N Load (kg)
3800	Golf Course	25.6	69.0	25.0%	442.2
7160	Tillable Forage	2.5	18.0	33.0%	15.1
7170*	Productive Woodlot	22.9	0.0	0.0%	0.0
7180	Pasture	29.6	18.0	33.0%	176.0
	Totals	80.7	105.0	91.0%	633.2

* Assuming no fertilizer applied

Note: Assuming no conversion of farmland

Table D3-9
DEP Model Results for Nutrient Loading in the Zone 2 WHPA: Tashmoo, Sandborn, and Manter Wells

Modeled Nitrogen Concentrations

- Existing 1.19 mg/l
- After buildout 2.91 mg/l

Analysis

	Water		Nitrogen	
	mgd	%	lb/yr	%
Septic systems	0.23	7.1	24724.4	85.5
Sewer leakage	0.00	0.0	0.0	0.0
Treatment plant	0.00	0.0	0.0	0.0
Precipitation	3.03	92.9	2769.2	9.6
Surface water	0.00	0.0	0.0	0.0
Lawn fertilizer			1427.6	4.9
Agriculture			0.0	0.0
Golf courses			0.0	0.0
Landfill			0.0	0.0
TOTAL	3.26	100.0	28921.1	100.0

Calculated recharge: 17 in./yr

Input Values

1. Residential

Single family houses	499 houses
with sewers	0 houses
Multi-family units	28 units
with sewers	0 units
Average occupancy	2.33* people/unit
N waste per person	5.9 lb/person/day
Lawn area per house	3000* square feet
Lawn fertilizer rate	1.5* lb N/1000 sq ft/year
percent leached	25%

Table D3-9
DEP Model Results for Nutrient Loading in the Zone 2 WHPA: Tashmoo, Sandborn, and Manter Wells (Cont.)

5. Commercial and Industrial

Total land area	94.977 acres
All business water	9933 gal/day
Sewered business water	0 gal/day
All municipal water	
Sewered municipal water	
Septic N concentration	35 mg/l

6. Agriculture

Crop A area	
fertilizer rate	
percent leached	25%
Crop B area	
fertilizer rate	
percent leached	25%
Range/pasture area	
fertilizer rate	
percent leached	25%
Number of cattle	
N production	162 lb N/animal/yr
percent leached	25%
Number of horses	
N production	118 lb N/horse/yr
percent leached	25%
Number of fowl	
N production	1.3 lb N/bird/yr
percent leached	25%

7. Other Nitrogen Sources

Landfill area	
leaching rate	
Golf course area	
fertilizer rate	3.5 lb N/1000 sq ft/yr
percent leached	25%
STP flow rate	
N concentration	

Table D3-9
DEP Model Results for Nutrient Loading in the Zone 2 WHPA: Tashmoo, Sandborn, and Manter Wells (Cont.)

8. Hydrological Data

Zone II area	2521.2 acres
Approved pumping rate	3.26 mgd
Pct surface water	0%
Surface N conc	0.05 mg/l
Precipitation N conc	0.3 mg/l

9. Future Development

Single family houses	701 houses
with sewers	0 houses
Multi-family units	115 units
with sewers	
Business water use	48764.1 gal/day
Sewered water use	
Point source flow	
N concentration	

Title 5 Allocation

Available nitrogen load (after buildout)	20763.9 lb/yr
Residential allocation	100.0%
Available N load	20763.9 lb/yr
Max. new residences	1396 units
Commercial allocation	0.0%
Available sewage flow	0 gal/day

Table D3-9
DEP Model Results for Nutrient Loading in the Zone 2 WHPA: Tashmoo, Sandborn, and Manter Wells (Cont.)

Notes:

Date: 5/31/2001

Run title: Nitrogen Loading to Zone 2

Prepared by: Stone Environmental Inc.

Zone II location: Tisbury, West Tisbury, and Oak Bluffs, MA

DEP Model Source: Horsley & Witten, Inc.

* Changed default value requires justification for DEP approval

Appendix D4: Management Tables

Water resource areas (Management Districts) were defined using Hoover's method (Hoover, 1997). The drinking water supply aquifers are the most valued resources, but are not at a high level of risk. Subareas were delineated within those Districts (Control Zones) based on whether apparent depths to seasonal high water table were greater than or less than six feet below ground surface. The town's GIS was used to assign parcels to control zones

The calculated risks are greatest relative to current nitrogen loading in to the Lagoon Pond watershed, because the current loading is at the nitrogen limit for Lagoon Pond. There is a potential risk from existing systems located in areas with shallow depth to seasonal high groundwater, and therefore potential for insufficient vertical separation between leaching fields and seasonal high groundwater. Depth to groundwater is not a limitation for siting an on-site system in Massachusetts—only that a system be designed to achieve adequate vertical separation to seasonal high groundwater.

