Appendix 3.4: Innovative and Alternative Septic Systems

– BBC West Falmouth Nitrogen-Reducing Report

MAY 2017 **STATUS REPORT**

WEST FALMOUTH NITROGEN-REDUCING SEPTIC SYSTEM DEMONSTRATION PROJECT

PROJECT PARTNERS

This project brought together the town of Falmouth, the Buzzards Bay Coalition, the West Falmouth Village Association, and the Barnstable County Department of Health and the Environment. Funding came from a U.S. EPA grant from the Southeast New England Coastal Watershed Restoration Program.

PROJECT OVERVIEW

For the past 20 years, West Falmouth residents have watched the health of their harbor decline due to nitrogen pollution. The harbor's health became so bad that, in 2002, it was listed on the federal "dirty waters" list as polluted with too much nitrogen.

In 2008, the U.S. Environmental Protection Agency approved a federal pollution limit called a Total Maximum Daily Load (TMDL) for West Falmouth Harbor. The TMDL required the town of Falmouth to take action to reduce the amount of nitrogen being discharged into this ecologically sensitive harbor.

At that time, the largest source of nitrogen was the town's wastewater treatment facility on Blacksmith Shop Road. After the Coalition and local residents advocated for pollution reductions to the harbor, the Massachusetts Department of Environmental Protection set strict permit limits and the town upgraded that facility.

But even with these improvements, the harbor's nitrogen limit will not be met without reducing nitrogen from neighborhood septic systems, which are now the main source of nitrogen pollution to the harbor.

The West Falmouth Nitrogen-Reducing Septic System Demonstration Project illustrates how nitrogen can be reduced by upgrading on-site septic systems. The project set out to answer two major questions:

- **Can existing nearshore homes with on-site septic systems be successfully retrofitted with the best available technology to reduce nitrogen?**
- **Will homeowners participate in a voluntary program that offers a $10,000 subsidy to offset the cost of upgrading their existing system to a nitrogen-reducing system?**

ON THE COVER
Nitrogen pollution from septic systems fuels the growth of algae in West Falmouth Harbor, like seen here in September 2016.

THIS PAGE
Algae grows along the shoreline at West Falmouth Town Dock.

SUMMARY CONCLUSION

West Falmouth homeowners responded enthusiastically to this program. Twenty properties around West Falmouth Harbor were identified in spring 2016, and new septic systems were installed at the homes by the end of the year.

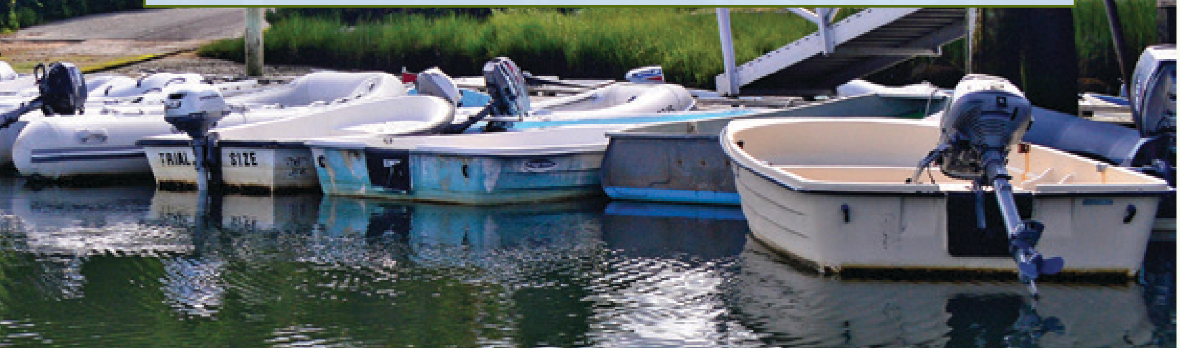
Project partners set out to reduce nitrogen from on-site septic systems at these 20 homes by at least 67%. Data collected to date indicates that nitrogen from these 20 systems has been reduced by at least 78%. The average cost to add on to a conventional Title 5 system was $20,417, while full upgrades from old cesspools cost an average of $33,225.

This project made it clear that it is possible to retrofit on-site septic systems with state-of-the-art nitrogen-reducing septic technology. The availability of septic technology was not a limiting factor – there are many types of systems available that can achieve a treatment level of 12 mg/L or less (about one-third of the nitrogen that's discharged from a conventional system).

Cost was the driving factor in homeowner decision-making, with willingness to pay estimated at $10,000-$15,000 to add on nitrogen-reducing technology to existing systems. Through this demonstration project, each homeowner was offered a $10,000 subsidy, which was sufficient to encourage participation in this neighborhood.

The long-term success of this demonstration project will be determined by how well these nitrogen-reducing systems operate over time and how many additional homeowners choose to follow the lead of these 20 homes. Each system will be sampled monthly for a full year to measure the amount of nitrogen being discharged.

The success of this program has led to a Phase II project, which will upgrade septic systems at an additional 10 homes in 2017 with a reduced $7,500 subsidy.



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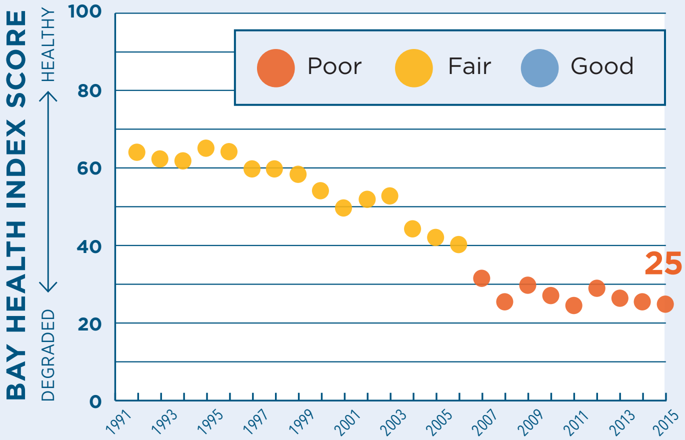
How does nitrogen pollution harm West Falmouth Harbor?

Water quality declines when too much nitrogen gets into the water. Nitrogen fuels the growth of algae that makes the harbor's waters look cloudy and murky. Beaches and boats can become covered with slimy green algae. Over time, underwater eelgrass beds die and fish and shellfish slowly disappear.

Data collected through the Coalition's Baywatchers program clearly tell the story of West Falmouth Harbor's declining health. The Bay Health score for portions of West Falmouth Harbor, such as Snug Harbor, have steadily fallen over time and are now considered "poor," with too much nitrogen pollution for the waterway to function as a viable ecosystem (see graph above right).

Septic systems are the largest source of nitrogen pollution to Buzzards Bay. Even properly functioning Title 5 septic systems cause pollution problems. When you add up all the homes that use septic systems around places like West Falmouth Harbor, they amount to the largest source of pollution.

West Falmouth Snug Harbor

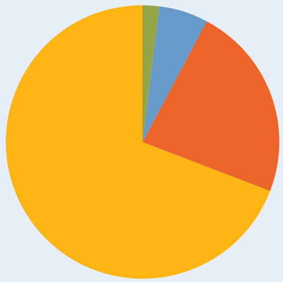


Septic Systems + Nitrogen

Prior to Falmouth's wastewater treatment facility upgrade in 2005 (top), 69% of the nitrogen in West Falmouth Harbor came from the sewage plant. Today (bottom), the primary source of nitrogen to West Falmouth Harbor is septic systems.

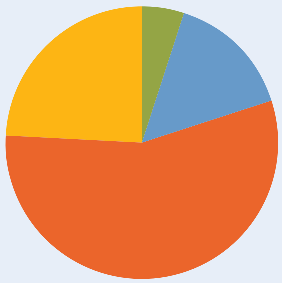
2005

23%	SEPTIC SYSTEMS
69%	WWTF
2%	FERTILIZERS
2%	IMPERVIOUS SURFACES



2016

56%	SEPTIC SYSTEMS
24%	WWTF
5%	FERTILIZERS
15%	IMPERVIOUS SURFACES



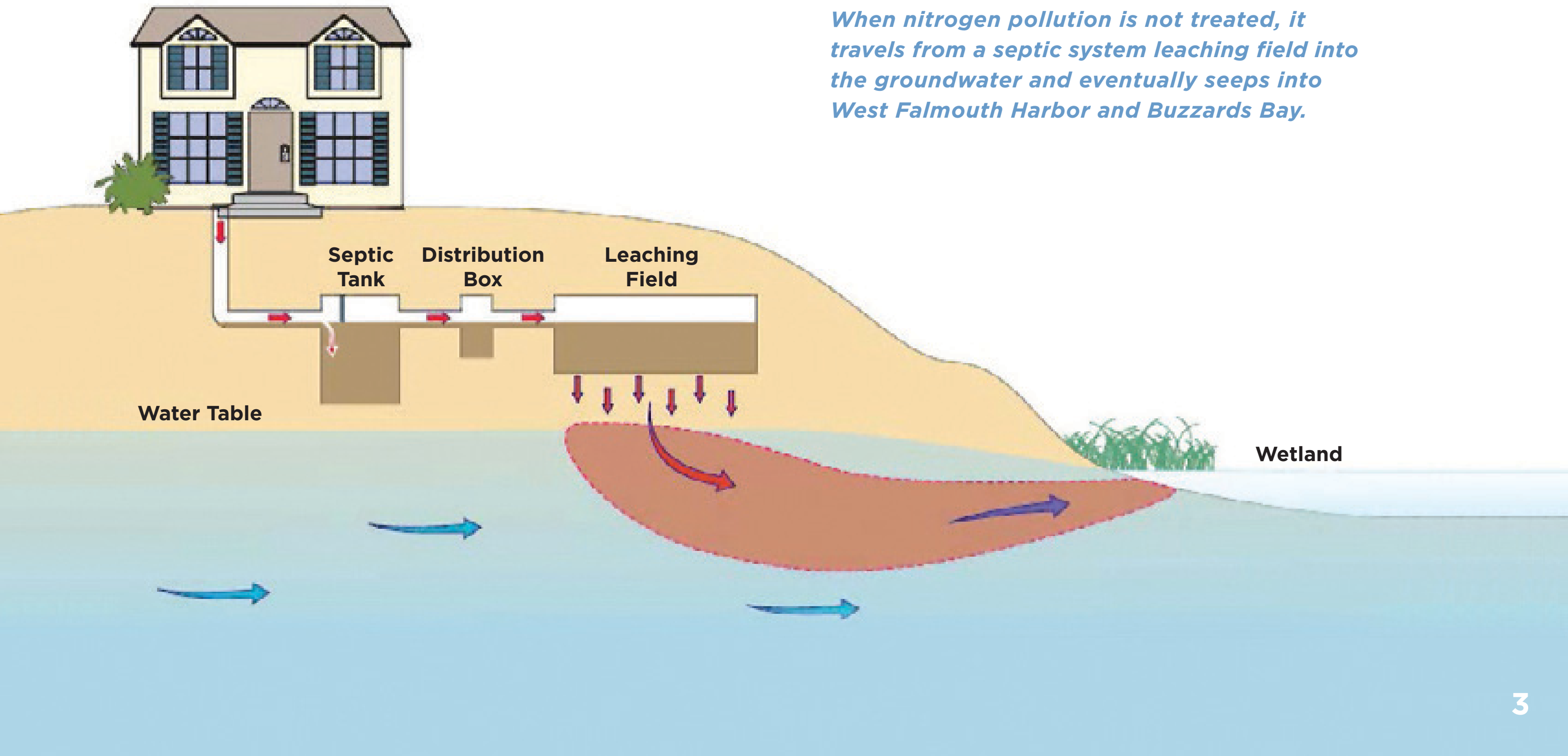
Sources: Massachusetts Estuaries Project (2005), Buzzards Bay Coalition (2016)

THE VALUE OF NITROGEN-REDUCING SEPTIC SYSTEMS

Although centralized sewer systems are highly effective at reducing nitrogen, they can be costly to expand to low-density residential areas. Affordable on-site septic systems that can remove a significant percentage of nitrogen are an important alternative to solve the nitrogen pollution problem, not only in West Falmouth Harbor but in coastal waters throughout southeastern Massachusetts.

Each home on a conventional Title 5 septic system around West Falmouth Harbor contributes an estimated 13.23 pounds of nitrogen to the harbor per year. The nitrogen-reducing septic systems installed through this project were required to reduce that amount of nitrogen to 4 pounds per house per year – slashing the overall nitrogen load from 20 homes by 68%, from approximately 265 pounds per year to 90 pounds per year.

When nitrogen pollution is not treated, it travels from a septic system leaching field into the groundwater and eventually seeps into West Falmouth Harbor and Buzzards Bay.



Participating Properties

Any home within 300 feet of mean high water was considered a potential site for a septic system upgrade. These 170 eligible properties were ranked based on four factors: how close the home was to the water, how close the home was to the Total Maximum Daily Load (TMDL) target water quality station, the type and age of their system, and how frequently the system was used.

Old systems on year-round homes that were very close to the water became the highest priority targets. The Buzzards Bay Coalition and the West Falmouth Village Association approached these homeowners about participating in the project. Support from community leaders also helped catalyze homeowner participation.

