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TARGETED WATERSHED PLAN FOR LAKE TASHMOO, TISBURY, MA

Prepared by

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for

Town of Tisbury, Massachusetts

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Acknowledgements

This report was prepared through a collaborative process between Scott Horsley, Water Resources Consultant, the Martha's Vineyard Commission, and the town of Tisbury. It builds upon a thorough Needs Analysis and Alternatives Assessment conducted by Environmental Partners (EP) as part of the Comprehensive Wastewater Management Plan (CWMP) and the pilot testing program for enhanced innovative and alternative (EIA) septic systems conducted by the town of Tisbury. The collaboration process and development of the report was coordinated by Jared Meader, Superintendent of Tisbury Wastewater Department, Maura Valley, Health Agent of Tisbury Health Department, Ben Robinson, Chairperson of the Tisbury Water Resources Committee, and Sheri Caseau, Martha's Vineyard Commission. Valuable input was provided by several Tisbury residents including Michael Loberg, Melinda Loberg, Gerald Hokanson, and John Best.

Dedication

This report is dedicated to Dr. Brian Howes. Brian led the development of the Massachusetts Estuaries Project (MEP) which has become the "gold standard" and basis for the development of numerous watershed restoration plans throughout Southeastern Massachusetts, Cape Cod and the Islands. His vision and innovation resulted in the development of the "linked model" that integrates watershed hydrology, land use analysis, and estuarine ecology. Brian always had an answer and a smile in response to the most challenging questions.

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1. Introduction/Purpose

Water quality in Lake Tashmoo is impacted by excessive nitrogen inputs from sewage, fertilizers, and stormwater runoff. Benthic fluxes from underlying sediments, direct precipitation onto the water surface and natural sources also contribute nitrogen to the ecosystem. Illicit discharges from boats may also contribute. The purpose of this report is to identify and evaluate options to manage the controllable nitrogen inputs and to develop a plan to restore water quality in Lake Tashmoo.

The Tashmoo Targeted Watershed Management Plan (TWMP) is intended as a planning document to assist the town on prioritizing nutrient management strategies and to provide a framework adaptive management plan as a guide to developing more site-specific options for the implementation of individual projects. This Plan incorporates both traditional wastewater collection and treatment and non-traditional (alternative) technologies and strategies. It relies upon existing documents and past studies and does not include any new field investigations.

The overall goals of the plan are as follows:

- Restoration of Ecosystems & Water Quality Compliance with Clean Water Act
- Quicker Results & Reduced Costs
- Promote Affordable Housing
- Maximize Local Co-Benefits
- Minimize Climate Change Impacts
- Incorporate Sustainability and Circular Economy

The specific objectives of this Targeted Watershed Management Plan are to:

- Compile prior plans and to update them in accordance with the findings of the recent Massachusetts Estuary Project (MEP) and Total Maximum Daily Load (TMDL) reports,
- Identify a locally-preferred, integrated nitrogen reduction approach using a combination of conventional and alternative technologies and adaptive management,
- Provide a conventional back-up plan that can be implemented using adaptive management,
- Compare the proposed nitrogen removals to the required threshold levels for Lake Tashmoo, and
- Provide the foundation for an application for financing to the State Revolving Fund (SRF) and for a Watershed Permit to be issued by the Massachusetts Department of Environmental Protection (DEP).

2. Existing Conditions and Required Restoration

The primary pollutant that this report addresses is nitrogen. Nitrogen is an essential nutrient needed to grow food and supports countless ecosystems, yet when present in excess quantities in the aquatic environment it causes eutrophication and the decline of native species such as eelgrass and related shellfish communities. In the natural environment the nitrogen cycle is balanced and nutrients are internally recycled with no excess waste. Historically, human settlements have imported excessive amounts of nitrogen exhibited by wastewater discharges, food waste, and commercial fertilizers for lawns. This excess leads to nitrogen as a waste product rather than a nutrient and ultimately eutrophication.

The concept of a circular economy that could reduce waste, encourage re-use, and enhance recycling is a good model to understand current conditions and may assist in developing a sustainable management plan for Lake Tashmoo (see figure 1). Point source reduction can be accomplished with green infrastructure including composting toilets and advanced septic systems. Technologies selected should consider opportunities for local jobs, economic development, and their carbon footprint. In concert with this, re-use and recycling of nitrogen-enriched groundwater could be substituted for commercial fertilizers using fertigation wells.

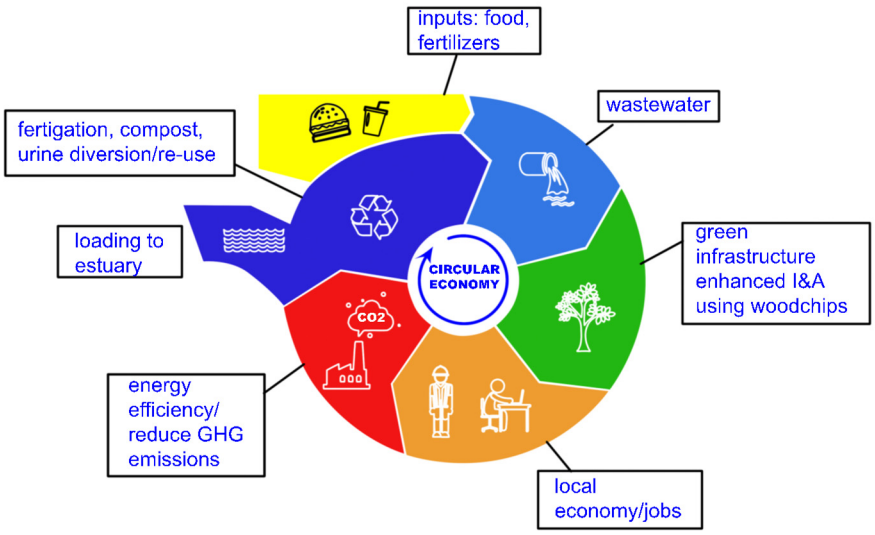

Figure 1 - Circular Economy Model

The Linked Watershed-Embayment Model report prepared by the Massachusetts Estuaries Project (MEP) and the Total Maximum Daily Load (TMDL) prepared by the Massachusetts Department of Environmental Protection (MADEP) in 2015 and 2017 respectively provide the most current documentation about the sources, effects, and required reductions of excessive nitrogen loading to the Lake Tashmoo estuary.

The MEP/TMDL reports indicate that the primary ecological threat to Lake Tashmoo is from excessive nitrogen enrichment and identify the following impacts.

- Loss of eelgrass beds, which are critical habitats for macroinvertebrates and fish;
- Undesirable increases in macro-algae, which are much less beneficial than eelgrass;
- Periodic decreases in dissolved oxygen concentrations that threaten aquatic life;
- . Reductions in the diversity of benthic animal populations; and
- Periodic algal blooms.

The MEP model includes a detailed land use analysis of all parcels within the Lake Tashmoo watershed. The watershed is defined as those land areas that contribute groundwater and surface water flows to the estuary. The majority of the watershed is within the town of Tisbury with smaller portions in West Tisbury and Oak Bluffs.

The MEP model accounted for nitrogen discharges from wastewater, fertilizers, stormwater, and natural background sources throughout the watershed. The model also accounted for direct precipitation to the Tashmoo water surface and inputs from the underlying benthic sediments.

The MEP/TMDL reports distinguish between non-controllable sources and controllable sources of nitrogen. Sources such as benthic fluxes from sediments and atmospheric deposition are not locally controllable. Sources such as wastewater discharges from septic systems and treatment plants, stormwater runoff and fertilizers are locally controllable. The largest controllable watershed sources of nitrogen were determined to be wastewater (75%), stormwater (8%), and fertilizers (10%). Table 1 provides a comparative summary of these various nitrogen sources and indicates that the nitrogen loading from watershed (controllable) sources was 9154 kg/year.

To determine the critical threshold nitrogen loading to Lake Tashmoo, the MEP established a sentinel station and determined a tidally averaged nitrogen target concentration of 0.36 mg N/l at that location. The MEP model then calculated the target threshold nitrogen load of 6244 kg/year[1]. Comparing the existing (2010) watershed loads to the threshold load indicates a required reduction of 2910 kg/year (32%).

[1] MEP (2015), Table VIII-4.

Table 1 - Summary of Nitrogen Loads and Required Reduction (kg/year)

Septic Systems	6861	75%
Wastewater Treatment Facility	107	1%
Landfill	56	1%
Turf Fertilizer	457	5%
Agriculture Fertilizers	179	2%
Agriculture Animals	277	3%
Stormwater	715	8%
Natural Sources	502	5%
Total MEP Watershed Loading (2010)	9154	
Watershed Loading (2023)	9831	
Watershed Loading (2043)	10605	
MEP Threshold (Critical Level)	6244	
Reduction Required (2010)	2910	32%
Reduction Required (2023)	3587	36%
Reduction Required (2043)	4361	41%

The MEP nitrogen loading analysis was based upon 2010 land use. To provide an updated analysis of nitrogen loading to current conditions (2023) we utilized the Tisbury Health Department records and a GIS-based, parcel-by-parcel analysis of the watershed provided by the Martha's Vineyard Commission. A summary of existing septic systems within the Tisbury portion of the Tashmoo watershed as of 2022 has been provided by the Tisbury Health Department (see Table 2). According to the MVC and Tisbury Health Department there were 53 new septic systems built within the watershed during the 2010 – 2020 period (including 6 FAST and 5 NitROE systems). During this time period there were also 31 upgrades and conversions to I/A systems. According to the most recent data provided by the Tisbury Board of Health for the years 2021-2022 there was only 1 new system added within the Tashmoo watershed.

According to a recent GIS analysis provided by Martha's Vineyard Commission there are also an estimated 261 septic systems in West Tisbury and 9 in Oak Bluffs within the Tashmoo watershed[2]. Thus, the estimated total number of septic systems within the Tashmoo watershed is 1130 (see Table 3).

[2] Marthas Vineyard Commission, GIS Land Use Analysis, Chris Seidel, April 26, 2023.