The management levels will be used to schedule inspections and determine the required frequency of inspections and function checks. The minimum standard will be to inspect every on-site system in Tisbury at least every seven years. The initial inspection completion dates are prioritized based on risk, with higher risk areas inspected before lower risk areas. The downtown Vineyard Haven area will receive the highest priority for inspections, followed by systems in ML-1 through ML-8. The frequency of inspections will be based on the type of use and type of on-site treatment system Table D4-1 and Table D4-2. Function checks frequencies were also based on risk, with a maximum of 3.5 years between function checks in Management Levels 1, 2, 3 and 4, due to the higher apparent risk in these areas.

The eight management levels were used in two applications: 1) Setting the frequency of function checks for each control zone (two frequency intervals were used), and 2) Setting the order of initial inspections in each control zone (these were distributed over a seven-year period based on the relative ranking of all eight Management Levels with high vulnerability areas inspected first).

Pumpout intervals will be based on septic tank volume and the number of users, as specified in the CWMP. Pumpout scheduling will be planned to distribute septage collection throughout the year. This will ensure that most of the septage is delivered to the town's wastewater treatment facility in the off-peak period, from September to May.

The number of systems in each WMD will be determined during the initial inspections. The current data has limited accuracy and only allows estimation of number of systems within each district.

Table D4-1
Proposed Inspection and Function Check Intervals for Management Levels 1, 2, 3, and 4

Type of Use and On-site System Type	Title 5 Inspection Interval	Function Check Interval
Single-Family Home		
Conventional	7 years	Every 3 1/2 years
Enhanced Treatment	7 years	Annually**
Condominiums		
Conventional	7 years	Annually
Enhanced Treatment	7 years	Semiannually**
Shared System		
Conventional	Annually*	Annually
Enhanced Treatment	Annually*	Semiannually**
Restaurant/Food Service		
Conventional	7 years***	Quarterly
Enhanced Treatment	7 years***	Quarterly**
Office/Commercial		
Conventional	7 years	Every 2 years
Enhanced Treatment	7 years	Semiannually**

Notes: * - Required by Title 5
** - Or as recommended by system manufacturer, whichever is more frequent
*** - Grease traps have special requirements per Title 5 (310 CMR 15.351)

Table D4-2
Proposed Inspection and Function Check Intervals for Management Levels 5, 6, 7, and 8

Type of Use and On-site System Type	Title 5 Inspection Interval	Function Check Interval
Single-Family Home		
Conventional	7 years	Every 7 years
Enhanced Treatment	7 years	Annually**
Condominiums		
Conventional	7 years	Annually
Enhanced Treatment	7 years	Semiannually**
Shared System		
Conventional	Annually*	Annually
Enhanced Treatment	Annually	Semiannually**
Restaurant/Food Service		
Conventional	7 years***	Quarterly
Enhanced Treatment	7 years***	Quarterly**
Office/Commercial		
Conventional	7 years	Every 2 years
Enhanced Treatment	7 years	Semiannually**

Notes: * - Required by Title 5
** - Or as recommended by system manufacturer, whichever is more frequent
*** - Grease traps have special requirements per Title 5 (310 CMR 15.351)

Appendix D5: Parts of the Original Tisbury Wastewater Management Program Updated in this Addendum

Table Of Contents, *1999 Wastewater Management Program: Town of Tisbury, Massachusetts*

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Acronyms and Abbreviations

CRWR	Center for Research in Water Resources
CWMP	Community wastewater management plan
DEM	(USGS) digital elevation model
DEP	(Massachusetts) Department of Environmental Protection
GIS	geographic information system
gpd	gallons per day
ha	hectare
IWIMS	Integrated Wastewater Information Management System
kg	kilogram
l	liter
MCL	maximum (permitted) contaminant level
mg	milligram
mgd	million gallons per day
ML	Management Level
MVC	Martha's Vineyard Commission
N	nitrogen
NDWRCDP	National Decentralized Water Resources Capacity Development Project
NLOAD	nitrogen loading model developed by the Massachusetts DEP
ppm	parts per million
RA/RM	risk assessment/risk management
SEI	Stone Environmental, Inc.
sq ft	square feet
sq ft bldg	square foot of building
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WMD	waste management district

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