Map: Buzzards Bay National Estuary Program

Outer W. Falmouth Harbor
Mashapaquit Creek
Snug Harbor
Harbor Head
Oyster Pond

Types of Denitrification Systems

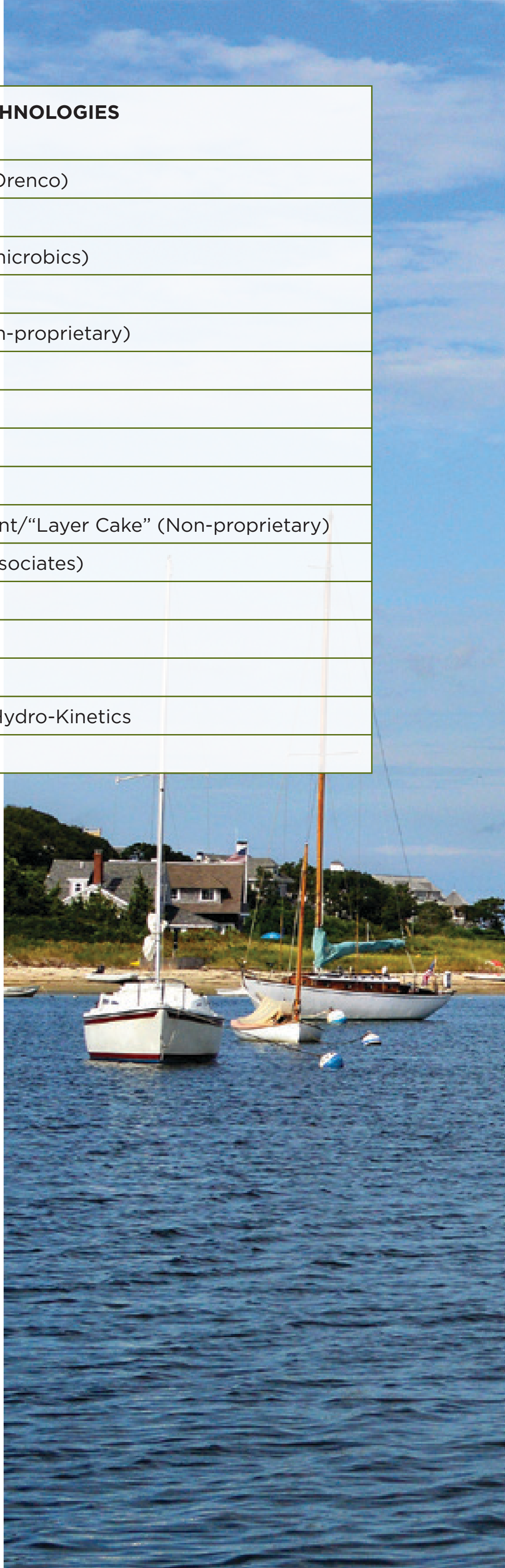
There is a wide range of septic systems on the market that can reduce nitrogen from wastewater. This project considered only the highest-performing systems that could reduce at least 67% of nitrogen compared to conventional systems. Nitrogen-reducing systems that qualified were required to show, through third-party verifiable information, that they were capable of achieving a treatment level of 12mg/L (a conventional system is assumed to discharge nitrogen at 35mg/L). The project team reviewed available technologies and determined that 16 different technologies met this requirement and could be offered to an interested homeowner (see table at right).

To understand how different on-site nitrogen-reducing septic systems work, it's helpful to understand how nitrogen is removed from wastewater. It is a two-step process that involves adding oxygen and then taking it away:

1. Raw wastewater contains ammonia: a form of nitrogen that comes from urine. That ammonia is converted to nitrate by adding oxygen to the raw wastewater. Oxygen promotes the growth of "nitrifying" bacteria that convert ammonia into nitrate.

2. Once the oxygen "nitrifies" the wastewater, the oxygen is taken away by denitrifying the wastewater. There are specific bacteria called "denitrifiers" that convert the nitrate to safe nitrogen gas, which is dissolved into the air we all breathe.

SEPTIC SYSTEM TECHNOLOGIES MEETING 12 MG/L
AdvanTex AX20RT (Orenco)
Amphidrome - SBR
Biobarrier MBR (Biomicrobics)
Bioclere (Aquapoint)
Blackwater Tank (Non-proprietary)
BUSSE Green Tech
Eliminite +Puraflo
GPC
Hoot BNR
Layered Soil Treatment/"Layer Cake" (Non-proprietary)
Nitrex (Lombardo Associates)
NJUN Systems
RUCK
SepticNET
SES Environmental: Hydro-Kinetics
Waterloo Biofilter



A NOTE ON DATA *– Data collection did not begin on all systems all at the same time. The installations of these systems began in February of 2016 with the last one completed on December 26, 2016. Therefore, the data presented here do not represent a full year of operation for all 20 systems. This report will be supplemented to reflect a fuller data set. It should also be noted that these systems need time to grow the necessary bacteria to remove nitrogen. Therefore, initial samples were taken before nitrogen removal was taking place. Regardless, those data were included.*

WHAT SYSTEMS DID HOMEOWNERS SELECT?

These qualifying technologies varied in complexity, aesthetics, energy use, and cost. To help homeowners rank systems based on their preferences, project partners created a Decision Support Tool. The top qualifying systems were then reviewed to assess how feasible they would be to install at each unique property. Systems were selected that could be tailored to site conditions and the needs of the homeowner.

Generally, homeowners wanted something simple, affordable, reliable, and out of sight – no surprises there. Because the majority of the project participants were seasonal residents, systems that operate well on a seasonal basis were popular.

When the project had 10 interested homeowners, project partners held a vendor presentation at a homeowner's house to showcase the most popular technologies. This presentation gave homeowners an opportunity to meet the vendors, learn more about each technology, and ask questions.

Ultimately, of the 14 systems offered, homeowners selected four: two proprietary systems, Eliminite and Hoot, and two non-proprietary, layer cake and blackwater systems. All systems required an operation and maintenance contract and compliance sampling throughout the year.

The next page describes the operation, installation, costs, and performance of these four systems.

Constructing a new septic system on an existing home site presents unique challenges. Partners were able to work with homeowners to find the best solutions that could be tailored to their specific needs and site conditions, such as this Hoot system installed under a small area of yard.

BLACKWATER SYSTEMS

The non-proprietary **blackwater system** was selected for many of West Falmouth's summer homes, which are typically only occupied 8-10 weeks a year. The blackwater system works by adding a 1,500-2,000 gallon concrete storage tank to a standard Title 5 septic system to store blackwater (wastewater from toilets). Because summer cottages often aren't insulated, it's relatively easy to re-plumb interior toilets to a new holding tank. The blackwater holding tank is sized to require only one or two pumpouts per season. An alarmed float meter alerts homeowners and property managers when the blackwater tank is two-thirds full, and a counter tracks the number of times the alarm is triggered.

How Blackwater Systems Remove Nitrogen

Blackwater systems prevent wastewater from entering the harbor by storing it in a tank until a septage hauler pumps out the tank and takes the contents to the Falmouth Wastewater Treatment Facility, where they are treated and then discharged. All other water from the home (sinks, showers, washers) goes to a 1,500-gallon greywater tank, which is discharged to a leach field.

Operating and Maintaining Blackwater Systems

The current estimated annual cost for operating and maintaining a blackwater system is $700. This includes at least two pumpouts per year ($300 per pumpout) and $100 for the annual inspection and total nitrogen sample, which is taken to a lab to confirm performance.

BLACKWATER SYSTEMS INSTALLED	9
AVERAGE INSTALLATION COST FOR FULL UPGRADE FROM CESSPOOL	$25,799
AVERAGE INSTALLATION COST FOR ADD-ON TO CURRENT TITLE 5 SYSTEM	$14,520
AVERAGE NITROGEN CONCENTRATION BEFORE UPGRADE	95 MG/L
AVERAGE NITROGEN CONCENTRATION AFTER UPGRADE	8 MG/L
REDUCTION IN NITROGEN FROM THESE HOMES	92%

ELIMINITE SYSTEMS

Eliminite is a denitrifying septic system developed in Bozeman, Montana. Two 1,500-gallon concrete tanks treat all household wastewater (both blackwater and greywater) for nitrogen. No interior plumbing changes are required, but this system does require a pump and electricity. Eliminite systems worked well for homes with an existing Title 5 septic system and a 1,500-gallon septic tank. Only one additional treatment tank was needed, which reduced the cost for these installations.

How Eliminite Systems Remove Nitrogen

The Eliminite system uses patented, proprietary treatment media called MetaRocks to remove nitrogen from wastewater. The MetaRocks provide a surface area for the nitrifying and denitrifying bacteria to grow. The first 1,500-gallon tank serves as a settling tank, and the second tank is a two-chamber tank which houses the MetaRocks and a pump. The MetaRocks treat the wastewater, and then the pump chamber pumps the treated wastewater out to the leach field.

Operating and Maintaining Eliminite Systems

Eliminites are new to Massachusetts, and the Massachusetts Department of Environmental Protection requires a robust inspection and sampling schedule for new technologies. At this time, annual operation and maintenance costs are $1,319.20. These costs and requirements will go down as data continue to show how the systems perform.

ELIMINITE SYSTEMS INSTALLED	3
AVERAGE INSTALLATION COST FOR ADD-ON TO CURRENT TITLE 5 SYSTEM	$21,040
AVERAGE NITROGEN CONCENTRATION BEFORE UPGRADE	78 MG/L
AVERAGE NITROGEN CONCENTRATION AFTER UPGRADE	30 MG/L
REDUCTION IN NITROGEN* FROM THESE HOMES	62%

These results may not be representative. One of the three homes sampled was under construction during sampling, and total nitrogen results were likely affected by construction constituents (paint thinners, etc.) being washed down drains. However, the results were included here to show the real-life impacts of on-site systems – sometimes bad stuff gets dumped down drains. If that result was removed from the data,* ***the total nitrogen reduction from these systems would be 85%.*

HOOT SYSTEMS

The **Hoot system** is a proprietary two-tank denitrifying system built by Hoot Systems, LLC of Lake Charles, Louisiana. Each tank is divided into two chambers, and all household wastewater (both blackwater and greywater) is treated for nitrogen. Hoot systems require a pump, compressor, and electricity. With several Hoot systems already in the ground and operating across Cape Cod, this locally distributed system was popular due to its track record in the region.

How Hoot Systems Remove Nitrogen

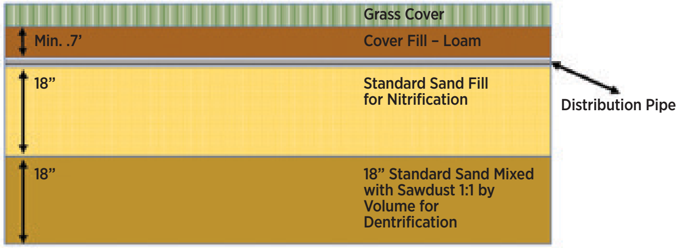
The first chamber acts like a septic tank where the solids and non-biodegradables sink to the bottom. The second chamber adds air to turn ammonia into nitrate. The third chamber takes the air away which promotes denitrification. The final chamber is a pump chamber, which discharges the treated wastewater out to the leach field.

Operating and Maintaining Hoot Systems

At this time, annual operation and maintenance costs are $600.

HOOT SYSTEMS INSTALLED	7
AVERAGE INSTALLATION COST FOR FULL UPGRADE FROM CESSPOOL	$37,726
AVERAGE INSTALLATION COST FOR ADD-ON TO CURRENT TITLE 5 SYSTEM	$28,291
AVERAGE NITROGEN CONCENTRATION BEFORE UPGRADE	63 MG/L
AVERAGE NITROGEN CONCENTRATION AFTER UPGRADE	12 MG/L
REDUCTION IN NITROGEN FROM THESE HOMES	81%

LAYERED SOIL TREATMENT ("LAYER CAKE") SYSTEMS



The **layered soil treatment system**, fondly known as the **"layer cake,"** is a passive, non-proprietary technique that layers sand over a mix of sand and wood cellulose (commonly known as sawdust) in the leach field. Layer cake systems most closely resembles a conventional Title 5 septic system: All wastewater from a house is sent to a typical 1,500-gallon septic tank, with no interior plumbing change required. A pump chamber then sends the wastewater to the modified leach field, where it is evenly distributed over the layered system. For homes that required a completely new septic systems, the simplicity and low maintenance of the layer cake was very popular.

How Layer Cake Systems Remove Nitrogen

As opposed to using treatment tanks like the three other technologies used in this project, layer cakes treat nitrogen in the leach field by passing wastewater through a sand layer (where oxygen converts it to nitrate) and then through a sand/sawdust layer (where there is no oxygen and the nitrate converts to nitrogen gas).

Operating and Maintaining Layer Cake Systems

One of the benefits of the layer cake system is the low operating and maintenance requirements. Other than annual maintenance of a simple pump, this system has no other components that require inspection. Estimated annual costs are $300 or less.