Table 2 Inventory of Septic Systems in Tashmoo Watershed (Town of Tisbury) - March 2023 (Source: Tisbury Department of Health)

Total number of septic systems	860
I/A systems (FAST, Bioclere, Waterloo, Advantix)	25
Enhanced I/A systems (E-I/A)(NitROE)	19
Cesspools	28
Title 5 systems pending upgrade (General Approval)	2
Title 5 systems pending upgrade (Provisional Approval)	5

Table 3. Number and Percentage of Septic Systems in Tashmoo Watershed

Tisbury	860	76%
West Tisbury	261	23%
Oak Bluffs	9	1%
Total	1130	

To update the nitrogen loading analysis to current conditions (2023) the MEP loading coefficients of 26.25 mg/liter and 171 gallons/day were applied to residential Title 5 systems and 0.066 gals/SF-day for commercial properties[3]. We applied effluent concentrations of 19 mg/liter for General Use I/A systems and 11 mg/liter for E-I/A systems. We also applied a lawn fertilizer loading rate of 1.47 kg/year for each new home derived from the MEP coefficients.

We projected an additional 153 septic systems and lawns during the 20-year planning period (2023 – 2043). The twenty-year projection is based upon an assumption that growth will continue at the growth rate experienced during the 2010 – 2023 period. It also assumes that all new septic systems within the Town of Tisbury will comply with its health regulation that requires E-I/A systems. However, new septic systems in West Tisbury are assumed to be standard Title 5 systems. This analysis indicates that future (2043) nitrogen loading from watershed sources is 10,605 kg/year and that a 41% reduction in nitrogen loading will be required to achieve the MEP target threshold of 6244 kg/year[4]. It also shows that nitrogen loading increases in West Tisbury will be greater than Tisbury (despite a smaller number of new septic systems) during the next 20 years due to its continued use of standard Title 5 systems (see figure 2).

[3] MEP report (2015), Table IV-1

[4] This required reduction of 41% is increased from the MEP estimate of 31.9% under (then) current conditions in 2010. Future growth in Tisbury is assumed to utilize enhanced I&A septics as required by the local health regulation. Future growth in West Tisbury and Oak Bluffs is assumed to utilize standard Title 5 septic systems.

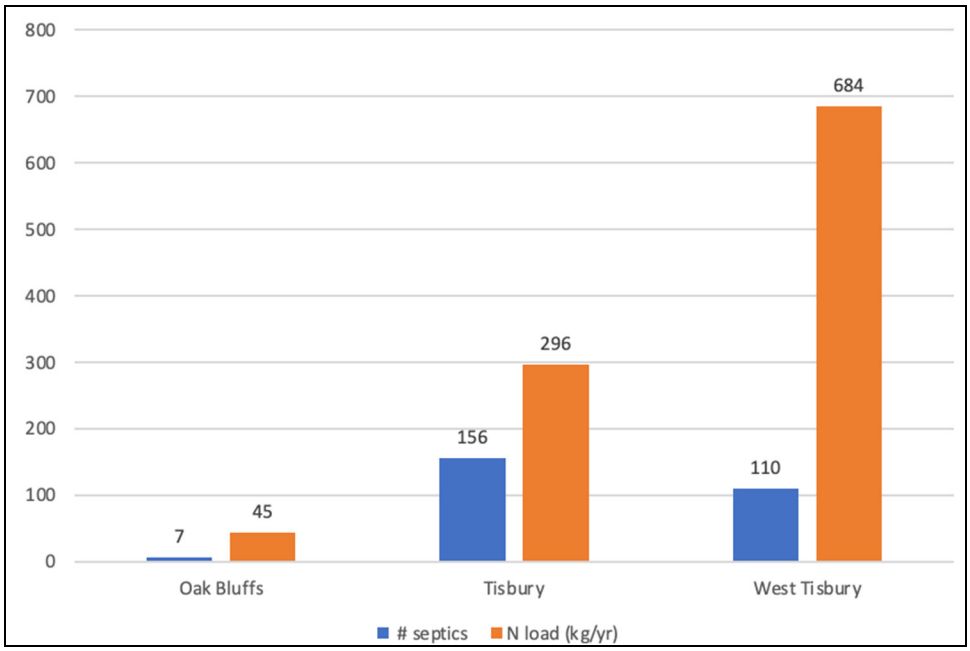

Figure 2 - Growth of Septic Systems and Nitrogen Loading (2023 - 2043)

A summary of the relative nitrogen loads to Lake Tashmoo from the three towns is presented in Table 4. This shows that West Tisbury's share will grow from 23% currently to approximately 26% in the year 2043. This analysis provides a basis to begin a discussion for equitable cost sharing of the proposed restoration strategy.

Table 4 - Relative Nitrogen Loading of Towns in Tashmoo Watershed

	2023	2043
Tisbury	76%	72%
West Tisbury	23%	26%
Oak Bluffs	1%	1%

Ecological indicators of the estuary include eelgrass conditions. The Massachusetts Division of Marine Fisheries has provided an updated ecological assessment of eelgrass with Lake Tashmoo (DMF, 2022). This assessment documents eelgrass declines since 1995 (see Table 6). However, the aerial coverage appears to have stabilized or partly recovered since 2001. The report indicates that eelgrass losses are "correlated to eutrophication, habitat degradation, climate change, and anthropogenic impacts".

Table 6 – Summary of Eelgrass Surveys 1995 - 2021

Survey	Areal extent
DEP Mapped Eelgrass in Tashmoo – 1995	91 acres
DEP Mapped Eelgrass in Tashmoo – 2001	38 acres
DEP Mapped Eelgrass in Tashmoo – 2006-2007	38 acres
DEP Mapped Eelgrass in Tashmoo – 2010-2013	45 acres
DEP Mapped Eelgrass in Tashmoo – 2015-2017	47 acres
DMF Lake Tashmoo Survey - 2021	47 acres

3. Prior Planning, Scientific, and Engineering Projects

The earliest available documentation of water quality and wastewater issues in Tisbury is the 1979 *Environmental Impact Statement Wastewater Collection and Treatment Facilities* by USEPA. This document recommended a three-phase program for sewers in the "developed areas of Vineyard Haven", and an 85,000 gallons per day (gpd) wastewater treatment and nightsoil (e.g., septic system sludge) composting facility. Since this time several additional studies were completed including the following[5].

- Draft Phase III Facilities Plan and Environmental Impact Report, Stone Environmental (1999)
- Island Plan (Section 10 - Water Resources), Martha's Vineyard Commission (2009)
- Lagoon and Tashmoo Pond Case Studies, Wright-Pierce and MVC (2011)
- Tisbury Wastewater Management Planning – Updated Estimates of Wastewater Flow, Wright-Pierce (2013)
- Tisbury Wastewater Management Planning - Summary of Needs Assessment, Wright-Pierce (2015)

[5] A summary of each of these reports is provided in the Needs Analysis completed by Environmental Partners (July 2021).

More recently the Lake Tashmoo Linked Watershed-Embayment Model Report was completed by the Massachusetts Estuary Project (MEP) in 2015. This report quantified nitrogen load sources and critical threshold levels within Tashmoo and provided the scientific basis for the adoption of the Total Maximum Daily Load (TMDL) report by the Massachusetts Department of Environmental Protection (MADEP) in 2017.

In addition to these planning documents, the Up-Island Management report prepared by the Marthas Vineyard Commission (2023) identified a series of potential nutrient management techniques for the three more rural towns of West Tisbury, Chilmark, and Aquinnah. As such the West Tisbury septic system management planning is of direct impact to the Tashmoo Watershed. It identified the principal sources of nitrogen as on-site septic systems, fertilized lawns and gardens, agriculture, and stormwater runoff. The report identified a broad range of possible management options including land preservation, growth controls, fertilizer management, management of agricultural practices, on-site wastewater treatment systems, aquaculture, habitat restoration, and green infrastructure. Public sewers and permeable reactive barriers are also discussed in the report but are only cost effective in more densely populated areas.

A larger Town-wide Comprehensive Wastewater Management Plan (CWMP) is currently being prepared by Environmental Partners Group (EPG) for Tisbury. The Needs Assessment portion of this project was completed in June 2021 and the Alternatives analysis is currently underway. The Needs Assessment included some updates to wastewater flows within the Tashmoo watershed. Specifically, it indicates that average household water usage has increased 19% since the MEP report (EPG Needs Assessment, page 36). This suggests that average household water discharge and associated nitrogen loads may have also increased. The report also indicates some relatively minor changes in wastewater treatment plant discharges to the Tashmoo watershed.

In 2018 the Town of Tisbury began a pilot testing program for enhanced I/A septic systems, (NitROE®), to compare their nitrogen removal capabilities with other onsite system technologies. The Town collaborated with KleenTu, LLC to conduct this pilot program, which was partially funded through a grant from the Massachusetts Clean Energy Technology Center. To date, nineteen (19) single family home NitROE systems have been installed and monitored. Sampling of the systems is conducted by the Town of Tisbury and the MVC and water quality analyses are performed by Envirotech.

4. Proposed Restoration Strategies and Nitrogen Reductions

The proposed watershed plan includes: 1) a recommended hybrid plan that incorporates both conventional and alternative technologies, and 2) a contingency or back-up plan wholly

comprised of conventional technologies. The recommended hybrid plan is presented in this section of the report. The contingency plan is presented in Section 5 of the report.

The recommended hybrid restoration plan is designed to achieve the required nitrogen loading reductions for the lowest cost, utilizing technologies and strategies that are acceptable locally and sustainable. The plan integrates a planned sewer extension project in the B2 Zoning District and technologies that were developed during various local pilot projects. These include the enhanced I&A septic stems pilot testing program conducted by the town of Tisbury and various stormwater retrofit projects designed by the USEPA and University of New Hampshire.

A series of three public workshops were conducted by Environmental Partners and hosted by the Tisbury Water Resources Committee on March 30, 2023, April 13, 2023 and April 27, 2023 to discuss and evaluate potential nitrogen reduction technologies applicable to Lake Tashmoo. Based upon discussions at this workshop and prior initiatives taken by the town of Tisbury a hybrid restoration plan was identified as the most advantageous and subsequently developed to incorporate both conventional wastewater treatment technologies and alternative nutrient management techniques.

The hybrid plan is presented in Figure 3 and Table 6. This plan includes five recommended strategies and the corresponding nitrogen loading reductions to achieve the MEP water quality thresholds. A summary of each strategy is outlined below followed by a more detailed description of each technology.

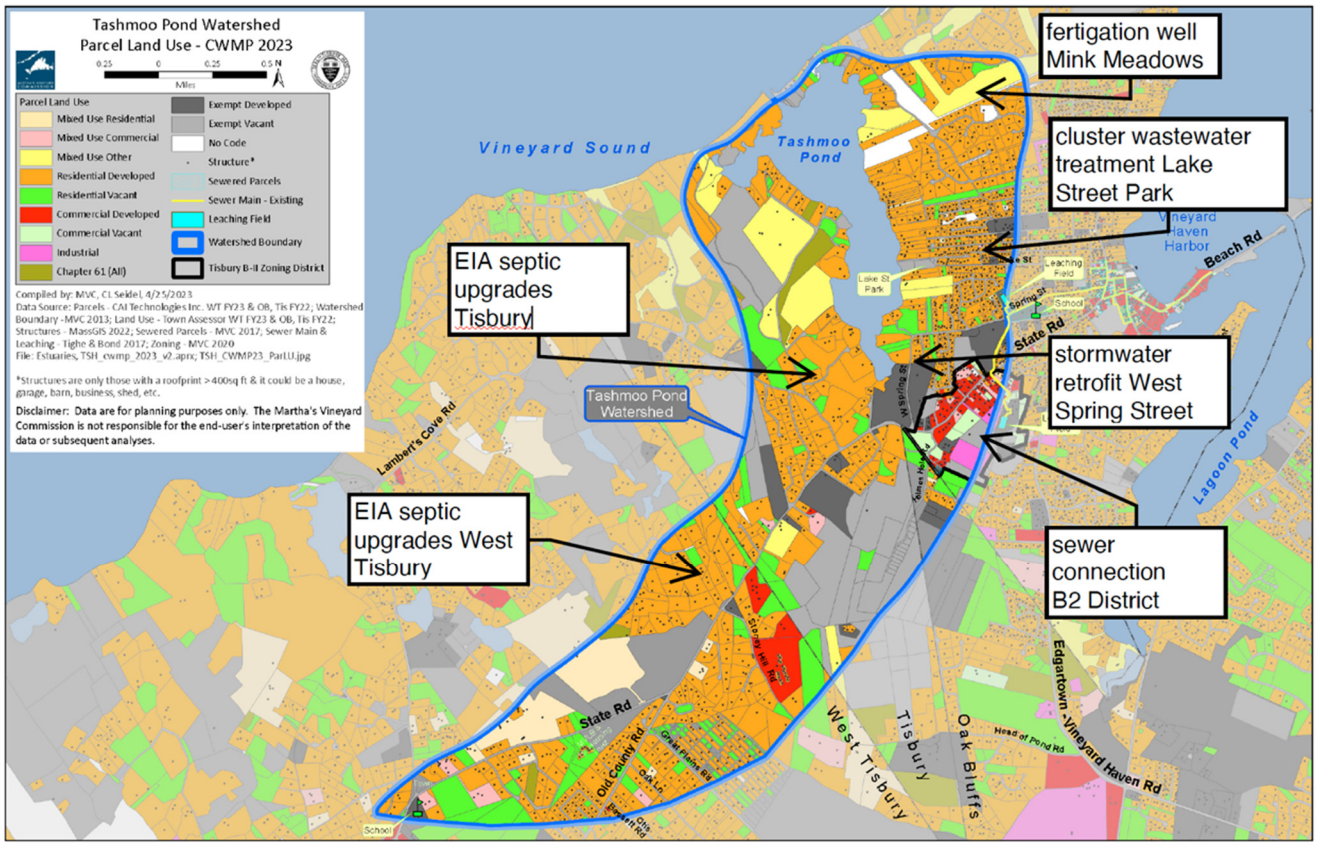

Figure 3 - Tashmoo Watershed Plan Overview (Map prepared by the Martha's Vineyard Commission, CL Seidel, 4/25/2023)

Table 6 – Summary of Hybrid Plan

Technology/Strategy	Calculation Summary			Reduction (kg/yr)
Sewering (B2 District)	16330	gals/day		560
Enhanced I&A Septics	838	upgrades	x 171 gals/day x (26.25 - 10.0) mg/liter	3217
Cluster Treatment	9900	gals/day	x (26.25 - 5.0) mg/liter	291
Fertilizer Management	25	percent	x 457 kg/year	114
Stormwater Retrofits	25	percent	x 715 kg/year	179
TOTAL				**4361**
Note: Calculations include conversion factors of 3.785 liters/gallon and 1,000,000 mg/kg				

• **Sewer Collection (B2 District)** – Existing septic systems within the B2 zoning district will be connected to a sewer collection system and directed to the Tisbury wastewater treatment

plant. The nitrogen loading associated with those existing systems will be removed from the Tashmoo watershed. Through the excellent work of the Tisbury Department of Public Works additional capacity has been provided by eliminated leaks (infiltration and inflow) to the system enabling this additional treatment.

• **Enhanced Innovative and Alternative (EIA) Septic Systems** – The town of Tisbury has already initiated a program to upgrade existing cesspools and Title 5 septic systems to advanced, nitrogen reduction EIA systems. This program is driven by a health regulation that requires upgrades for new construction, repairs, expansions, and real estate transfers. The plan includes an estimated 838 septic upgrades to EIA systems. This is approximately 55% of the septic systems in the watershed that are projected to be in use by 2043. An average treated effluent of 10 mg/liter was utilized for this analysis. This concentration is consistent with the definition of "best available nitrogen reducing technology "in the recently amended MADEP Title 5 regulations (310 CMR 15.002). If the E-I/A systems continue to perform at the average concentrations reported over the last five years (7.4 mg/liter) the number of required systems can be substantially reduced. The required number of upgrades could also be substantially reduced if West Tisbury were to adopt a health regulation similar to Tisbury requiring the EIA systems for all new construction.

• **Cluster/Neighborhood Treatment Facilities** – In higher density areas it may be cost effective to construct a small-scale sewer collection system and a localized shared treatment plant to replace existing cesspools and Title 5 septic systems. The Lake Street neighborhood was identified as a high-density neighborhood in the Environmental Partners Needs Analysis and the Lake Street Park may serve as good pilot project for a cluster/neighborhood wastewater treatment facility. These types of facilities have the ability to treat nitrogen to an average effluent concentration of approximately 5 mg/liter.

• **Stormwater Management** – The town of Tisbury has identified and evaluated several untreated stormwater discharges to Tashmoo. These discharges contribute nitrogen, phosphorus, metals, hydrocarbons, and pathogens. The plan includes several stormwater retrofit projects designed to capture runoff and provide treatment using green infrastructure such as bioswales, constructed wetlands, and infiltration systems. A preliminary credit of 25% reduction of the existing nitrogen loading from stormwater that is identified in the MEP report is included with this plan. This reduction will need to be documented with individual projects during the 20-year implementation period.

• **Fertilizer Management** – Tisbury has already enacted a fertilizer bylaw designed to raise awareness and reduce fertilizer applications. Additional reductions can be achieved by working with the Mink Meadows golf course and homeowners to site irrigation wells that draw from nitrogen-enriched groundwater and recycle the nutrients onto the turfgrass areas as a substitute for commercial fertilizer applications. According to the MEP model turfgrass can

attenuate 80% of the nitrogen applied[6] and the use of on-site irrigation (fertigation) wells would also reduce demands on the public water supply system. A preliminary credit of 25% reduction of the existing nitrogen loading from fertilizers that is identified in the MEP report is included with this plan. This reduction will need to be documented with individual projects during the 20-year implementation period.

A more detailed discussion of each restoration strategy follows.

Core Sewer Collection Area (B2 District) – The hybrid plan includes a sewer extension into the B2 Zoning District to connect a number of commercial and residential properties (see figure 4). This area includes 73 parcels with an estimated average wastewater flow of 16,330 gallons/day and an estimated nitrogen load reduction of 560 kg/year[7].

[6] Table IV-1 of the MEP report for Lake Tashmoo provides nitrogen loading coefficients and includes a 20% leaching factor for fertilizers applied to turfgrass. This assumes that 80% is attenuated.

[7] Environmental Partners, Memorandum "Tisbury CWMP Conventional and Cluster Alternatives for the Lake Tashmoo Watershed", July 13, 2023.