LAYER CAKE SYSTEMS INSTALLED	1
AVERAGE NITROGEN CONCENTRATION BEFORE TREATMENT	56 MG/L
AVERAGE NITROGEN CONCENTRATION AT BOTTOM OF LEACH FIELD	29 MG/L
REDUCTION IN NITROGEN* FROM THIS HOME	48%

**This does not include a full year of data. Results from the Massachusetts Alternative Septic System Test Center indicate that layer cake systems can regularly achieve an 88% reduction in nitrogen.*

Engineering, Permitting, Installation & Costs

Site Design & Engineering

In the town of Falmouth, a registered civil engineer must prepare site plans to place a system on a property. A site plan identifies the placement of all system components – including tanks, compressors, plumbing, and electrical – together with site and groundwater elevations. After homeowners selected their desired nitrogen-reducing technology, they engaged a professional site engineer to design the placement of their systems.

Approval Process - Permitting

After final plans were completed and approved by the homeowner, project partners worked with the requisite town boards to approve the plans. All plans required approval from the Falmouth Board of Health. In most cases, Falmouth Conservation Commission approval was also required because the system was placed within 100 feet of a wetland resource. Both the Board of Health and the Conservation Commission were extremely supportive of the project and the homeowners who voluntarily took action to improve water quality in West Falmouth Harbor.

Additional state permitting was required for the layer cake and Eliminite systems because they were being installed for the very first time in Massachusetts.

Installation

Whether you're installing a conventional Title 5 system or a nitrogen-reducing system, septic system construction on an existing home site presents many challenges. Working around existing buildings, driveways, utilities, landscaping, and often challenging geology with heavy machinery is vastly more difficult than installing a system for new construction on a vacant lot. Nitrogen-reducing septic systems can be more complicated due to the need for additional tanks, blowers, pipes, and control panels.

For this project, installation required heavy machinery to dig large holes for concrete tanks that were over six feet wide and ten feet long, as well as to dig long trenches for piping to bring wastewater from the home to the treatment tanks. These large concrete tanks were delivered on trailers with large booms, which sometimes required moving landscaping to accommodate delivery.

In cases where homeowners were upgrading from a cesspool, underground utilities were relocated to accommodate the installation of a new leach field. Some installations encountered groundwater, which required the use of special equipment to ensure the stability of the hole and pumps to draw down high groundwater during tank placement.

Costs

Installation costs for any septic system range broadly depending on unique site conditions, such as groundwater elevation, soil type, existing building and landscaping features, and condition of each existing system (conventional system or cesspool). The major cost components for this project included engineering, equipment, installation, and landscaping.

A key learning of this project is that higher costs were related to specific site conditions, not the nitrogen-reducing technology itself.

Costs were higher for upgraded cesspools because a whole new leach field was required in addition to installing treatment tanks. A total of 11 cesspools were upgraded as part of this project.

ITEM	AVERAGE COST	COST RANGE
Equipment (denitrification tanks)	**$8,437**	**$4,146-$10,625**
Engineering	**$2,620**	**$606-$4,200**
Installation (adding a nitrogen-reducing system to an existing Title 5 system)	**$11,096**	**$10,600-$15,350**
Installation (full upgrade from a cesspool)	**$20,675**	**$17,720-$25,600**
Landscaping	**$2,142.97**	VARIABLE

Installing nitrogen-reducing septic system technology on an existing home site presents unique challenges to work around existing buildings, driveways, landscaping, and utilities.

Lessons Learned

1 **West Falmouth homeowners wanted to participate in this project.** They all recognized the negative effects of poor water quality on their homes and were willing to take action when offered a $10,000 subsidy.

2 **Neighborhood outreach was integral to the success of this project.** The West Falmouth Village Association and a local septic system installer became key allies in the effort to encourage homeowners to sign up for the project.

3 **Cost, not technology, is the main factor in successfully upgrading septic systems.** There are many vendors of nitrogen-reducing septic system technologies today. That was not the case even a few years ago. Today, the challenge is finding the cheapest option that works for each site.

4 **Upgrading on-site septic systems is not a one-size-fits-all project.** Each home is unique based on a number of challenges, including soils, utilities, home use, siting additional treatment tanks, and proximity to wetlands.

5 **West Falmouth wants more nitrogen-reducing septic systems.** The success of this program has led to a Phase II project, which will upgrade septic systems at an additional 10 homes in 2017 with a reduced $7,500 subsidy.

6 **The West Falmouth project provides a model that can be used to upgrade septic systems and reduce nitrogen pollution in similar neighborhoods all around Buzzards Bay.** Solving the nitrogen pollution problem in Buzzards Bay will depend on septic system upgrades. This project helps point the way forward for homeowners, town officials, and septic installers in all towns.

Although the installation of nitrogen-reducing septic system technology was invasive during construction (top photo), contractors and homeowners found innovative ways to keep the systems out of sight, but still accessible for monitoring. At this home, the homeowners used landscaping to hide the cover of their new Eliminite system in the driveway garden (inset photos).

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Appendix 3.4: Innovative and Alternative Septic Systems

– Draft TMDL Compliance Implementation Plan

DRAFT 1-19-19 with Appendix

Implementation Plan to meet TMDL Compliance for the Oyster Pond Watershed, Falmouth, MA. using Advanced Innovative/Alternative Septic Systems

1.0 Definitions

BOD Biological Oxygen Demand
DEP Department of Environmental Protection
I/A Innovative/Alternative
RME Responsible Management Entity
TMDL Total Maximum Daily Load of Nitrogen in mg/l
TN Total Nitrogen [nitrite, nitrate and Total Kjeldahl Nitrogen [TKN]]
TSS Total Suspended Solids
TWMP Targeted Watershed Management Plan

2.0 Watershed Boundaries

The boundaries of the TWMP watershed will be those defined in the Massachusetts Estuaries Project Linked Watershed/Embayment Model for Oyster Pond, as adopted by Massachusetts DEP and by the Falmouth Town Meeting. The TWMP will designate which properties within the watershed will be required to install an Advanced I/A System.

3.0 Plan: The Town of Falmouth proposes to meet the TMDL for Oyster Pond through a two-phase program using Advanced I/A Systems to remove 3020 lbs/yr of Total Nitrogen from the watershed.

3.1 Advanced Innovative/Alternative Septic Systems: I/A systems meeting less than 10 mg/l TN or at least 75% removal of TN* will be used for all the systems required to be installed in the watershed.

3.1.1 Qualifying systems shall be configured such that no more than one pump for the conveyance of fluid is necessary and the total power consumption of all system components is less than 2.5 kWh/day.

3.1.2 The denitrification portion of the system shall have a carbon source that does not need replacement or replenishment for a period of at least five years and that shall be accessible for easy replacement.

3.1.3 Candidate vendors are referred to the State of Florida Onsite Sewage Nitrogen Reduction Strategies Study(www.floridahealth.gov/environmental-health/onsitesewage/research/b15report.pdf andwww.floridahealth.gov/environmentalhealth/onsitesewage/research/_documents/rrac/hazensawyervol0iireportrappend.pdf) for examples.

*To calculate % removal of TN refer to local Board of Health Regulation FHR 15.0 Approval of Alternative Onsite Septic Systems, 15.3.8 Calculating Compliance Using Mass Loading.

A conceptual model and specifications of systems that might meet these requirements are provided in Appendix I.

3.2 Phased Implementation

3.2.1 Phase 1: This phase of the plan has two purposes and two time lines, one to determine the effectiveness of the permitted technologies and the second to determine if additional dwelling units must be added to meet water quality compliance for the watershed. Phase 1 will include 172 dwelling units (Wright Pierce, Alternatives Analysis report, Table 5-8, Oct. 2017) and will have a duration of six years from the Start Date to evaluate the permitted technologies and ten years from the start date to evaluate the impact on watershed compliance.

3.2.2 Phase 2: This phase of an additional 70 dwelling units (Wright Pierce, as above) will be initiated after ten years if compliance has not been achieved in Phase 1.

4.0 Management

4.1 Property Owner Requirements

Owners of designated properties within a watershed who are required to install an Advanced I/A System must obtain a Disposal System Construction Permit (DSCP) from the municipality within one year of the Start Date (see section 4.3 below). Owners must have completed installation of an Advanced I/A System within three years of the issuance of the DSCP and must grant a right of access to the municipality and its designee to periodically inspect, monitor total nitrogen and other constituents as necessary, maintain and pump the Advanced I/A Systems.

4.2 Municipal Participation

The Town of Falmouth will purchase and supply the designated property owners with the physical components of the Advanced I/A systems, at no charge. The designated property owners will be responsible for the site engineering plans, permitting from town agencies, components of a normal Title 5 System and the installation of the system.

4.3 Responsible Management Entity (RME)

The Executive branch of the Town of Falmouth will designate an appropriate town department as the Responsible Management Entity (RME). The RME will be responsible for record keeping, inspecting, nitrogen and other monitoring, pumping and other maintenance, enforcement, and reporting to DEP on watershed nitrogen TMDL compliance. The RME may engage public or private contractors to perform some or all of these duties. The RME will designate the Start Date for installation of the Advanced I/A Systems within the watershed.

4.4 Advanced I/A Systems Approval

The RME will issue a Request for Proposals (RFP) to vendors of Advanced I/A Systems who wish to have their systems installed in the Town of Falmouth. Responsive vendors must meet the qualifying requirements of the RME, provide bonded warranties and train local technicians in the operation and maintenance of their systems. The RME will designate which vendors' Advanced I/A Systems will be approved for installation in the Town of Falmouth's watersheds.

4.5 Performance Monitoring

4.5.1 Probation Period: Monitoring for TN, BOD and TSS will be conducted by the RME or its designee. There shall be no ownership, management or employee connection between any monitoring contractor and any system or maintenance vendor. Upon installation, all systems will be considered under probation and sampled every other month for one year. However, if a system is not in use for any months during probation (as determined by water meter readings) then the RME at its discretion may alter the schedule to obtain the six required readings during occupied months that may be contiguous. If there are fewer than six occupied months in the year, the probation period may extend up to three years.

4.5.2 After Probation Period: If after the probation period the mean or equivalent nitrogen load reduction has not reached the required standard of 10 mg TN/L or 75% TN removal, the owner shall be responsible for the cost of bringing the system into compliance within one year of notification of this exceedance and shall resume probation period sampling.

4.6 Compliant System Monitoring

Following the Probation Period, 1/12 of the systems in the watershed will be monitored for effluent total nitrogen each month. Properties chosen for sampling that month will be picked with a random number generator that excludes properties already sampled since the previous September 1 (start of the monitoring calendar year) and unoccupied seasonal homes. Each property will be sampled at least once per year at an unpredictable time. If at any future time a system is found to exceed the 10 mg TN/L standard or equivalent nitrogen load (75% removal), it will revert to probation status if subsequent resampling within 60 days indicates non-compliance [see Section 4.5.1 above].

4.7 Operation and Maintenance (O&M)

Advanced I/A Systems must be maintained by the RME in accordance with Mass. DEP standards. In addition to the annual nitrogen monitoring described in section 4.6, the RME will inspect the control panel and other above ground components of the system twice yearly, either by means of remote sensing or onsite examination. An annual system inspection that includes operation and maintenance of the system shall be performed by vendor-trained and certified technicians under contract to the RME within a reasonable time following said annual nitrogen monitoring.

4.8 Pump-Outs

Septic systems will be pumped every five years by RME -approved contractors or as determined by inspection in compliance with 310 CMR 15.35

4.9 Record Keeping

Records will be kept by the RME for each property within the watershed and will be tied to the municipal geographic information system. Records shall include:

4.9.1 Engineered and “as built” plans submitted electronically;
4.9.2 Water readings (from transponder equipped water meters at each property);
4.9.3 Monitoring results for TN, BOD and TSS;
4.9.4 Operation and Maintenance [O&M] records; and
4.9.5 Pumping records

4.10 Reporting

The RME will report watershed compliance to DEP on an annual basis. Compliance may be demonstrated by any of the following:

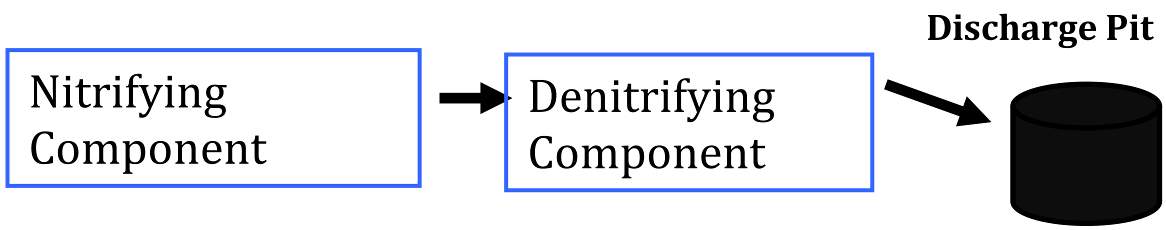
4.10.1 All systems meet the effluent standard of 10 mg TN/L or 75% removal of TN; or
4.10.2 Systems that fail to meet the standard are balanced by systems that exceed the standard; or
4.10.3 The TMDL-mandated water column nitrogen concentration for Oyster Pond is met at the sentinel station; or
4.10.4 The watershed load meets the target load needed to achieve TMDL compliance. The watershed load is calculated quarterly, based on water usage and the twelve month rolling average of accumulated nitrogen documented in the annual sampling data for total nitrogen.

5.0 Fees

Each dwelling unit with an Advanced I/A System will be assessed a fee semi-annually that will cover appropriate RME costs.