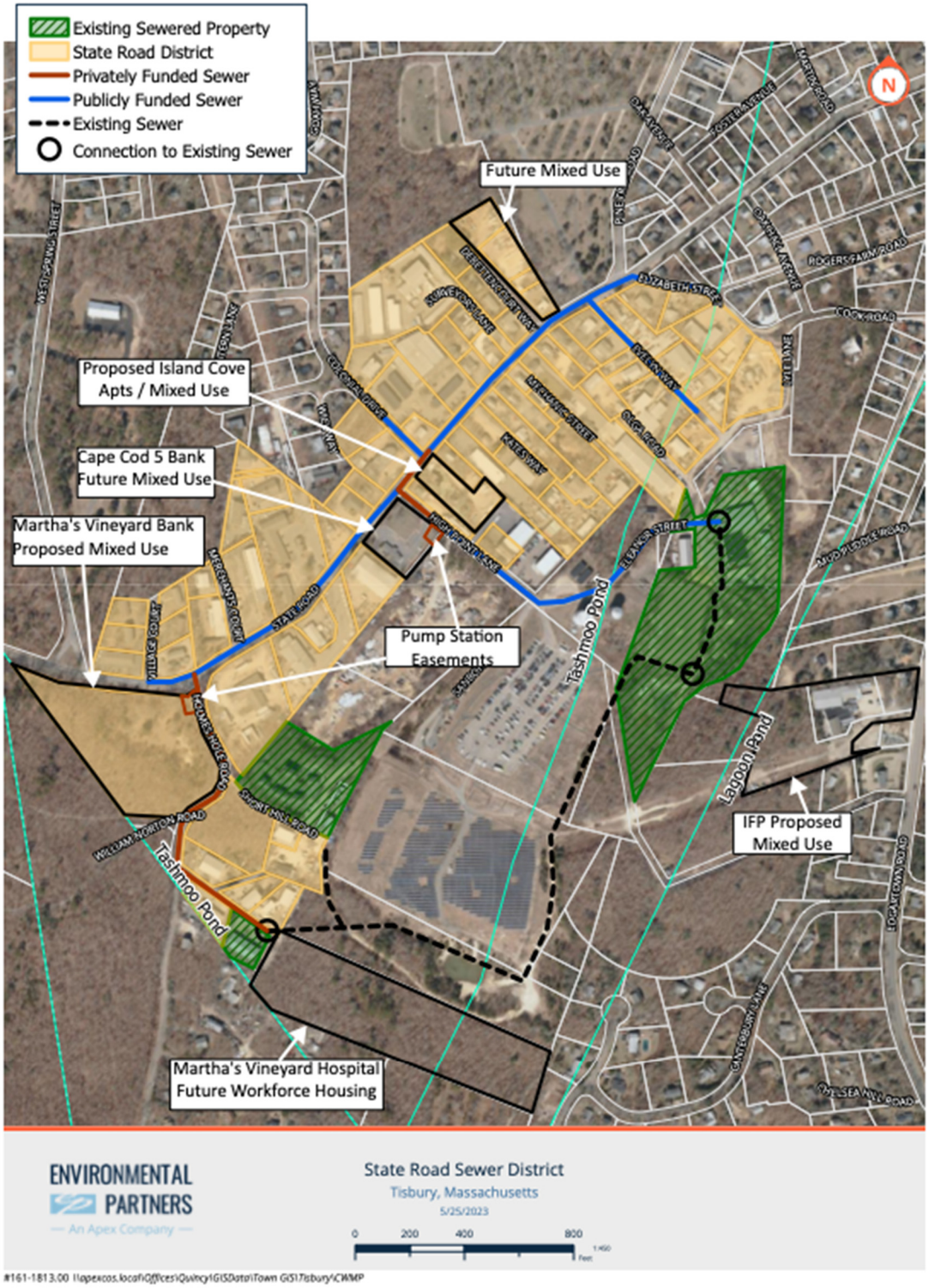

Figure 4 - Core Sewering Area (B2 Zoning District)

Neighborhood/Cluster Wastewater Treatment Facility -

A neighborhood or cluster system with a design flow 0f 9900 gallons/day is proposed to provide a single, larger E-I/A septic system for a group of approximately 30 homes (see figures 5A and 5B). Lake Street Park was selected as a favorable location for such a facility. It is a town-owned parcel on the east side of Lake Tashmoo and is downgradient from a group of homes on relatively small lots. This setting provides for higher density and gravity flow – both features providing improved cost effectiveness. The higher density reduces the costs per home associated with the collection system (sewer pipe) installation. Gravity sewer eliminates the need for costly pump stations.

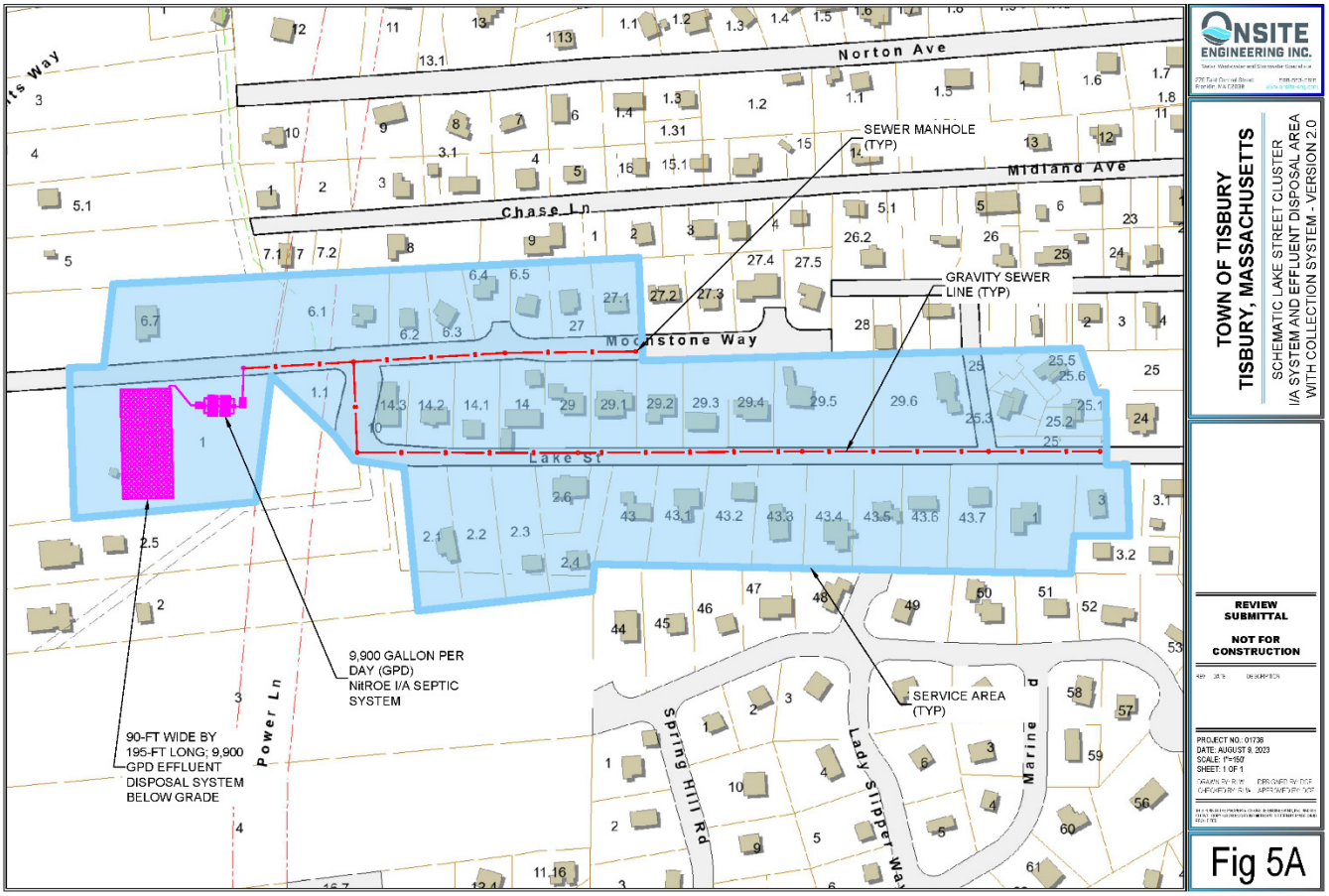

Figure 5A - Lake Street Park Cluster System Service Area (Conceptual)

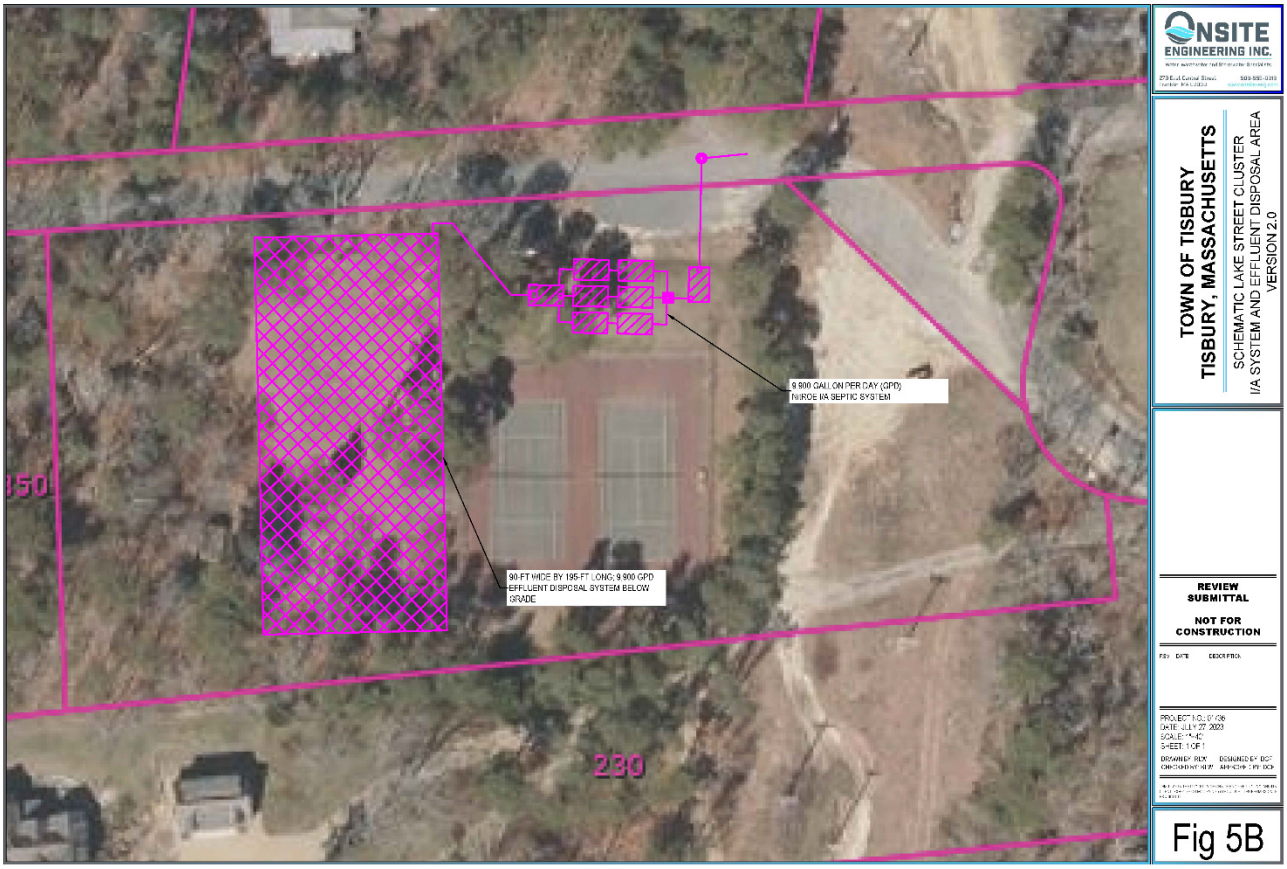

Figure 5B - Lake Street Park Cluster System Layout (Conceptual)

Enhanced Innovative and Alternative Septic Systems

The towns of Tisbury, West Tisbury, and Oak Bluffs have relied upon on-site wastewater disposal systems throughout most of its history. They include cesspools and Title 5 systems. Cesspools are simply a subsurface infiltration structure that collects building sewer waste into a chamber that is not solid, so the liquid portion can leach out into the surrounding soil, while the solids are retained and somewhat broken down due to microbial activity. Title 5 systems are comprised of a water-tight septic tank (to separate solids) and a leaching field that is designed to infiltrate the resulting septic tank effluent into the underlying soils and groundwater. While these systems are generally effective at removing biological solids and pathogens (by retention in the tank and subsequent filtration through soils) they do not attenuate appreciable amounts of nitrogen as any reduced and/or organic forms of nitrogen in the sewage are mostly water-soluble and therefore migrate with the liquid phase of the wastewater into the surrounding soil, whereby it is rapidly oxidized into an even more water soluble forms of nitrogen (nitrite and nitrate). The Massachusetts Estuary Project (MEP) report and model applies an average

effluent concentration of 26.25 mg/liter for a Title 5 system[8]. Significantly higher concentrations are being reported in current studies on Cape Cod and Martha's Vineyard[9].

Over the last twenty years several on-site wastewater treatment technologies have been developed with the objective of nitrogen removal. These systems are referred to as innovative and alternative (I&A) septic systems and are regulated my MADEP. Most of these systems have achieved a permitted effluent concentration of 19 mg/liter. This represents a reduction of approximately 28% of the nitrogen as compared to a standard Title 5 system.

However, a new generation of I&A technologies have been developed utilizing woodchip bioreactors and are providing significantly better results with nitrogen attenuation rates that exceed 90%[10]. These systems were identified as "enhanced" I&A (EIA) systems in the Cape Cod Commission's Cape Cod 208 Water Quality Plan Update. There are currently two commercially-available enhanced I&A systems that are achieving effluent concentrations of 10 mg/liter or less – Nitrex and NitROE. Both utilize a woodchip-based treatment system (see figure 6). The woodchips provide a carbon source for naturally-occurring bacteria to break down the nitrogen to harmless nitrogen gas (a process called denitrification).

A recent data set provided by NitROE indicates an average attenuation rate of 92% with an average (actual) influent concentration of 104 mg/liter and an average effluent concentration of 7.4 mg/liter[11]. Nitrex reports an overall average removal rate of 97%+ for nitrate (NO_3^-), achieving nitrate NO_3^- - N effluent quality of 0.1 mg/l, when water temperatures are above 48° F[12].

Because future long-term performance of these systems is unknown we have prepared a sensitivity analysis that includes a range of effluent quality from 8 mg/liter to 10 mg/liter (see Table 7). This range is based upon the reported monitoring data and the Provisional Permits issued by MADEP (Nitrex) and (NitROE). The sensitivity analysis shows that the required nitrogen loading reductions identified by MEP can be met with the proposed hybrid plan and with the E-I/A systems performing at 8 - 10 mg/liter. The number of required systems varies based upon the performance.

To be conservative we have utilized the higher effluent value of 10 mg/liter in the Plan. The ultimate number of installations within the Tashmoo watershed required to achieve the MEP

[8] MEP report for Lake Tashmoo, pages 33 – 35. This effluent concentration is based upon an assumed influent concentration of 35 mg/liter and nitrogen losses of approximately 25% within the system.
[9] The Barnstable Clean Water Coalition working with USGS, USEPA, and The Nature Conservancy have installed twelve EIA septic systems at the Shubaels Pond neighborhood in Barnstable and have been carefully monitoring both influent and effluent. Influent concentrations have averaged 75 mg/liter.
[10] Gobler, Chris, et al. 2021.
[11] Data report submitted to MADEP on March 10, 2023 by John Smith of KleanTu (NitROE) includes 450 sampling events on 50 installations over 2017 – 2023.
[12] Source: Nitrex website - http://lombardoassociates.com/nitrex.php

nitrogen thresholds will be determined through adaptive management and will be based upon the actual nitrogen reduction performance determined from on-going monitoring.

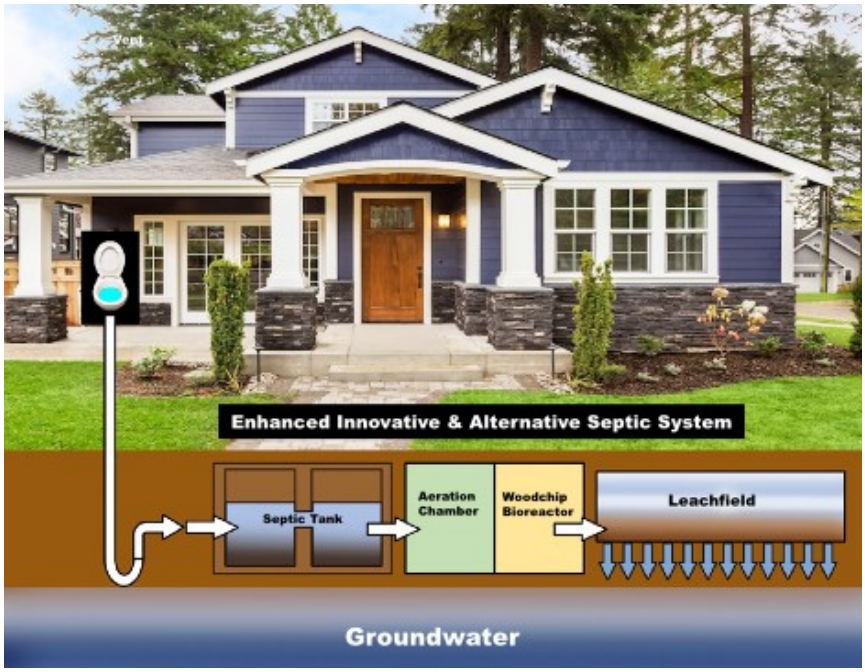

Figure 6 – Typical NitROE Enhanced I/A Septic System

Table 7 – Comparative Nitrogen Loading of I/A Systems at Various Performance Levels

	mg/liter	load (kg/year)	net reduction (kg/year)	percent reduction
Title 5 system	26.25	6.20		
I&A @ 19 mg/liter	19	4.49	1.71	28%
I&A @ 10 mg/liter	10	2.36	3.84	62%
I&A @ 8 mg/liter	8	1.89	4.31	70%
I&A @ 5 mg/liter	5	1.18	5.02	81%

Source Reduction Toilets:

Another on-site, decentralized option to manage wastewater is the use of source reduction toilets. These include composting and urine-diversion toilets. Composting toilets can remove

100% of urine and feces from the waste stream with an overall nitrogen reduction of 70 – 80%[13]. Homes still need to dispose of "gray water" that includes shower and sink drainage. Composting toilets have achieved General Approval by MADEP and are allowed for new construction in Title 5 (310 CMR 15.289). Title 5 also allows for a reduced leaching field area of 50% for gray water systems (310 CMR 15.262(2)(a).

Urine-diversion toilets can also provide a significant reduction in nitrogen loading. Approximately 80% of the nitrogen in human wastewater is contained within urine. In this case urine is directed to a holding tank and can be pumped annually and potentially processed and re-used as a fertilizer[14] .

Stormwater Management:

The MEP report estimates that stormwater discharges contribute 715 kg/year (8% of the controllable load) to Lake Tashmoo. Stormwater carries a broad array of other pollutants as well including metals, hydrocarbons, and pathogens. Mitigating these sources will have multiple benefits including nitrogen load reductions as well as bacterial concentrations in swimming and shellfishing areas.

As such, a Drainage Master Plan was prepared by Environmental Partners (2018). This report identifies several untreated stormwater discharges within the Tashmoo watershed. These include an outfall near West Spring Street near the head of the estuary and Lake Street along the eastern shore of Tashmoo.

The outfall pipe near West Spring Street discharges untreated stormwater near the head of Tashmoo and is described as having a very large drainage area. Several alternatives to address this discharge are identified in the Drainage Report. They include low impact development (LID) practices and potential infiltration systems at the school and American Legion properties.

A small, vegetated swale has been constructed at Lake Street Park (see figure 7). However, the Drainage Master Plan indicates that the inflow to the system appears to be blocked. The Master Plan recommends a re-design and upgrading of this facility. The lower portion of Lake Street drainage (downhill from Lake Street Park appears to be an untreated direct discharge. This discharge can be intercepted and treated with a system located at the parking lot near the Tashmoo shoreline.

[13] Cape Cod Commission, Cape Cod 208 Plan Update, 2015, page 4-11.
[14] Rich Earth Institute, https://richearthinstitute.org

Figure 7 - Lake Street Park swale (Environmental Partners, 2018)

The MADEP Stormwater Handbook and a report prepared for the Cape Cod Commission provide guidance on potential stormwater treatment systems and their potential pollutant removal rates. These include bioretention systems, constructed wetlands, and infiltration systems (see Table 8 and Figures 8a, 8b, 8c).

Table 8 – Stormwater Best Management Practices

Stormwater Treatment Practice	Nitrogen Removal Estimates	
	MADEP[15]	Cape Cod Commission[16]
Bioretention	30 – 50%	55%
Constructed Wetland	20 – 55%	30 – 55%
Infiltration System	40 – 70%	40 – 65%

[15] MADEP Stormwater Handbook, Volume 2 Chapter 2: Structural BMP Specifications for the Massachusetts Stormwater Handbook, pages 23, 36, and 94.

[16] Offshoots, Inc. and Horsley Witten Group, Inc. (2016) Route 6 Stormwater and Vegetation Management Plan (Prepared for Cape Cod Commission) Table 2b.

Figure 8a - Bioretention/Rain Garden: Stormwater flows into this vegetated practice, then infiltrates down through the root zone.

Figure 8b - Constructed Wetland: Stormwater flows into the wetland and then moves laterally through the root zone which is constantly saturated providing excellent treatment.

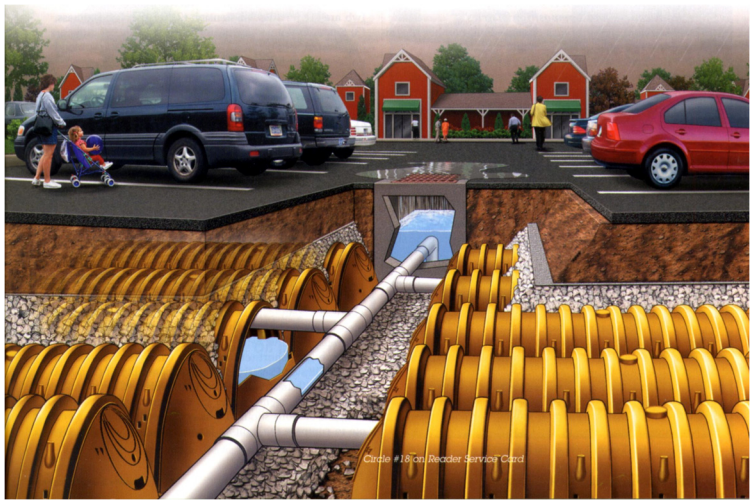

Figure 8c - Infiltration System: Stormwater flows into a series of subsurface structures open to the bottom where it is filtered by native soils.