Appendix I

Conceptual Model for Nitrogen Removal using Advanced Innovative Alternative Septic Systems to: Achieve < 10mg/L TN or >75% removal of TN



System Performance Requirements:

1. Effluent Total Nitrogen (TKN + nitrate + nitrite) < 10 mg/L or >75% TN removal
2. Effluent BOD, TSS < 30 after 4 months of operation
3. Maximum power usage for entire system shall not exceed 2.5 kWh/day
4. Denitrifying medium must have a replacement requirement of not less than five years and be easily replaced without system excavation .

Nitrifying Component:

There are a number of candidate technologies that might meet the requirements for nitrification. Refer to DEP web site: www.mass.gov/guides/title-5-innovativealternative-technology-approval-letters

Denitrifying Component:

Technologies that might meet the criteria for denitrification would have enclosed chambers with a cellulosic medium such as used in the Nitrex™ and NitROE™ systems.

Discharge Component:

Discharge is proposed with variously sized pits using loading and design criteria from the pre-1995 Code. Tests* indicate that these pits when receiving effluents with a treatment level of TN< 10mg/L and BOD and TSS levels <30mg/L after 4 months of operation will be as effective as currently required field configurations and do so at considerable cost savings.

*Component evaluated at the Massachusetts Alternative Septic System Test Center, a Division of the Barnstable County Department of Health and Environment

Appendix 3.4: Innovative and Alternative Septic Systems

– Falmouth Home Rule I/A Regulations

Draft Additions to the Falmouth Home Rule Board of Health Regulations

15.3 Approval of Alternative Onsite Septic Systems. **1-24-19**

1. **Purpose.**
   In certain situations, alternative septic systems, when properly designed, constructed, operated, and maintained, may provide enhanced protection of the public health and the environment. Notwithstanding the sound technical basis of many alternative technologies, the Falmouth Board of Health seeks, through these regulations, to ensure that those alternative on-site septic systems installed within its jurisdiction are operated in compliance with the appropriate Commonwealth of Massachusetts approvals for these technologies. In addition, by ensuring the completion of all required monitoring, the Board of health seeks to gain information on the efficacy of such technologies and modify its approval process accordingly.

2. **Application Requirement.**
   a. All applications for disposal system construction permits involving the use of alternative septic system components purporting enhanced treatment shall be submitted to the Board of Health which shall hold a hearing to consider their approval. No abutter notification shall be required for this approval except as otherwise required. The Board of Health may deny the use of an alternative septic system if in its opinion the installation of said system is not in the interest of public health.
   b. All applications for alternative septic systems shall be accompanied by a copy of the MA DEP Approval Letter appropriate for the technology indicating the level of approval (General Use, Remedial Use, Provisional Use, Piloting Use, or Site-Specific Pilot Approval).
   c. All applications submitting under Piloting Approval shall be accompanied by performance data from all piloting sites where the alternative system has been similarly configured.

3. **Requirements of Plans.**
   All alternative septic systems shall have sampling ports appropriate for obtaining a representative sample and that are easily accessible and secured from unauthorized tampering. The design plans incorporating the use of alternative septic systems shall contain a clear illustration of all sampling ports, accompanied by an illustration and explanation for their use.

4. **Monitoring Requirements.**
   a. The system effluent of all Innovative/Alternative (I/A) septic systems installed for the purpose of nitrogen reduction must undergo an initial probationary period of two years, during which the system shall be sampled and analyzed quarterly for parameters indicated by the Board of Health. Seasonally occupied homes shall be sampled two or three times during periods of occupancy with a minimum of six

weeks between samples until eight measurements have been made. These requirements are in addition to those stated in the Massachusetts Department of Environmental Protection (MA DEP) Approval Letter.

b. Excluding the first quarter, if at any time thereafter during this initial sampling period a value exceeds the permitted level of any contaminant by greater than 25%, the maintenance contractor must notify the property owner, the Board of Health, and the Barnstable County Department of Health and Environment within 48 hours of receipt of the laboratory results, determine a plan for additional sampling, and initiate corrective action within 30 days. Reported results of corrective actions must include the results of all follow-up samples taken, and must be submitted within 60 days from the initial non-compliant value.

5. Probationary Period.

The probationary period shall conclude after two years of consecutive quarterly measurements, or in the case of seasonal homes after eight samples taken during periods when the home is occupied, if the following requirements are met:

a. No more than two measurements of the primary parameter, as defined by the Board of Health approval letter, exceed the permitted value by more than 25% and

b. The average of the eight measurements is equal to or less than the value permitted for the use of the technology.

6. Reduction of Testing Schedule.

Following successful completion of the probationary period, the applicant may petition to the Board of Health for a reduction of the testing schedule, provided that all of the permitted requirements have been satisfied.

7. System Failure.

If the Board of Health determines that a system is in failure it may at its discretion mandate corrective actions including system upgrades or replacement. The system will be considered in failure if at the end of the probationary period or following a reduced schedule of testing the concentrations of the permitted parameters repeatedly fail to meet the system requirements through either standard sampling results or through the use of mass loading calculations as defined in FHR15.3.8 (below).

8. Calculating Compliance Using Mass Loading.

a. An I/A system that is considered to be failed using standard sample results may still achieve compliance if it can be demonstrated, by use of influent concentration of total nitrogen (TN) and/or concurrent documented reduced water use, that the system meets or exceeds the permitted reduction in nitrogen loading. For example, in a system permitted at 19 mg/l TN, the system would need to meet or exceed a 50% reduction in TN, a system permitted 12mg/l TN would need to meet or exceed a 70%

reduction in TN, and a system permitted at 10 mg/l TN would need to meet or exceed a 75% reduction in TN.

b. Information required for use in this alternate means for determining system performance shall include:
   - Influent TN concentration and the means by which this value was determined;
   - Concurrent water use records in the form of a statement from the Falmouth Water Department;
   - The number of occupants during the period of consideration;
   - Any additional information the applicant considers relevant to the explanation of system performance.

c. When it is not feasible to obtain a system influent TN concentration, a qualified wastewater professional may submit information for consideration for alternate means of determining system performance, which shall be considered by the Board of Health.

9. Reporting Requirements.

Any person or entity that owns, operates, inspects or monitors an alternative on-site septic system or pressure dosed septic system in Falmouth shall cause the results of all monitoring and inspections to be submitted to the Barnstable County Department of Health and Environment in a format designated by that department. All reports regarding maintenance, monitoring, or inspections of alternative septic systems shall be submitted within thirty (30) days of the time when the maintenance, inspection, or monitoring was initiated.

10. Notification with Registry of Deeds.

No certificate of compliance for a septic system that incorporates an alternative septic system that has any regular inspection or service requirement under the MA DEP Approval Letter shall be issued until the applicant has filed with the deed for the property a notice indicating the presence of an alternative septic system and the requirement for a service contract for the life of the system

11. Requirement for Use of Shared Systems.

All subdivisions subject to the requirement of denitrification by any Board or Commission in the Town of Falmouth, shall be required to construct a shared septic system as defined in 310 CMR 15.002 and shall meet a limit of twelve (12) mg/l TN or achieve 70% TN removal at the point where the treatment unit discharges to the soil absorption system. Individual on-site denitrifying septic systems shall be prohibited in subdivisions subject to denitrifying requirements.

12. Requirement for Accessory Apartments.

An accessory apartment, located in a Coastal Pond Overlay District, where there is a request for additional flow (bedroom) shall install an enhanced I/A system meeting a limit of 12 mg/L Total Nitrogen (TN) or achieve 70% TN removal.

Appendix 3.4: Innovative and Alternative Septic Systems

– BBC WFHSSR Project Final Report

FINAL REPORT

West Falmouth Harbor
Shoreline Septic System Remediation (WFHSSR) Project
October 12, 2016

Prepared by:

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1. Background

The town of Falmouth and the Buzzards Bay Coalition (Coalition), with the help of the West Falmouth Village Association, identified more than 20 homeowners within 300 feet of West Falmouth Harbor (WFH) willing to voluntarily upgrade or replace their existing Title 5 septic systems and cesspools with Innovative/Alternative (I/A) septic systems or eco-toilets (either composting or urine-diverting systems). I/A septic systems are referred to as nitrogen-removing systems in this Final Report. The installed nitrogen-removing systems reduce septic tank effluent to at least 12 mg/L nitrogen (N). This high level of *voluntary* participation by homeowners in a program where they incurred significant costs to install nitrogen-removing septic systems is unprecedented.

Moreover, with modest education and outreach by the Town and the Coalition, the number of homeowners and community leaders willing to invest in a nitrogen reducing septic solution soon surpassed the 20 subsidies provided by this grant. A waiting list has been developed with the hope that further grant funds will become available to continue this effort. It is clear that the West Falmouth community is committed to contributing to clean water in West Falmouth Harbor and quickly agreed to do their part in reducing nitrogen pollution. Homeowners contributed more than $275,000 dollars out-of-pocket over and above the $200,000 provided in the taxable government subsidy. We believe that this commitment and investment in improving water quality can be both continued in West Falmouth and replicated throughout southeastern Massachusetts.

Key program goals included:

- Reduce the amount of nitrogen pollution entering WFH;
- Validate the performance of best-off-the-shelf nitrogen-removing septic systems; and
- Demonstrate the benefit of targeting nitrogen-removing septic installations along the shoreline.

WFH fails to meet water quality standards due to nitrogen pollution. WFH is listed as a Category 4a water on the Final Massachusetts Year 2012 Integrated List of Waters. Originally listed as a Category 5 nitrogen impaired waterbody in 2002, a Total Maximum Daily Load, (TMDL) was approved by EPA in 2008 establishing a nitrogen concentration limit of .35mg/L at the sentinel station. Subsequent modeling was done by SMAST for a scenario that included (1) full build-out of the WFH watershed and (2) 0.5 million gallons per day of effluent from the Wastewater Treatment Facility (at the current enhanced level of treatment of 3 mg/L) discharging into this watershed. This scenario modeling found that the nitrogen concentration at the Sentinel Station for WFH would be significantly reduced due to improvements at the Wastewater Treatment Facility (WWTF), going from .464 mg/L to .364 mg/L. Thus, improvements to the WWTF that the Town of Falmouth has *already* implemented almost achieve the TMDL for this watershed, at full build-out. Thus, the actions planned in this Project contribute significantly to achieving the TMDL-compliance goals for WFH.

The best scientific understanding, as documented in the Massachusetts Estuaries Project (MEP) Reports for coastal communities throughout Buzzards Bay, is that wastewater from septic systems is the most significant contributor to nitrogen pollution. Collection systems associated with central sewers in low-density residential areas are costly, making this solution difficult for many towns to afford. Affordable, on-site septic systems and eco-toilets that remove a significant percentage of nitrogen are therefore seen as a critically important technical alternative. The concentration of nitrogen from septic system effluent that has enters a Soil Treatment Area (drainfield) is assumed to be approximately 35 mg/L. Based on water use data from town records as reported in the MEP Report for West Falmouth Harbor, this septic effluent concentration translates into a household contribution of 13.23 lbs N/year to the drainfield or cesspool. These retrofits will meet a nitrogen limit of 12mg/L as opposed to the current 35 mg/L.

Nitrogen-removing septic systems that achieve 66% nutrient removal (to 12 mg/L) should reduce the mass of nitrogen from 6 kg/parcel/year (or 13.23lbs/year) to 2 kg/parcel/year (or about 4lbs/year) in WFH. **This will reduce the overall nitrogen load from 20 homes from ~265lbs/year to ~90lbs/year (removal of 175lbs).**

The removal of approximately 175lbs of nitrogen is equivalent to removing 22% of the fertilizer load from the entire watershed, according to the MEP Report for WFH. It is also equivalent to removing the entire stormwater load from lower Mashapaquit Creek. Coupled with fertilizer reductions that are expected to be realized because of the passage and enforcement of a town-wide Nitrogen Control Bylaw for Fertilizer and the bottom planting of second-year oysters in Snug Harbor, the remediation of these harbor front septic systems may bring West Falmouth Harbor into TMDL-compliance. The ecosystems service that this reduction in nitrogen could accomplish also includes aesthetic improvements (fewer algae blooms), and increased water clarity leading to enhanced eelgrass restoration, which provides invaluable fisheries habitat.

2. Project Implementation

A number of steps were required to successfully complete this Project, including:

- Technology Evaluation
- Participant Selection and Enrollment
- Nitrogen-Removing Septic System Design
- Permitting
- Installation
- Monitoring

2a. Technology Evaluation

A Working Group was convened to review nitrogen-removing septic technologies that qualified to participate in the WFHSSR Project. Members included: Gerald C. Potamis, Wastewater Superintendent; Sia Karplus, Water Quality Technical Consultant; John Waterbury, Ph.D, member Falmouth Board of Health and Water Quality Management Committee; George Heufelder, Director/Chief Health Officer of Barnstable County Department of Health and Environment (BCDHE); Dr. Rachel Jakuba, Science Director, Buzzards Bay Coalition and Korrin Petersen, Esq. Senior Attorney, Buzzards Bay Coalition. To enable comparisons amongst nitrogen-removing septic systems, a vendor questionnaire was developed by the Working Group and sent to fifteen vendors. The questionnaire (Appendix A) asked for the following information; Cost (equipment and installation), Cost of Operation and Management, Monthly Energy Use, Warranty, Number of Pumps, Ability to Retrofit to Existing Title V System, Components visible above ground.