Fertilizer Management: The MEP report estimates that fertilizer applications contribute 636 kg/year (7% of the controllable load) to Lake Tashmoo. The MEP estimated that lawns would be fertilized at a rate of 3 pounds of nitrogen per 1,000 square feet and estimated the nitrogen loading rates by fertilizers to groundwater and embayments based on average lawn sizes. MEP estimated that the fertilizer component of nitrogen to groundwater is 1.08 pounds per residential lawn per year.

In 2015, the Town of Tisbury established the *Town of Tisbury Board of Health Regulations – The Content and Application of Fertilizer for Turf on Martha's Vineyard*. The regulations limit the application of nitrogen and phosphorus in fertilizers. Phosphorus fertilizer is prohibited unless a need is indicated by a soil test. Specific nitrogen fertilizer regulations include:

- No fertilizer application on impervious surfaces
- No fertilizer application between November 15 and the following April 15
- No more than 0.5 pounds of nitrogen per 1,000 square feet per application, and 3 pounds of nitrogen per 1,000 square feet per year
- A minimum of 50% of the nitrogen must be in slow-release type
- Prohibits fertilizer application within 10 feet of a Resource Area, and limits nitrogen application with the Buffer Zone.
- For golf courses: No fertilizer application between December 15 and the following April 15

Another potential option for fertilizer reductions is the Mink Meadows golf course. Approximately half of this nine-hole golf course is located within the Tashmoo watershed.

A combination of reductions of fertilizer applications and the use of a fertigation well could reduce nitrogen loading from this source. A fertigation well could be sited and operated to

recapture nitrogen within the groundwater and re-apply it to the golf course as a combined source of fertilizer and irrigation (see Figure 9). Turfgrass is capable of attenuating and estimated 80% of the applied nitrogen. Fertigation wells could also be utilized in residential areas and public parks and gardens.

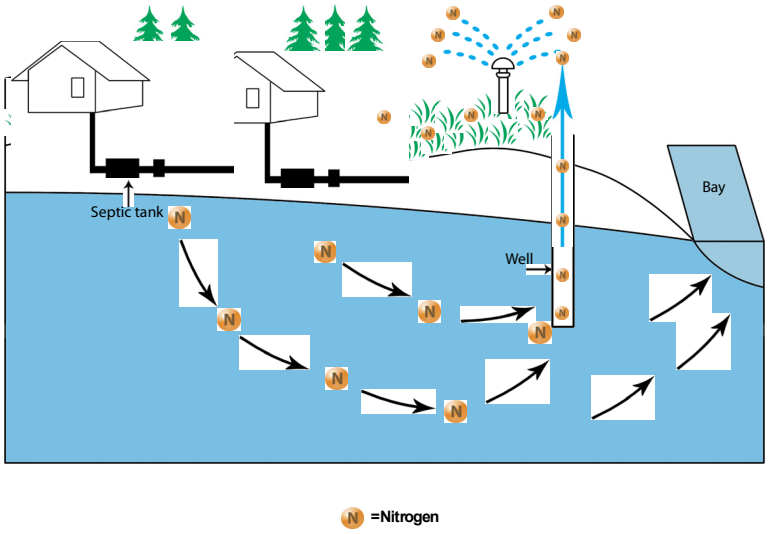

Figure 9 – Fertigation Well

5. Contingency Plan (B) – Backup Collection System & Treatment Plant – In the event that the mitigation measures used to reduce the nitrogen load into the Tashmoo watershed does not meet the required reduction goals set forth in the MEP report, the Watershed Management Permit requires a contingency plan to be developed and in-place. As such, the contingency plan for Lake Tashmoo includes a combination of conventional sewering and innovative & alternative septic systems that have achieved General Approval use and have a demonstrated track record of nitrogen removal levels in the State of Massachusetts (see figure 10). A preliminary design for the sewer collection system has been prepared by Environmental

Partners as part of their work on the CWMP[17]. This plan is likely to be modified if it were to be further developed into a more detailed design.

As presented in the Environmental Partners Memorandum summarizing options for the Lake Tashmoo Watershed, the conventional sewering plan would include constructing five sewer zones (including the B2 Zoning District discussed earlier in this report) with an estimated flow 67,150 gallons/day and an estimated nitrogen load reduction of 2305 kg/year. The nitrogen load calculation incorporates a distribution of the effluent disposal between the Tashmoo and Lagoon Pond watersheds at the effluent beds located at the Emergency Services Building (ESB).

The contingency plan also identifies the deployment of approximately 183 septic system upgrades within the town of Tisbury using I&A systems rated at 19 mg/liter effluent that have MADEP General Approval. The estimated nitrogen reduction from these systems is estimated at 2.03 kg/year-system or 373 kg/year[18]. EP estimates that a total of 460 upgrades would be required to meet the estimated current TMDL/MEP goal by reducing the nitrogen load by 3243 kg/year. They also indicate that there are only 435 existing Title 5 systems within Tisbury that could be upgraded (outside of the sewer zones) and that additional upgrades would be needed in West Tisbury and/or Oak Bluffs.

To achieve the TMDL/MEP goals in 2043 with the anticipated future growth within the watershed will require a total reduction of 4266 kg/year. Using conventional technologies only this would require an additional 552 I/A (General Approval) systems. In summary the conventional plan (for year 2043) would require sewer collection system with a wastewater flow of 67,150 gallons/day and 1012 General Approval I&A systems.

[17] Environmental Partners, Memorandum "Tisbury CWMP Conventional and Cluster Alternatives for the Lake Tashmoo Watershed", July 13, 2023.

[18] The reduction of 2.04 kg/yr. is based upon an assumed effluent of 19 mg/liter and an average household wastewater flow of 203 gals/day. The MEP report estimated household flows at 171 gals/day. This would reduce the estimated reduction at 19 mg/liter to 1.71 kg/yr.

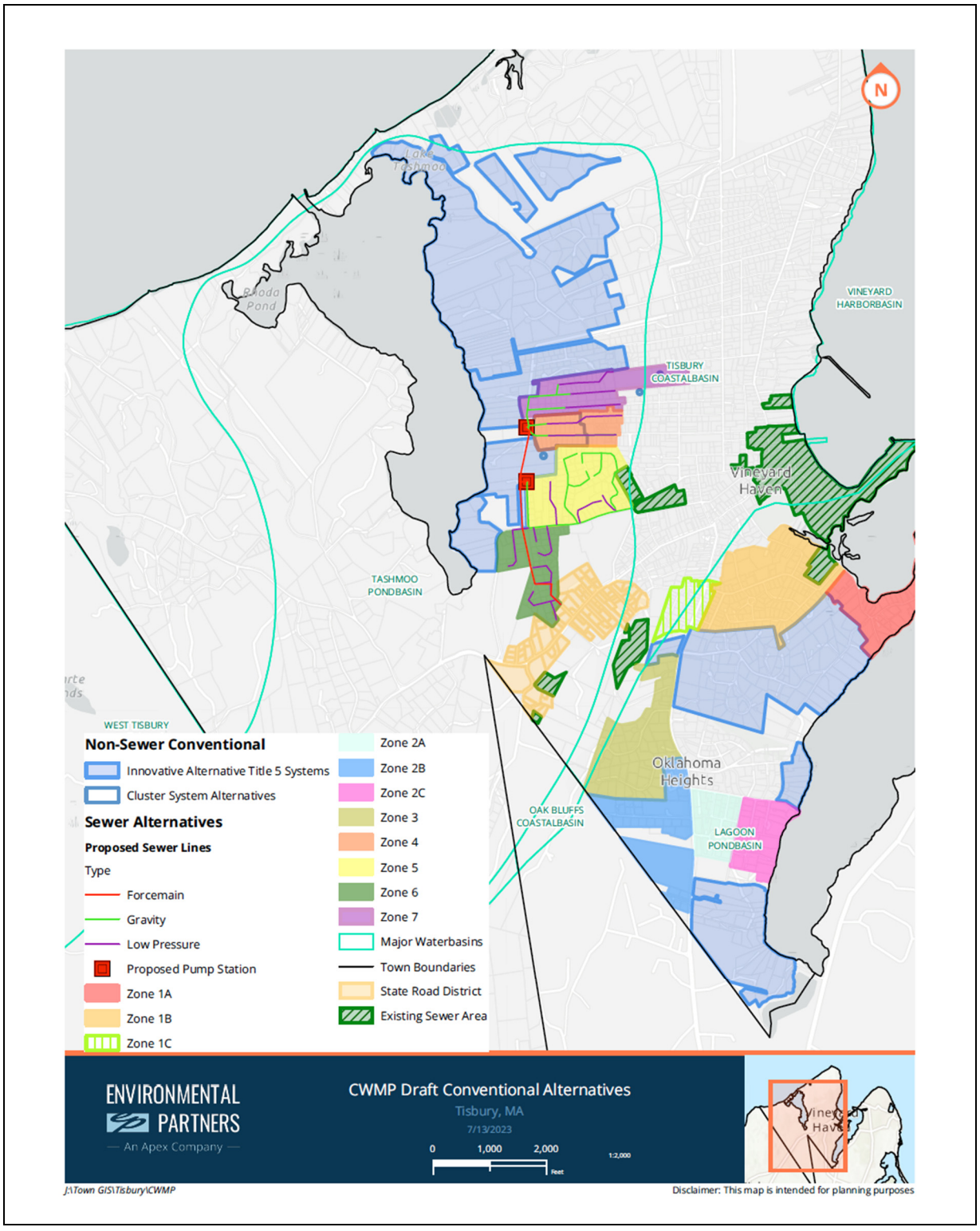

Figure 10 – Conventional Plan for Lake Tashmoo Watershed (Source: Environmental Partners)

6. Growth Management

The restoration plan assumes that future development and growth within the watershed during the next twenty years continues at a rate similar to the 2010 – 2023 period. There are several possible factors that could alter these future projections. The real estate market and economy is a significant driver and is difficult to predict.