Review of the vendor responses for single-family nitrogen-removing technologies was based on several criteria:

- Proven ability to achieve a discharge concentration of 12 mg/L N based on data submitted by the vendors; and
- Available third-party data.

Based on vendor responses to this questionnaire, a master list of recommended technologies was developed by the Working Group, and provided to property owners. All eco-toilets currently approved for use in the Town of Falmouth were also eligible for installation. This included both composting systems that have received Product Acceptance from the State Board of Plumbers and Gas Fitters as well as urine-diverting and composting systems that have received Test Site Status for installation in Falmouth.

Nitrogen-Removing Septic System Technology Descriptions

- Fifteen commercially-available systems qualified for the WFHSSR Project, including:
  - AdvanTex AX20RT (Orenco) Joseph Soulia 800-230-9580
    http://www.orenco.com/sales/choose_a_system/advanced_treatment_systems/index.cfm
  - Amphidrome - SBR Mollie Caliri 781-982-9300 x 33
    http://www.amphidrome.com/
  - Biobarrier MBR (Biomicrobics) Lauren Usilton 508-823-9566
    http://www.biomicrobics.com/products/bio-barrier-membrane-bioreactor/
  - Bioclere (Aquapoint) Mark Lubbers 774-930-3900 or 508-985-9050
    http://www.aquapoint.com/bioclere.html
  - BUSSE Green Tech Ingo Schaefer 708-204-3504
    http://www.busse-gt.com/
  - Eliminite +Puraflo Tom Kallenbach 406-581-1613
    http://www.eliminite.com/index-1.html#
  - GPC Mike McGrath 508-548-3564
    http://www.holmesandmcgrath.com/index.html
  - Hoot BNR Ron Suchecki 254-299-0821
    http://hootsystems.com/about-hoot-systems/
  - Nitrex (Lombardo Associates) Lombardo Associates 617-964-2924
    http://www.lombardoassociates.com/
  - NJUN Systems Duncan Corley 404-925-1289
    http://www.njunsystems.com/
  - RUCK Mike McGrath 508-548-3564
    http://www.irucks.com/
  - SepticNET Steve Anderson 406-498-6850
    http://www.septic-net.com/
  - SES Environmental: Hydro-Kinetics Camel McGill 401-785-0130 or 508-406-8381
    http://www.seswastewater.com/hydro-kinetic.html
  - Waterloo Biofilter Greg Corman 519-856-0757
    Chris James 519-830-1490 http://waterloo-biofilter.com/
  - SeptiTech Lauren Usilton 508-823-9566
    http://www.septitech.com/staar-residential/

In addition, two non-proprietary technical solutions were developed as this Project progressed, a blackwater storage tank system and the Layered Soil Treatment Area system (Layer Cake).

2b. Participant Selection and Enrollment

To develop a list of priority properties within the WFH watershed, locations were ranked on a scale of 1 to 5 (with higher scores considered most advantageous) based on the following criteria:

- Proximity to Shoreline –Using mapping software, properties directly abutting West Falmouth Harbor and all septic systems within 300 feet landward of mean high tide were identified. Septic systems very close to shore may contribute more nitrogen than properly functioning systems hundreds of feet from shore because there are some nitrogen losses in the septic plume near the leach field. In addition, the short travel time of the plumes from these systems to reach the bay makes their replacement desirable because nitrogen reductions to the bay will occur in weeks or months and not years.
- Proximity to Sentinel Station – A primary goal of this project is to help achieve water quality standards in WFH and meet the TMDL nitrogen concentration limit of .35mg/L at the sentinel station, which is in the Snug Harbor subwatershed. Properties which abut the shoreline within the Snug Harbor subwatershed were ranked highest.
- Type and Age of Septic System – It is presumed that Title 5 septic systems and cesspools discharge approximately the same amount of nitrogen. However, cesspools located in saturated soils close to water bodies will discharge more nitrogen due to the lack of soil attenuation. For this reason, cesspools will receive a slightly higher priority ranking than Title V septic systems for this project. Furthermore, upgrading cesspools has the additional benefit of reducing bacteria and pathogen contamination with positive water quality and public health benefits. The type and age of system will be determined by reviewing Board of Health records for selected properties and through interviews with property owners.
- Annual Occupancy – In order to optimize the reduction of nitrogen currently discharged from properties within the WFH watershed, homes that are occupied year round received a higher rank than homes that are used on a seasonal basis. However, seasonally occupied homes were also selected in order to assess the performance of nitrogen-removing septic systems that are used on an intermittent basis.
- Willing Property Owners – As long as the property fell within 300 feet landward of mean high tide, a property owner's willingness to participate in the project became the ultimate determining factor.

To identify interested households, the Coalition, together with the leaders from the West Falmouth Village Association sent personalized letters and Fact Sheets (Appendix B) to the top sixty priority candidates. This first round of letters yielded 9 commitments to participate. A subsequent letter was sent to the entire list of 170 qualifying properties within 300 feet landward of mean high tide. Follow-up included numerous emails and phone calls as well as site meetings. In addition, the Coalition presented the project at the West Falmouth Village Association's annual meeting in July 2015.

A significant factor in enrolling participants was gaining the support of community leaders. West Falmouth is a close-knit community and once community leaders supported the project, many others residents agreed to participate. In this case it was critical to win the endorsement of a local property management company that many homeowners along WFH rely on for handling technical issues related to their property and to whom homeowners defer to with respect to septic system upgrades. Working in partnership with this property management company we were able to sign up many homeowners for upgrades.

2c. Site Specific Technology Selection

It was not practical to present 15 different I/A systems and 10 different ecotoilet options without a way for the property owner to objectively evaluate each option. For those candidates committed to exploring an upgrade, the Town's Technical Coordinator and the Coalition created a Decision Support Tool (Appendix C) to help homeowners rank systems based on their preferences for such attributes as aesthetics, complexity, energy use, and cost. The town's Technical Coordinator and the Coalition then reviewed the top technologies for installation feasibility and reviewed the top qualified nitrogen-removing septic systems and ecotoilets with property owners. Each property had a unique set of site constraints such as space limitation, proximity to resource areas, depth to groundwater, and existing landscaping features. Therefore, not all of the qualifying systems were feasible to install.

To help property owners gain familiarity with different nitrogen-removing septic systems and their vendors, the Town and the Coalition held a workshop at the home of a WFH resident interested in participating in the project. Based on approximately 15 different homeowner interviews and the results of the Decision Support Tool, six different types of systems were the most popular and those vendors were invited to present their systems. Representatives of the Bioclere, Eliminite, Hoot, Nitrex, and NJUN systems attended. Over ten property owners attended this workshop, along with BCDHE, the Town's technical Consultant, staff from the Coalition and members of the Falmouth Water Quality Management Committee. Most of the homeowners who attended this workshop participated in the Project and those who did not participate are very committed to participating in a future phase. Homeowners top priorities for choosing a system were aesthetics (minimize visual impacts of components above grade), cost, and complexity (number of pumps required). Ultimately, four system types were selected by property owners for installation, and are described in the paragraphs below.

- Blackwater storage as part of a Title 5 system (for seasonal homes)
- Eliminite
- HOOT
- Layered Soil Treatment Area (STA)

Table 1 lists the twenty systems that were installed as part of this Project.

Table 1. System Types Installed and Replaced with Location by Case Study Number

Case Study #	System Type	System Replaced
BW1	Blackwater Holding Tank	Cesspool
BW2	Blackwater Holding Tank	Title 5
BW3	Blackwater Holding Tank	Cesspool
BW4	Blackwater Holding Tank	Title 5
BW5	Blackwater Holding Tank	Cesspool
BW6	Blackwater Holding Tank	Cesspool
BW7	Blackwater Holding Tank	Cesspool
BW8	Blackwater Holding Tank	Title 5
BW9	Blackwater Holding Tank	Title 5
BW10	Blackwater Holding Tank	Cesspool
EL1	Eliminite	Title 5
EL2	Eliminite	Title 5
EL3	Eliminite	Title 5
HO1	HOOT	Cesspool
HO2	HOOT	Cesspool
HO3	HOOT	Cesspool
HO4	HOOT	Title 5
HO5	HOOT	Cesspool
HO6	HOOT	Title 5
LSAS1	Layered SAS	Cesspool

Blackwater Storage

2,000 Gallon Blackwater Tank installed in parallel with an existing Title V systems at the location of Case Study BW9.

In WFH there are many homes that are only occupied eight to ten weeks out of the year. These homes are typically uninsulated and located on small lots in close proximity to wetlands. An innovative, non-proprietary, cost effective solution was developed to enable nitrogen-removing septic systems to be installed in these homes. This system adds a 1500 to 2000-gallon storage tank to a standard Title 5 septic system. Interior toilets are re-plumbed to divert into this holding tank. Thus greywater from sinks, showers, dishwashers and washing machines does not need to be stored. Sizing of the blackwater holding tank is calculated to require only one or two pump-outs per season. An alarmed float meter is installed to alert homeowners and property managers when the blackwater tank is 2/3 full and a counter is also installed to track the number of times the alarm is triggered. Figure 1 shows one of many possible configurations of this system. A total of 10 Blackwater tanks were installed.

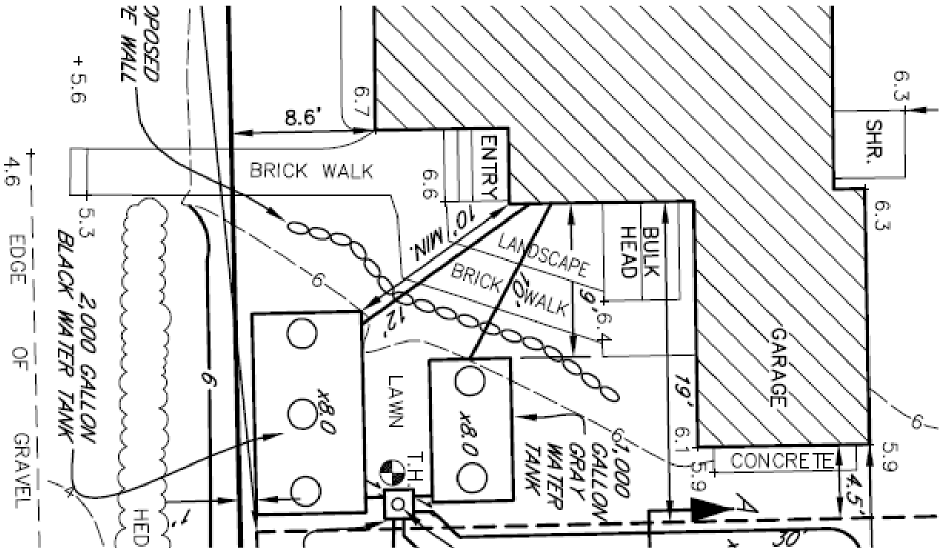


Figure 1. Blackwater Storage Tank Configuration

Eliminite

Eliminite is a fixed-film biological reactor with recirculation and alternating aerobic/anoxic treatment processes. While many models and configurations targeting a variety of wastewater constituents are available, the most basic configuration consists of a single primary settling tank (septic tank) and a single Eliminite treatment tank. The treatment tank houses the fixed-film bioreactor, recirculation/storage volume, level control and effluent pump(s).

Eliminite systems utilize patented, proprietary treatment media called MetaRocks. MetaRocks media represents a significant improvement over other types of trickling filter media common to the industry. Long-term use has proven that MetaRocks possess superior treatment characteristics which are absent from other types of fixed-film systems, including the following:

- High specific surface area in excess of 60 ft2/ft3 provides ample surface for microbial attachment and biofilm development.
- Large void volume exceeding 70% ensures low headloss for efficient air transfer through entire media bed.
- Large average void space diameter of 0.5 to 1.5 inch translates to nearly zero clog potential.
- Rough surface reduces time to maturation and enhances water holding characteristics.
- High hydraulic loading capacity, 250 gal/(min* ft2).
- Polar surface is hydrophilic and wets completely with water.
- Thin liquid surface film allows oxygen to penetrate into the full depth of the developed biofilm.
- Light weight at 7 lb/ft3 allows for deep media bed with no additional structural requirements imposed on the tank manufacturer.
- MetaRocks are free-flowing and take the shape of the vessel they occupy while retaining superior hydraulic and biological properties. This allows for their use in virtually any type of tank.

Eliminite Tank installed in parallel with an existing Title V systems at the location of Case Study EL3.

Eliminite was developed in Bozeman, Montana in 1994 in response to evolving water quality regulations developed by Montana Department of Environmental Quality (MDEQ). The new regulations identified nitrogen, due to its potential mobility in the saturated zone, as the contaminant of primary concern. Between 1994 and 2004, no formal classification for nutrient removal systems existed in Montana. However, early results from the Eliminite technology were so promising that MDEQ allowed them to be installed on a case-by-case basis until the formal rules were prepared. By the time MDEQ finalized the regulations, Eliminite systems had been in use in residential, commercial and community applications throughout Montana for 10 years. Eliminite are now used in hundreds of homes, businesses and government facilities in Montana, Colorado, New Mexico and California. Figure 2 is a technical drawing of the Eliminite System and Figure 3shows the Eliminite process. A total of 3 Eliminite Tanks were installed.

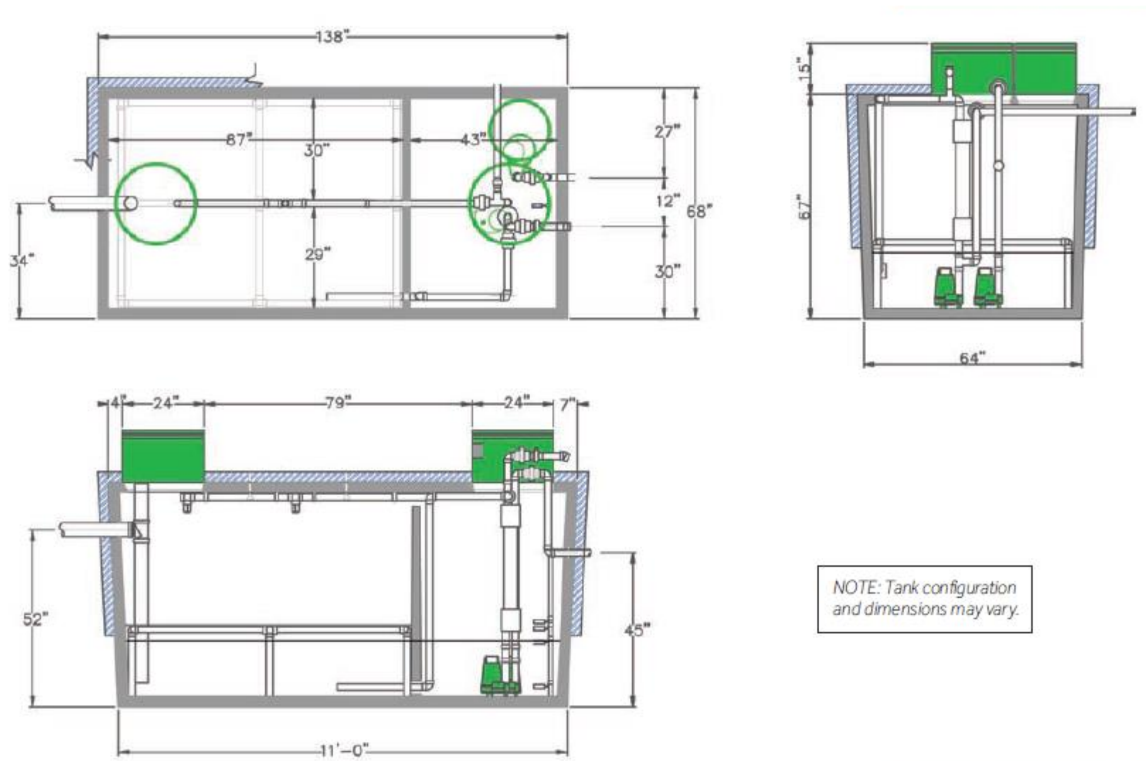


Figure 2. Eliminite Schematic

The Eliminite Process

1. Collection

Sewage flows from the home or facility into a watertight primary tank or chamber. The solids settle and the liquid effluent flows by gravity through an effluent filter to the Eliminte system.

2. Treatment

The recirculating biofilter provides passive biological treatment through an active biofilm matrix. MetaRocks, suspended in the tank, provide large surface area for microorganisms to attach and grow. The Lung supplies additional oxygen to the biofilm through the action of the recirculation pump.

3. Dispersal

Treated effluent is pump dosed from the Eliminite recirculation chamber into gravel trenches, chambers, LPP, drip irrigation or other dispersal methods. Effluent is suitable for reuse. Chemical or UV disinfection may be required.

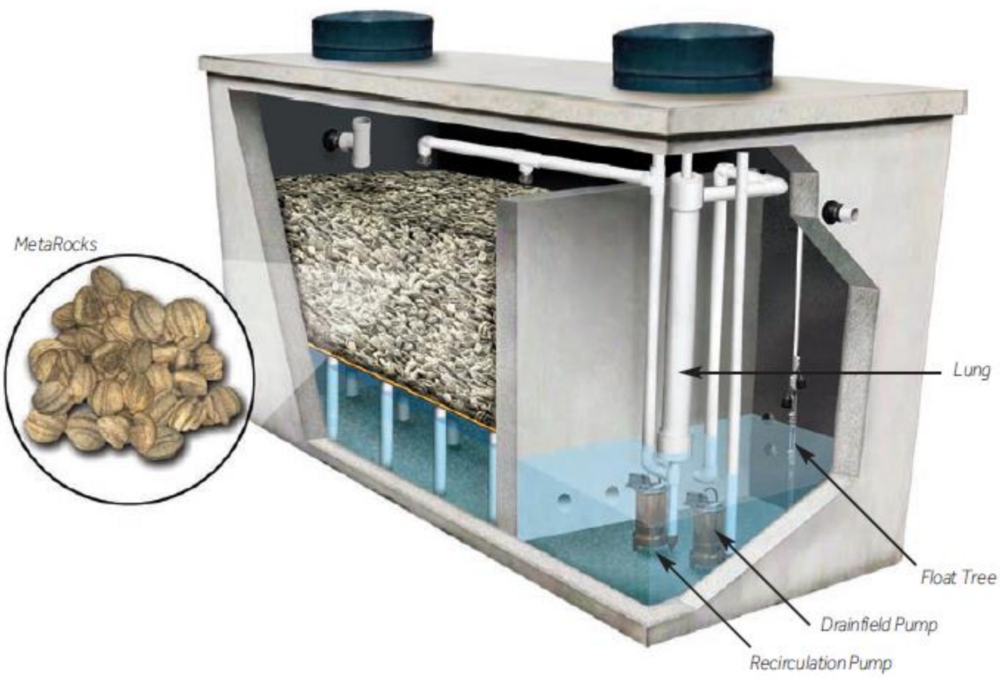


Figure 3. Eliminite Process

Hoot

The Hoot ANR Treatment System is comprised of five components, namely a pretreatment tank, aeration chamber, clarifier, media tank and final clarifier/pump tank.

The pre-treatment tank or trash trap contains the volume of approximately 1 day's system flow. The pre-treatment tank, aids in the anaerobic decomposition of the influent by providing a storage area for non-biodegradables which are inadvertently added to the system. This tank functions like a septic tank, providing a space for components that are lighter than water to float (e.g. fats oils and grease - which should not be added to the system in the first place) and a place for other solids (e.g. hair, dirt and other non-biodegradable solids) to settle A reduction of up to 50% of the Total Suspended Solids (TSS) and approximately 25% of the Biochemical Oxygen Demand (BOD) occurs within this tank. This tank also contains a mid-level, baffled crossover by which the liquid waste enters into the aeration chamber.

The aeration chamber is the heart of the activated sewage treatment of the plant, using a Troy air blower to incorporate oxygen into the sewage. This introduction of oxygen is done to intimately mix the organics of the sewage with the bacterial populations in the aeration chamber. Reduction of the organics is accomplished by these organisms. Excess oxygen not needed for the organic decomposition is utilized by nitrifying bacteria to convert ammonia into the more stable form on nitrogen known as nitrate. Movement of sewage in the aeration chamber also causes the activated sludge that settled in the final clarifier to be re-introduced into the aeration chamber.

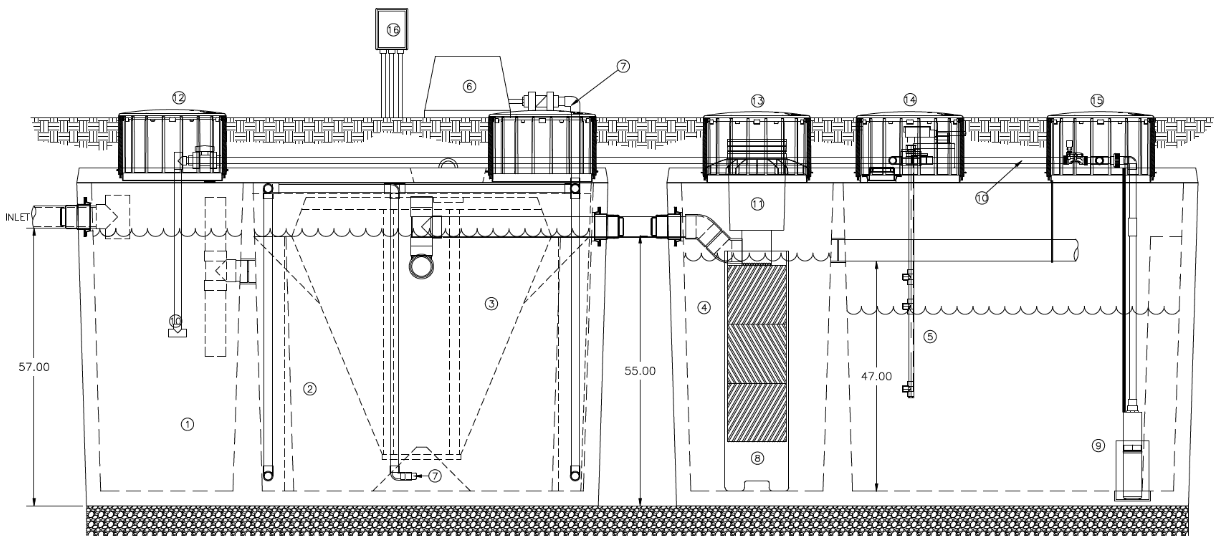
The clarifier is a still chamber located within the aeration chamber and provides a quiescent zone where the clear odorless effluent rises through the outlet, located 6 inches below the surface of the clarifier. This chamber holds approximately ½ day's capacity of effluent which passes from the clarifier into the media tank.

The media tank contains a fixed media surface. This fixed media is an environment optimized for the growth of denitrifying bacteria. A proprietary carbon source, HOOT-CS is added via a peristaltic pump to the wastewater in this chamber, providing the energy needed for *Nitrosomas* and *Nitrobacter* to convert nitrate into N_2, harmless airborne Nitrogen gas. Approximately 78% of the air we breathe is made up of odorless, colorless, Nitrogen gas. The chamber that holds the fixed media cell contains approximately a day's worth of flow volumetrically. From this media chamber, the effluent leaves and passes into an optional final clarifier/pump or directly to the SAS.

Hoot system installed as part of a full upgrade from cesspools at the location of Case Study HO2.

The final clarifier/pump tank is the last treatment component before release to the soil treatment area. This chamber contains a screening device that provides for storage of settled solids to be stored before the final discharge. This storage prevents the solids from reaching the pump so that pump will run cool and last longer. A calculated portion of the daily flow of the system is recirculated from this chamber back to the pre-treatment tank. The pump tank also serves as a storage chamber for holding the treated effluent for disposal at a later time.

All HOOT systems are designed to have a minimum of 12 hours of flow after the alarm to give ample time for service personnel to arrive and correct any problem which may have occurred. Additional storage volume above the chambers in the air space provides approximately 2 days of additional emergency storage. ANSI/NSF Standard 40 and 245 requires a minimum removal of various constituents for wastewater treatment systems. For a system to be certified as a Standard 40 Class I Treatment unit, the arithmetic mean of all effluent samples for Biological Oxygen Demand (BOD) collected in a seven-day period must be less than 45 mg/L. The HOOT ANR System has an average BOD of 6 mg/L with an average influent of 250 mg/L BOD and a Total Suspended Solids (TSS) average of 4 mg/L with an average influent of 300 mg/L, both averaging over a 98% removal efficiency. In Addition to the Class I performance for BOD and TSS, for the Standard 245, the System was sampled 3 times per week for Total Kjeldahl Nitrogen (TKN), nitrate and nitrite to determine Total Nitrogen (TN). The influent in TKN averaged 37.2 mg/L and effluent averaged 5.8, producing a nitrogen removal efficiency of 82%. If the HOOT ANR is properly installed, used and maintained, it is capable of producing similar effluent quality in actual use conditions. Figure 4 shows a schematic of the HOOT system. A total of 6 Hoot Systems were installed.



1) PRETREATMENT TANK– WHERE ANAEROBIC DIGESTION OCCURS AND STORAGE FOR NON–BIODEGRADEABLE MATERIALS.

2) AERATION CHAMBER– WHERE AIR IS INTRODUCED INTO SEWAGE FOR DIGESTION.

3) CLARIFIER– A STILL CHAMBER WHERE SOLIDS SETTLE OUT AND THE CLEAR EFFLUENT RISES.

4) MEDIA TANK – CARBON LOADED MEDIA CHAMBER.

5) PUMP TANK – CONTAINS RECIRC PUMP, CAN PROVIDE PUMPED OR GRAVITY DISCHARGE.

6) TROY AIR LINEAR AIR BLOWER– LONG LIFE, EFFICIENT LINEAR BLOWER WHICH COMPRESSES ATMOSPHERIC AIR AND UNDER PRESSURE DELIVERS IT TO THE TANK. MUST BE LOCATED NO GREATER THAN 6 FEET FROM THE PANEL AND NO GREATER THAN 50 FROM THE TANK.

7) AERATION LINE– DELIVERS THE AIR FROM THE BLOWER TO THE MANIFOLD. CHECK VALVE INCLUDED, TERMINATED AT DIFFUSER INTO TANK.