Transfer of Development Rights (TDR) is a zoning approach to reduce the intensity of development within the watershed and re-direct future growth to less sensitive areas that have higher assimilative capacity for additional nitrogen or to the town center areas where sewer infrastructure already exists. This could be accomplished using a transfer-of-development rights (TDR) regulatory mechanism. TDR is a growth control option that can be adopted as part of the town's zoning bylaw. TDR provides the option (and incentive) to trade or transfer development rights from those watersheds that are most threatened by excessive nitrogen from future development to those areas of town that have more capacity.

Open space preservation and land acquisition is another option to reduce future nitrogen levels in the Watershed. Specifically, reductions can be achieved by acquiring developable land as part of an open space/land conservation program. The Vineyard Conservation Society and the Marthas Vineyard Land Bank have been active in acquiring open space and developing conservation restrictions.

7. Costs & Financing

Preliminary cost estimates for the recommended hybrid restoration plan and the contingency backup plan using conventional technologies are summarized in Table 9 below.

To estimate costs we have applied the preliminary cost estimates for sewering and upgrades to the wastewater treatment plant provided by Environmental Partners (EP) as part of their work on the CWMP[19]. This includes the costs associated with the B2 sewering district (which is constant in both the conventional contingency plan and the recommended hybrid plan). It also includes four additional sewering areas (zones) and upgrades to the wastewater treatment plant. The number of I&A upgrades (583) to meet existing (2021) nitrogen loads included in the conventional plan was also derived from the EP Memorandum. We have revised that number of upgrades (1012) to account for future growth out to year 2043. Cost estimates for I/A upgrades using technologies with General Approval were estimated at $35,000 - $45,000.

The cost estimate for the recommended hybrid plan includes the same sewering cost estimate for the B2 zoning district. It also includes a range of 746 – 838 upgrades to septic systems using

[19] Environmental Partners, Memorandum "Tisbury CWMP Conventional and Cluster Alternatives for the Lake Tashmoo Watershed", July 23, 2023.

E-I/A technology with a range of performance from 8 – 10 mg/liter. The cluster/neighborhood system at Lake Street Park was estimated to cost $1,776,000 – 2,005,000. Cost estimates for upgrades using E-I/A technologies were estimated at $45,000.

Table 9 - Preliminary Cost Estimates

Conventional	low	high	Hybrid (Alternative)	low	high
B2 Sewer	$3,454,000	$3,454,000	B2 Sewer	$3,454,000	$3,454,000
Additional Sewers & WWTF Upgrade	$17,635,650	$20,587,150	Cluster System	$1,776,000	$2,005,000
I&A Upgrades (19 mg/liter)	$35,411,765	$45,529,412	EIA Upgrades	$33,570,000	$37,710,000
TOTAL	$56,501,415	$69,570,562	TOTAL	$38,800,000	$43,169,000

There are various options for financing the project. A summary of potential financing mechanisms is described below.

7.1 Short-Term Rental Tax

Legislation was signed into law in December, 2018 which expands the room occupancy excise, G.L. c. 64G, to short-term rentals of property for more than 14 days in a calendar year, starting July 1, 2019 for which a rental contract was entered into on or after January 1, 2019. According to the most recent data provided, the town of Tisbury collects nearly $1 million per year from this source. Therefore, over the next 20 years it is estimated this fund could generate in excess of $20 million.

7.2 Cape Cod & Islands Water Protection Fund

Currently this Fund is limited to Cape Cod communities. However, Martha's Vineyard communities may join. Preliminary projections for revenue to be generated by the Cape Cod & Islands Water Protection Fund (CCIWPF) amount to $18 million annually. A tax rate of 2.75% is applied to stays in hotels, motels, B&B's, other lodging establishments as well as short-term rental properties rented in excess of 14 days in a calendar year. The revenue will be awarded to communities in the form of principal subsidies on loans issued through the State Revolving Loan Program.

7.3. American Rescue Plan Act (ARPA)

In 2022 the United States Congress passed legislation authorizing funding to assist states and local governments with infrastructure funding. Current discussions at the Barnstable County Commissioners suggest that these funds will be available to subsidize the Cape & Islands Water Protection Fund and the Barnstable County Septic Loan (Aquifund) Program.

7.4 Barnstable County Septic Loan (Aquifund) Program

Historically this loan program has been administered by the Barnstable County Department of Health & Environment and assists homeowners to upgrade hydraulically failed septic systems

(I.E. septic systems that fail to pass a Title 5 inspection). This program has recently been expanded to include system upgrades that adds E-I/A septic treatment in the form of lower interest rates and potentially loan forgiveness.

7.5 Stabilization Fund

A new Town sponsored Stabilization Fund could be established to dedicate a portion of some of these new revenue streams to fund the comprehensive management of the town's water and wastewater needs rather than that revenue being credited to the General Fund.

7.6 Sewer Assessments

Chapter 83 of the General Laws allows for the issuance of assessments to property abutters for a proportional share of the cost for a common sewer. The town will make every effort to maximize the number of property abutters on a specific sewer project to keep the proportional share of the costs to the least amount possible. The town could set an upper limit on the sewer assessments and subsidize them depending upon the amount of principal subsidies received from the CCIWPF and tax revenue generated from meals and rooms taxes. A reasonable upper limit is often defined as the average cost to replace a septic system, since property owners that do not live in an area that has municipal sewer, are required to fund that eventual replacement of their septic system themselves.

When sewer connections become available, property owners typically have to commit to pay the assessment even if the connection to the sewer does not happen immediately, As such, property owners have the option to pay the sewer assessment in full, or apportion the cost to future tax bills for up to 30 years under Chapter 83 of the General Laws. The interest rate applied to the apportioned assessments is either 5%, or by vote of the Selectboard, can be at a rate up to 2% above the net rate of interest chargeable to the town for the project to which the assessment relates.

7.7 System Development Charges

This is a fee in the utility industry that is charged to new customers of a utility system to pay for the investments made into the "backbone" of a system. There are three (3) methods that could be used to calculate the charge:

- Historical buy-in method – typically used when the existing system has sufficient capacity to serve new development now and into the future;
- Incremental cost method – typically used when the existing system has limited or no capacity to serve new development and new facilities are needed to serve the next increment of new development;
- Combined approach – typically used where some capacity is available in parts of the existing system, but new or incremental capacity will need to be built in other parts to

serve new development in the near future. The financing plan includes a system development charge that would be paid at the time of connection to the sewer system

7.8 Debt Issuance, State Revolving Fund (SRF), and Massachusetts Clean Water Trust

When debt is necessary to finance capital improvements, the town either issues General Obligation Bonds through the capital markets or obtains loans through state agencies such as the Department of Environmental Protection's Massachusetts Clean Water Trust (MCWT) and the State Revolving Fund (SRF) that offers municipal infrastructure financing programs at low (or no) interest rates, occasional principal subsidies, and with attractive repayment terms.

The MCWT/SRF offers 0% loans for projects that contribute to nutrient enrichment reduction; 1.5% loans for Housing Choice Communities and 2% loans as a standard option. The loans can be amortized for up to 30 years provided the asset has a useful life exceeding that time period.

Project costs that are not financed through the MCWT/SRF will be financed with a General Obligation Bond issue in the capital market. The town's current bond rating is AAA and should result in 20-year loan rates of approximately in the 4% to 6% range under current market conditions.

7.9 Federal & State Grants

Most grants available from state and federal agencies for sewer infrastructure require target pilot projects and innovative or "green" projects. Grants are typically not available for standard utility infrastructure needs such as replacing sewer mains or building of pump stations to meet on-going demand. Federal and State assistance has been directed to the MCWT to date which has allowed for the favorable borrowing conditions mentioned previously. This financing plan assumes this method of assistance will continue.

7.10 Property Taxes

The financial plan can include property taxes as a funding source for the program. They may be in the form of an operating override dedicated for a capital or debt exclusion to cover some or all of a project's cost, or a reprioritization of the existing tax levy for this purpose.

7.11. Tax Credit

The Commonwealth of Massachusetts currently provides a tax credit of $6000 for septic system upgrades. This provides a direct cash credit to homeowners. Pending legislation seeks to increase this tax credit to $16,000.

8. Implementation Schedule & Adaptive Management

Implementation of the plan will take place in four, 5-year phases over the 20-year planning period (see Table 10). Adaptive management will be used to track progress and modify strategies as necessary. For example, the number of E-I/A systems can be increased if average effluent concentrations are higher than the planned 10 mg/liter effluent. The number could also be increased to substitute for any shortcomings in other strategies such as fertilizer and stormwater management. The number could also be decreased in the event that they perform better than 10 mg/liter as assumed in the plan. The number of anticipated upgrades will be adjusted at the end of each 5-year phase.

Table 10 – Implementation Schedule

Phase	Design	Construction	Nitrogen Reduction (kg/year)
1	Lake Street Park Cluster	B2 Sewer, 140 EIA	1098
2	Stormwater Retrofits	Lake Street Park Cluster, 160 EIA	905
3	Fertilizer Reductions	Stormwater Retrofits, 180 EIA	870
4		Fertilizer Reductions, 180 EIA	805
5		180 EIA	691
Total			4369

Note: Nitrogen reductions associated with EIA installations are calculated based upon an average wastewater flow of 171 gallons/day, influent at 26.25 mg/liter and effluent at 10 mg/liter = 3.84 kg/year-system. Nitrogen reductions associated with other plan elements are derived from Table 6 of this report.

To estimate the implementation and adoption rate for the installation of E-I/A system Tisbury Board of Health records were reviewed relative to replacement/upgrade septic system permits issued. During the 2018 – 2022 period there were 62 upgrades (or an average of 12 per year). This was prior to the new health regulation adopted in 2022 which now requires upgrades for all new construction, and as well as for any system repairs. The Tisbury Board of Health has proposed an amendment to the regulation that would be to require upgrades upon all property transfers, i.e.; even if the system passed a standard Title 5 inspection.