8) MEDIA BLOCK – FIXED SURFACE AREA FOR FOR ANOXIC DENITRIFICATION TO OCCUR ON.

9) SUBMERSIBLE RECIRC/DISCHARGE PUMP – A SINGLE PUMP (OR MULTIPLE PUMPS) ARE USED FOR RECIRC. & EFFLUENT DISCHARGE.

10) RECIRC. LINE – A PORTION OF THE DAILY FLOW IS REPROCESSED THROUGH THE SYSTEM FOR ADDITIONAL TREATMENT (MIN. 50%)

11) HOOT CS CONTAINER – STORAGE CONTAINER PROVIDES CARBON SOURCE AND A LOW LEVEL INDICATOR.

12) PRE–TREAT/AERATION RISER – ACCESS THROUGH THIS RISER ALLOWS FOR OBSERVATION OF PRE–TREATMENT TANK, RECIRC. LINE, TRANSFER BAFFLE, AERATION CHAMBER & CLARIFIER. ALSO USED TO PUMP SYSTEM.

13) MEDIA CHAMBER RISER – ALLOWS ACCESS TO MEDIA BLOCK, REFILL OF CARBON SOURCE AND LOCATION OF PERISTALTIC PUMP.

14) MEDIA EQUIPMENT ACCESS – PROVIDES ACCESS TO PROBE, PERISTALTIC PUMP, WATER METER AND OPTIONAL UV DISINFECTION (IF EQUIPPED)

15) PUMP TANK/ SAMPLE PORT ACCESS – PROVIDES ACCESS TO PUMP TANK, RECIRCULATION & DISCHARGE LINES OR OPTIONAL GRAVITY FLOW OUTLET. ACCESS TO DISCHARGE EFFLUENT IN TANK OR FROM SAMPLE VALVE.

16) SYSTEM CONTROLLER – OPERATES BLOWER, PUMPS (DISCHARGE, RECIRC. AND PERISTALTIC) AND PROVIDES ALARM NOTIFICATION BY TRIGGERING AUDIBLE/VISUAL ALARM. MUST BE LOCATED NO GREATER THAN 6 FEET FROM THE BLOWER, AND 50 FEET FROM THE TANK.

Figure 4. HOOT systems configuration and component description

Layered Soil Treatment Area (Layered STA)

Layered STA installed as part of a full upgrade from cesspools at the location of Case Study #6.

With funding from various sources, staff at the Massachusetts Alternative Septic System Test Center (MASSTC), which is operated by BCDHE, have been experimenting with a simple, non-proprietary technique of layering soil mixed with wood byproduct (sawdust, woodchips) beneath a standard soil treatment area (STA; alternately known as soil absorption system or leaching field) in order to reduce nitrogen loading. The principle is fairly simple. Components of a standard STA generally convert the ammonia-nitrogen in septic tank effluent into nitrate, which is then leached into the groundwater where it contributes to the over-production of algae and consequent eutrophication of our bays and estuaries. If the percolating nitrate-laden effluent can be first directed through a layer of sawdust matrix and certain conditions are maintained before it reaches the groundwater, the nitrate can be reduced to harmless nitrogen gas (denitrification) and vented to the atmosphere. MASSTC has been studying simple and inexpensive ways to produce the sequential conditions necessary to complete the above-described process. Figure 5 shows the main components of this layered STA concept, which includes a septic tank, pump chamber, pressure dosing system, and 18-inch layer of sand and, 18-inch layer of sawdust matrix. Figure 6 shows the conceptual model that invites the name Layer Cake as well as results from one installation at MASSTC. One Layered STA was installed.

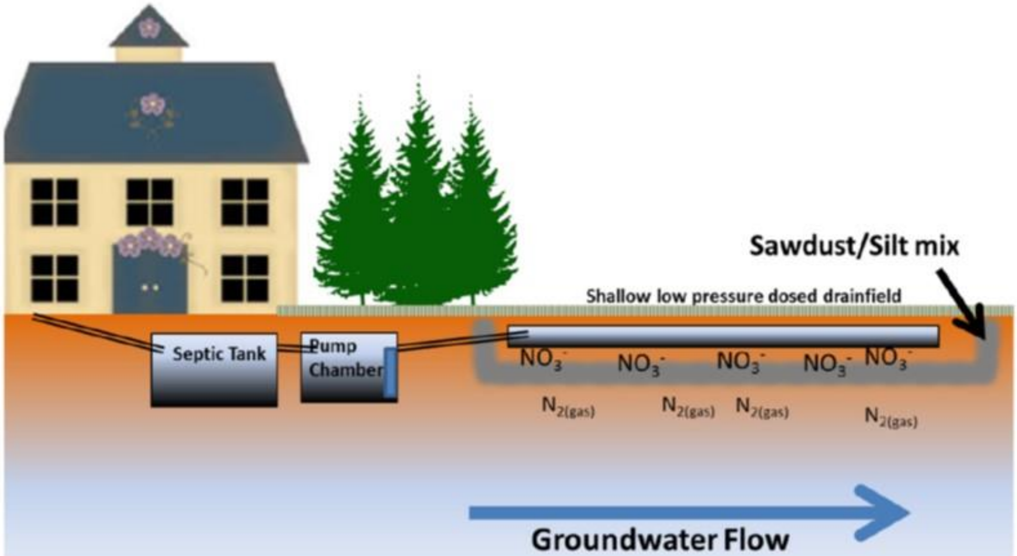
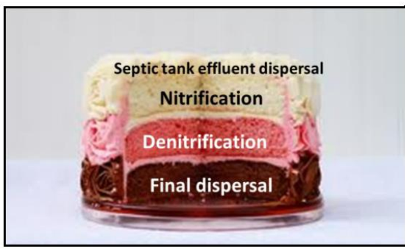
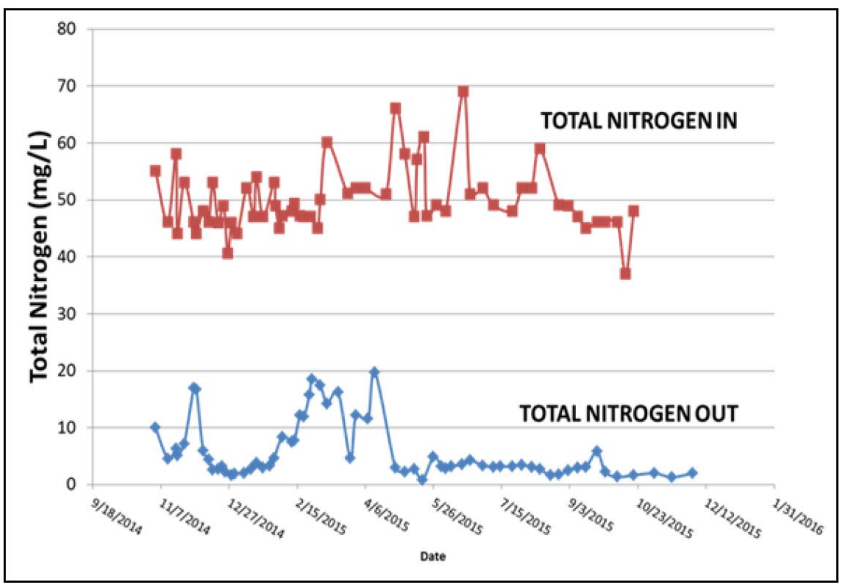


Figure 5. Layered STA Schematic



The concepts detailed here could be described as a ***layer cake,*** *where septic tank effluent passes sequentially through a layer for nitrification, denitrification and then final dispersal.*



Results from one of the three designs being tested at the Massachusetts Alternative Septic System Test Center

Figure 6. Layered STA Test Results

2d. Design, Permitting and Installation

These systems were not only new to the homeowners but relatively new to the engineers and installers and therefore a steep learning curve existed for all stakeholders. It became evident early in the process that the Town Technical Coordinator and the Coalition would have to manage and ensure follow-through of the various steps required to design, permit and install a nitrogen-removing septic system. While property owners were willing to participate, given the timeframe of the grant, none were able to take on the responsibility of project management, which consisted of the following critical activities:

- Technology Selection
- Engineer of Record Selection
  - Coordinating engineering quotes for services
- System Design
  - Coordinating plan preparation with vendors
  - Coordinating location of system components with Conservation and Board of Health agent as well as property owners
- Permitting
  - Meeting with Board of Health and Conservation agents
  - Preparing permit applications
  - Attending hearings
- Installer selection
  - Coordinating installation quotes for services
  - Coordinate timing of installations
- Site management of installations

Once a technology was selected, an engineer of record was hired to prepare plans for the system for Board of Health approval and solicit quotes from qualified septic system installers. The Technical Coordinator and the Coalition worked with these engineers of record and coordinated with vendors and local regulators to ensure plans were prepared correctly. In several cases, percolation tests and site surveys were needed prior to plan preparation. Depth to groundwater, soil types, distance from wetlands and other siting information was specified on all engineered plans.

Town of Falmouth Technical Coordinator and the Coalition interfaced with the Town Health Agent and Conservation Agent to identify and apply for all required permits. Review of draft engineering plans with these agents was often required. The Applications were prepared by Technical Coordinator in collaboration with the property owner and engineer of record, with the selected vendor providing technical information. The approval hearings with the Board of Health and Conservation Commission were attended by the Town's Technical Coordinator, who presented these plans, and the Coalition's Senior Attorney. Four installations required site-specific pilot approvals for technologies not yet approved for use in Massachusetts, the Eliminite system and the Layer Cake. The Town Technical Coordinator worked closely with MADEP to obtain these site specific pilot approvals.

The following list of permits were required for installations. Not all locations required all of these permits.

- Local Board of Health Approval for nitrogen-removing septic systems
- Local Conservation Commission RDA filing
- Massachusetts Department of Environmental Protection (DEP) Site Specific Pilot Approvals for system not already approved for use in Massachusetts

Once plans were prepared and approved, the Technical Coordinator and Coalition worked with participants to identify certified installers from which to request quotes and made these inquiries on behalf of participants. Once selected by participants, scheduling of installations was also coordinated for them.

2e. Site Management of Installations

Participating homeowners relied on the Town's Technical Coordinator and the Coalition as the project manager. In most circumstances, the homeowners were not on-site for the installation and deferred to the Town's Technical Coordinator and the Coalition to be present on site during installation to ensure that the impacts to existing landscaping, and components are located in a way that is acceptable to property owners. Many decisions related to installing septic systems are made in the field. Engineering plans do not typically specify final locations of a number of components, and field conditions often require modifications to engineered plans. Installing the concrete tanks, blowers, pipes, and control panels associated with septic systems often present siting challenges on properties with mature landscaping. Installation requires digging large holes to accommodate tanks that are over six feet wide and ten feet long and digging long lengths of trenches for the piping that brings effluent from the home to these tanks. Delivering concrete tanks on trailers with booms large enough to move them can require moving smaller trees or even cutting larger ones. The disruption to existing landscaping and restoration thereof can increase total installation costs significantly.

Other details of installations require careful management. Coordinating equipment purchase and delivery, as well as electrical and plumbing modifications were all necessary. Another important detail is whether septic tank covers are exposed at grade to enable access to pumps and other system components for maintenance. These covers are twelve to thirty-six inches in diameter and can present aesthetic challenges. In addition, control panels and blowers for aeration must also be carefully located to minimize both noise as well as aesthetic impacts. The importance of a knowledgeable person to oversee installations is critical.

3. Total Project Cost

The total project cost of different nitrogen-removing septic systems is shown in Table 2. Total project costs includes engineering, equipment, installation and restoring landscaping. While the range for the Eliminite and HOOT systems are modest, approximately $1000 and $6000 respectively, the range for the blackwater storage tank option is significant (approximately $15,000). This large range for costs can be explained by the difference in installation requirements. In some cases, existing Title 5 systems were in place and the addition of a blackwater tank and plumbing modifications were all that was required. In other cases, full Title 5 upgrades, including a soil absorption system (leachfield) were needed. The cost range for the HOOT system illustrates the significance of site conditions on installation costs. The low end of the installed costs was a case where there were minimal site constraints. The high end case had significant landscaping constraints, adding to the time required for installation and the extent of landscaping to return the property to existing conditions. For the Layered STA system, the costs associated with a deep excavation and fill were the cost drivers. A standard drainfield would have similar costs.

Table 2. Installation Costs by System Type

System Type	Average Total Installed Cost by System Type ($)	HIGH Total Installed Cost by System Type ($)	LOW Total Installed Cost by System Type ($)
Blackwater Holding Tank	$ 18,274	$ 32,327	$ 13,353
Eliminite	$ 20,760	$ 21,458	$ 19,523
HOOT	$ 34,581	$ 40,425	$ 28,158
Layered STA	$ 42,530 (please see note)	only one installation	only one installation
Layered STA NOTE:	The cost of this installation was dominated by the required 15-foot strip-out of the STA area.		
	The cost for a standard STA (drainfield) would have been comparable.		

Source reduction via nitrogen-removing septic systems will, by and large, require installing these systems on existing properties where there are numerous constraints that limit the area available for tanks and STA (drainfield) siting, including:

- Lot size;
- Location of existing structures on the property;
- Proximity to wetlands;
- Soil types;
- Depth to groundwater; and
- Mature landscaping, including trees.

Installation costs will be significantly affected by these site-specific constraints.

4. Monitoring

Treatment system effluent samples are being taken on a monthly basis at locations just prior to discharge to the final disposal field. Assays for Total Kjeldahl Nitrogen (TKN) and nitrate-nitrite will allow for a computation of total nitrogen concentration. Measurements for Total Nitrogen were taken from septic tank effluents prior to nitrogen-removal septic system installation to estimate initial nitrogen concentrations and loading. Field measurements of temperature and pH will be taken coincident with sampling. As part of site specific pilot approval from MADEP, composite samples will be taken at these locations. All samples will be analyzed at the BCDHE Water Quality Laboratory or their subcontractors, all of whom are certified by Mass DEP to test wastewater. Approved sampling and laboratory analysis protocols, as described in the Project Quality Assurance Program Plan (QAPP) for this Project will be used. BCDHE will provide an analysis of the sampling data in a separate report.

In addition, data on occupancy will be collected and reported. All data is being collected using standard protocols currently in-place at the BCDHE and reported to the BCDHE Innovative-Alternative Septic Tracking System in accordance with Town of Falmouth Board of Health regulations, and data will be made available online with property identity obscured for privacy. This tracking system provides an ongoing, long term reporting system for the performance results of the installed alternative systems. In addition, tracking of the operation and maintenance of these systems is accomplished through this well-established County system.

The Town of Falmouth Water Department installed radio read meters at all twenty properties to facilitate efficient collection of water use data.

5. Lessons Learned

5a. Neighbors in Impaired Waterbodies Embrace Solutions

In addition to the 20 property owners who were the first to quickly agree to participate in the WFHSSR Project, there is now a waiting list of homeowners who would do the same. If grant funds were to become available to enable $10,000 subsidies to be offered, this effort could continue in West Falmouth. The West Falmouth community is committed to contributing to clean water in West Falmouth Harbor and continues to want to do their part in reducing nitrogen pollution.

5b. Project coordination needed

Deeply engaged project management was key to successfully recruiting 20 participants and ensuring that installations happened appropriately and in a timely manner. The Town Technical Coordinator and Coalition's Senior Attorney coordinated myriad details during all phases of project implementation, including:

- Technology selection;
- Development of engineering plans;
- Design;
- Permitting; and
- Installation

The main reason a significant level of project management was required was that local engineers and installers were largely unfamiliar with the nitrogen-removing septic system technologies selected, and the fact that property owners generally did not have time to manage the project due to the seasonal nature of the community. A valuable outcome of this project was the education of engineers and installers with respect to the types of nitrogen-removing septic systems available and how to install them. Due to this investment in educating the stakeholders, it is expected that future projects can be managed by the installer. To ensure that this responsibility is clearly understood, a clear and comprehensive specification sheet should be distributed to installation contractors as part of the request for installation quotations once the engineer of record has completed the site plan. This specification sheet would detail all aspects of the installation that are the installer's responsibility, which is critical for the installer to understand as part of the process of estimating the cost of a job.

Managing the execution of the installation process so that it runs smoothly from the perspective of the property owner is very important. Septic installation contractors are accustomed to managing the complete installation of standard title 5 components including the ordering of equipment and management of plumbers and electricians. An experienced installation contractor will be able to manage all phases of an installation of a nitrogen-removing septic system in a residential location.

While denitrification systems present new equipment or methodologies, installation contractors are able to be responsible and liable for the complete management of installation of these systems. Installation contractor should be able to work directly with equipment vendors to coordinate ordering of equipment, manufacturing of tanks, and installation of pumps, as well as all electrical and plumbing needs. As more nitrogen-removing septic systems are deployed, installers as well as engineers will become familiar with the process. In cases where the selected installation contractor is uncomfortable or inexperienced, a dedicated project coordinator is needed to manage the project and address issues that arise in a timely manner, so that installations are done correctly, both technically and process-wise.

5c. Estimated equipment and installation costs provided by venders were in some cases significantly lower than actual costs

Estimated costs for complete installations from selected vendors of proprietary systems, including labor and materials, averaged approximately $14,000 for the Eliminite system and almost $18,000 for the HOOT system. As shown in Table 2, actual costs averaged approximately $21,000 for the Eliminite system and almost $36,000 for the HOOT system. The key difference between estimated costs and installed was the actual cost of installation, which was affected significantly by site constraints and local installer costs. The Blackwater storage tank and Layered STA are non-proprietary systems that were estimated on a site-specific basis, with better local knowledge of installation costs.

Operation and maintenance contracts are approximately $500 - $600 per year, and estimated costs for quarterly monitoring are approximately $400 per year.

5d. Timeline for Planning, Permitting and Installations

There are three key milestones required for installing nitrogen-removing septic systems: plan preparation, permitting and site installation. Based on the experience gained from this Project, it is possible to estimate the timeframe for completing each of these steps. Once an engineering company is contracted, plan preparation typically takes 8 – 12 weeks, depending upon the availability of the engineer, and whether a site survey and/or Perc Test is required. Once plans are prepared, scheduling a Board of Health hearing takes approximately 2 weeks. Where abutter notification is required, hearings must be scheduled to allow ten days to elapse from the time abutters receive notification to the time of the hearing. Conservation Commission Request for Determination of Applicability (RDA) hearing typically take two to three weeks to schedule. Concurrent with permitting, it is possible to request quotations from certified septic installers and hire a contractor. Once all permits are in place, an installation can be scheduled. The actual work of installing the system typically takes one week. However, contractors typically schedule work one month in advance. Given these timeframes, from the time an engineer is contracted to prepare plans to the time an installation is complete will take close to five months. This assumes that plans are prepared in eight weeks, and as soon as the plans are prepared, permitting is scheduled and abutter notices are sent out immediately. This timeline also assumes that installation contractors are hired during the permitting process.

6. Summary

This was the first demonstration project to leverage participation of homeowners in a program to voluntarily replace existing septic systems with nitrogen-removing onsite systems. The actions taken, beginning with the prioritization of program participants, through homeowner education, ending with system installation, was a resounding success and warrants replication in other areas around Buzzards Bay and throughout Cape Cod. Nitrogen-removing septic systems that achieve the performance of the systems implemented as part of this Program are a critical solution in both seasonal and less densely developed watersheds with Total Maximum Daily Load (TMDL) requirements for nitrogen. The Town and the Coalition look forward to showcasing the success and lessons learned through this project to communities throughout Buzzards Bay and Cape Cod.

APPENDIX A: Vendor Questionnaire

NAME OF I/A SYSTEM VENDOR:____

Innovative/Alternative (I/A) Septic System Questions - Single Family

Technical and Performance Questions:

- **Please provide a brief overview of the treatment technology and provide a schematic showing the placement of the system in context of a standard septic tank/leachfield (please provide approximate dimensions of components on the diagram and list all components necessary to achieve 12 mg/l at the discharge)**

- **Can the I/A system be retrofit to an existing septic tank-soil absorption system?**

- **List general requirements for installation, such as:**
  - **Must the installer be certified by the company?**
  - **Are there any site limitations?**
  - **Other general requirements?**

- **How long has the Company been in business?**

- **How many systems are installed in the ground (please specify how many in New England and how many in other states)?**

- **What is the expected system longevity?**

- **Are there data to support a claim that this system will achieve total nitrogen removal to 12 mg/L as measured prior discharging to drainfield? (Please supply data and source of data information):**

Permitting and Approval Questions

- **Does the system manufacturer hold proprietary patents or are there patents pending? Please list USPTO numbers:**

- **List state or provincial approvals held by the technology:**

NAME OF I/A SYSTEM VENDOR:____

- **If not approved in the Commonwealth of Massachusetts, is your company willing to file an application for a Site-Specific Pilot?**
- **List installation sites on Cape Cod (if any):**
- **Do you partner with specific engineering firms? If so, whom?**
- **What type of warranty do you offer?**
- **Please list three references that can be contacted (including 1 regulatory official) for their familiarity with your system performance and operation.**

Cost-Related Questions:

- **Equipment Cost:**
- **Estimated Single Family Installation Cost (average and range):**
- **Estimated monthly energy usage (kWh) including required pretreatment components:**
- **Typical long-term Maintenance Cost:**
- **Typical inspection and sampling cost (excluding analyses).**

APPENDIX B: Letter to Potential Participants and Fact Sheet

BUZZARDS BAY COALITION
WEST FALMOUTH VILLAGE ASSOCIATION

July 20, 2015

Dear ,

We hope you'll join us to help clean up West Falmouth Harbor.

Because you are someone who loves West Falmouth Harbor, the West Falmouth Village Association and the Buzzards Bay Coalition thought you might be interested in a **voluntary program** that will reduce nitrogen pollution, help improve the harbor's natural beauty, and protect the water for generations to come.

Nitrogen pollution is the greatest long-term threat to the health of West Falmouth Harbor. The town of Falmouth is reducing the amount of nitrogen coming from the wastewater treatment plant and great progress has been made in the past few years. More pollution reduction will restore our Harbor's health quicker. As a homeowner, there is something you can do to give the harbor a hand.

In the fall of 2014, the Buzzards Bay Coalition pursued a $200,000 grant to subsidize the **voluntary** replacement of 20 individual on-site septic systems around West Falmouth Harbor with a nitrogen-reducing solution. Homeowners who want to take advantage of this opportunity would **receive up to $10,000** to replace their septic systems and cesspools with a solution that can reduce nitrogen pollution to West Falmouth. (Please see the attached fact sheet for more detail about this program.)

How can you get involved?

As a West Falmouth Harbor property owner near the water with a septic system which causes nitrogen to flow into the Harbor, you have the opportunity to receive this subsidy and upgrade your system. Your property is among 170 homes that qualify for this subsidy. However, there are only 20 subsidies available. If you are interested in this opportunity, please contact Korrin Petersen at the Buzzards Bay Coalition as soon as possible at (508) 999-6363 ext. 206 or petersen@savebuzzardsbay.org. **There is no upfront commitment required.** Simply contact the Buzzards Bay Coalition to find out more and receive a no-cost evaluation. If you choose to take part in the program, the Coalition will assist you in selecting a solution, hiring an engineer, and completing the permitting process.

Thank you for making a difference to protect West Falmouth Harbor.

Sincerely,

John Weyand, President
West Falmouth Village Association

Mark Rasmussen, President
Buzzards Bay Coalition

buzzards BAY COALITION

FACT SHEET

Upgrade Your Septic System to Help Save West Falmouth Harbor

The Problem: Septic Systems and Nitrogen Pollution

Septic systems are the largest source of nitrogen pollution to Buzzards Bay. Even properly functioning Title 5 septic systems cause pollution problems.

When you add up all the homes on septic systems around places like West Falmouth Harbor, this amounts to a major source of pollution.

If nitrogen pollution is not treated, it travels into the groundwater and reaches West Falmouth Harbor.

When too much nitrogen pollution gets in the water, it fuels the growth of algae that makes the harbor cloudy and murky. Eelgrass dies, fish and shellfish disappear, and beaches and boats can become covered with green algae.

Nitrogen pollution is the greatest long-term threat to West Falmouth Harbor. For 20 years, West Falmouth residents like you have watched the harbor's health decline due to nitrogen pollution from the wastewater treatment plant.

The good news is that recent upgrades and new pollution limits are reducing the amount of nitrogen from the wastewater treatment plant.

We can reduce even more nitrogen and speed up the harbor's recovery. By upgrading your home's on-site septic system to a nitrogen-reducing system or eco-toilets. **There is funding available for you to do this.**

What are nitrogen-reducing septic systems and eco-toilets?

Cesspools and Title 5 septic systems do not treat for nitrogen – which means that the majority of homes around the harbor contribute pollution.

There are two technologies that can help reduce nitrogen pollution:

- **Nitrogen-reducing septic systems** remove approximately 66% of the nitrogen from a Title 5 system or cesspool by treating the wastewater on-site and discharging it through a leach field.
- **Eco-toilets** collect human waste by composting or separating urine, which is then disposed of or used as fertilizer off your property.

Why should I upgrade my current system?

By participating in this program, you can make a difference to reduce nitrogen pollution to West Falmouth Harbor. A healthy harbor means better fishing and shellfishing, swimming, and boating. In addition, clean water can protect real estate values. Installing a new septic system is a significant positive investment in the value of your home.

Turn over to learn about funding to upgrade your home's on-site septic system. →

APPENDIX C: Decision Support Tool Screen Shot

NAME:
WEST FALMOUTH PROPERTY ADDRESS:
DATE:

Please tell us how important the follow characteristics are to you based on the following scale:

First Cost (equipment and installation)		**1 = very important**
20 Year Present Worth (including O&M)		**2 = important**
Energy Use		**3 = somewhat important**
Aesthetics		**4 = not very important**
Complexity		**5 = not a concern**

Is there another criteria not listed here that is important to you?

Summary of top 7 systems to consider based on your weighting of the above criteria:

System Name Contact Website	Decision Tool Total Score	Average Estimated Installed System Cost	Annual Cost for Quarterly Inspections	Lab Costs after 1st year	Monthly Energy Use (kWh)*	20 year Present Worth for O&M**	Company Warrantee on System	Special Considerations	Number of Pumps