According the LINK real estate service there were 858 real estate transfers in Tisbury during the ten-year period 2013-2022 period[20]. This equates to an average rate of 86 transfers per year. In that there is 6.5 square miles of land in Tisbury this represents 14 transfers/square mile-year. Prorating this data to the Tashmoo watershed (4.15 square miles) yields an estimated 55

[20] LINK data provided by John Best

transfers/year. Over the 20-year planning period this represents an estimated 1154 real estate transfers.

Based upon this data it appears that the proposed installation of 838 E-I/A systems can be achieved by a combination of required system upgrades and property transfers driven by the real estate market processes.

Another possible approach to implementation would be to prioritize upgrades to existing septic systems closest to the shoreline first. The Tisbury Health Department has prepared an inventory of existing systems within 500 feet and 1000 feet of the shoreline. This represents a groundwater travel time of approximately 1.4 years and 2.8 years respectively and would provide expedited, real-time water quality improvements in the estuary[21].

As noted, the number of E-I/A upgrades will be monitored throughout 20-year planning period. If necessary, additional upgrades can be required through the adaptive management process. For example, the health regulation could be amended to require upgrades of all systems within a 1000-foot distance of the shoreline to expedite the number of upgrades and the resulting in restoration of water quality in Tashmoo.

The hybrid plan is designed to be implemented over a twenty-year timeframe using an adaptive management approach (see figure 11). At the end of each five- year phase the effectiveness of the plan at achieving nitrogen loading reductions will be evaluated. Accordingly, adjustments will be made to the plan as needed.

The number of enhanced innovative and alternative (E-I/A) septic systems that will be required to meet the TMDL/MEP threshold will depend upon their treatment performance. The plan includes 838 E-I/A systems assumed to be discharging nitrogen at 10 mg/liter as well as a cluster E-I/A septic system proposed for the Lake Park area of the watershed. If the performance of these systems continues at the existing average effluent of 7.4 mg/liter the number of required individual home E-I/A systems to meet the target threshold might be able to be reduced.

A conventional sewer collection system is included as a contingency in the plan. In the event that the enhanced innovative and alternative (E-I/A) septic systems cannot perform at 10 mg/liter or better, portions of the contingency sewering plan can be implemented. This would occur in phases according to the preliminary sewer collection plan and modifications that are made in the future.

[21] Groundwater flow velocity on Martha's Vineyard are estimated at approximately 1 foot/day.

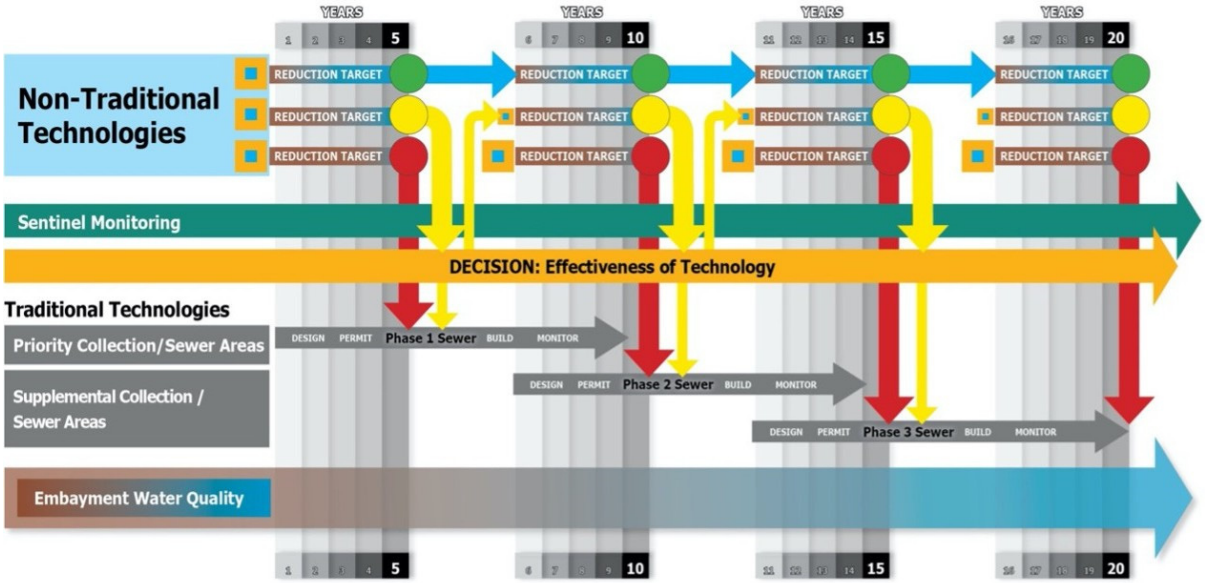

Figure 11 - Adaptive Management

Responsible Management Entity (RME): An important component of an enhanced I/A septic system program is the development of a Responsible Management Entity (RME). The RME will be responsible for compiling and reporting the monitoring data to determine the overall effectiveness of these systems in removing nitrogen. They may also be responsible for oversight of operation and maintenance to ensure that they systems are property functioning. Currently, the Barnstable County Health and Environment Department is evaluating the possibility of providing some of these RME services. The Cape Cod Commission has organized an RME working group and is in the process of developing options for communities looking to establish an RME. It is likely that an RME can reduce annual operation and maintenance costs by integrating remote sensing of mechanical system operational status and economies of scale in providing coordinating sampling services across an entire Town or Watershed.

A significant part of the proposed plan relies upon these E-I/A systems and their cumulative benefit at reducing nitrogen loading to Tashmoo. As with most wastewater treatment technologies, their effectiveness is largely dependent upon a well -coordinated management program that optimizes design, installation, operation, and monitoring. A responsible management entity (RME) is being considered to provide this function.

In the specific case of the Tashmoo Watershed, the town of Tisbury is well positioned to function as the RME for this Watershed Management Plan. The Tisbury Health Department has already adopted a Health Regulation requiring the installation of E-I/A systems for all new

construction, expansions, and repairs. They have also developed a detailed inventory of existing septic systems, I/A septic systems, and E-I/A systems currently in use. This inventory includes an analysis of the number of systems within 1000 feet of receiving waters. These "near-shore" systems can serve as a priority area to target additional E-I/A system, as they have a limited travel time (approximately three years) and will result in quicker water quality improvements within the estuary.

Furthermore, the Tisbury Wastewater Department (TWD) can provide operations, maintenance, and monitoring (OMM) services for the proposed single family home E-I/A and Cluster E-I/A systems as their staff includes licensed wastewater treatment plant operators. In addition, the commercial vendors of E-I/A systems (NitROE and Nitrex) can provide remote monitoring systems that can be used by the TWD to ensure that systems are operating as designed. TWD also has a laboratory that can be expanded to provide the required water quality monitoring.

The Tisbury RME could be expanded to provide these services first within the Watershed (to Oak Bluffs and West Tisbury) but then regionally to the six towns on Marthas Vineyard in the future, if necessary. The Up-Island Plan (2022) includes E-I/A as a key component of future water quality restoration and therefore will be utilized throughout the Island as a component of nitrogen pollution mitigation. This was noted as a favored approach because this portion of Marthas Vineyard is relatively low in development density, which means that conventional wastewater collection and treatment systems are unlikely to be cost effective. A regional RME could provide a very cost-effective option for the entire island.

9. Monitoring

Water quality monitoring will be conducted in the receiving waters (at the MEP sentinel station) and at the locations of the nitrogen reduction strategies. Effluent water quality and flow will be measured at the wastewater treatment facilities (including the central wastewater treatment plant and the Lake Street Park cluster project). Enhanced I/A septic systems will be monitored in accordance with MADEP requirements.

Water quality monitoring will also be conducted at the Sentinel Station in Lake Tashmoo and other in-water stations to correlate reductions in effluent nitrogen with observed water quality and ecosystem health improvements over time.

9. Public Participation

The town of Tisbury established a Water Resources Committee that conducts regular (generally monthly) meetings to coordinate the CWMP and TWMP projects. A series of four public workshops were hosted by the Tisbury Water Resources Committee on March 30, 2023, April 13, 2023, April 27, 2023, and July 13, 2023 to discuss and evaluate potential nitrogen reduction technologies applicable to the Lake Tashmoo Watershed. The Plan was presented to the Tisbury Select Board and unanimously approved on July 26, 2023. A copy of this report will be posted on the town website.

10. References

Environmental Partners, Tisbury Comprehensive Wastewater Management Plan, Needs Analysis.

Environmental Partners, Drainage Master Plan, January 2018.

Environmental Partners, Memorandum - Tisbury CWMP Conventional and Cluster Alternatives for the Lake Tashmoo Watershed, July 13, 2023.

Environmental Partners, Memorandum - Tisbury CWMP Conventional and Cluster Alternatives for the Lake Tashmoo Watershed, July 23, 2023.

Gobler, Chris et al., New York State Center for Clean Water Technology, Stony Brook University, Stony Brook, NY "Removing 80%–90% of nitrogen and organic contaminants with three distinct passive, lignocellulose-based on-site septic systems receiving municipal and residential wastewater", Ecological Engineering 161 (2021) 106157.

MADEP Stormwater Handbook, Volume 2 Chapter 2: Structural BMP Specifications for the Massachusetts Stormwater Handbook.

Massachusetts Division of Marine Fisheries (MADMF), Lake Tashmoo, Tisbury, MA Eelgrass Survey, Steven Voss, John Logan Ph.D., Christian Petitpas Ph.D., Mark Rousseau, Fisheries Habitat Program, 2022.

Marthas Vineyard Commission, RJS Development Solutions, and Wright Pierce, Up-Island Management Plan – Possible Management Solutions – 208 Equivalency Report Project, February 2, 2023.

Massachusetts Department of Environmental Protection, Final Lake Tashmoo Estuarine System Total Maximum Daily Load For Total Nitrogen (CN 353.1), August 2017.

Massachusetts Estuaries Project (MEP), Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Threshold for the Lake Tashmoo Estuary, Towns of Tisbury, West Tisbury, and Oak Bluffs, February 2015.

Offshoots, Inc. and Horsley Witten Group, Inc. (2016) Route 6 Stormwater and Vegetation Management Plan (Prepared for Cape Cod Commission).

U.S. Environmental Protection Agency (USEPA), Tisbury Ma Impervious Cover Disconnection (Icd) Project: An Integrated Stormwater Management Approach For Promoting Urban Community Sustainability And Resilience, 2022.