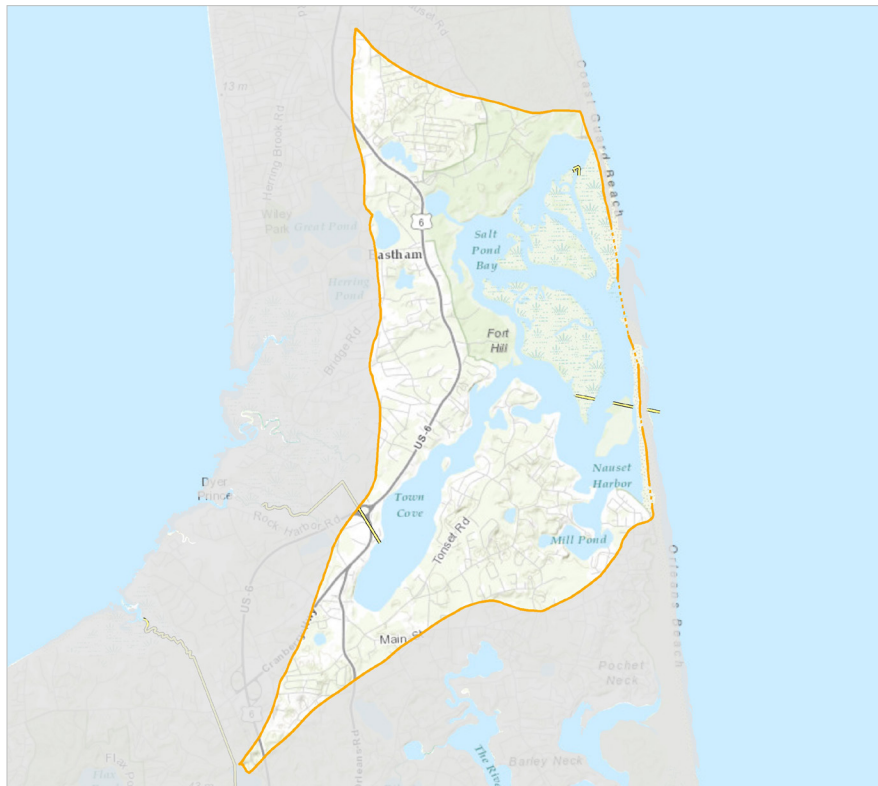
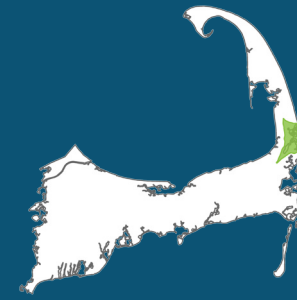


Nauset Harbor

ORLEANS & EASTHAM

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Nauset Harbor Watershed

Introduction to the Watershed Reports

In 2001, the Massachusetts Estuaries Project (MEP) was established to evaluate the health of 89 coastal embayment ecosystems across southeastern Massachusetts. A collaboration between coastal communities, the Massachusetts Department of Environmental Protection (MassDEP), the School of Marine Science and Technology (SMAST) at the University of Massachusetts-Dartmouth, the US Environmental Protection Agency (US EPA), the United States Geological Survey (USGS), the Massachusetts Executive Office of Energy and Environmental Affairs (EEA), and the Cape Cod Commission, the purpose of the MEP is to identify nitrogen thresholds and necessary nutrient reductions to support healthy ecosystems.

The Cape Cod 208 Plan Update, certified and approved by the Governor of the Commonwealth of Massachusetts and the US EPA in 2015, provides an opportunity and a path forward to implement responsible plans for the restoration of the waters that define Cape Cod.

On Cape Cod there are 53 embayment watersheds with physical characteristics that make them susceptible to nitrogen impacts. In its 2003 report, “The Massachusetts Estuaries Project – Embayment Restoration and Guidance for Implementation Strategies”, MassDEP identifies the 46 Cape Cod embayments included in the

MEP. Thirty-three embayments studied to date require nitrogen reduction to achieve healthy ecosystem function. A Total Maximum Daily Load (TMDL) has been established (or a draft load has been identified and is under review) for these watersheds. For those embayments not studied, the 208 Plan Update recommends planning for a 25% reduction in nitrogen, as a placeholder, until information becomes available.

The 208 Plan Update directs Waste Treatment Management Agencies (WMAs) to develop watershed reports within 12 months of certification of the Plan Update. The Watershed Reports outline potential “bookend” scenarios for each watershed that include two scenarios to meet water quality goals in the watershed – a traditional scenario, which relies completely on the typical collection and centralized treatment of wastewater, and a non-traditional scenario, which uses remediation, restoration, and on-site reduction techniques to remove nutrients from raw and treated wastewater, groundwater and affected waterbodies.

The intent of the Watershed Reports is to outline two distinct approaches for addressing the nutrient problem. The reports are not intended to identify preferred and detailed plans for each watershed, but to facilitate discussions regarding effective and efficient solutions, particularly in watersheds shared by more than one town. In some cases, towns have provided information on collection areas and non-traditional technologies that have been specifically considered by that town.

The 208 Update developed a regionally consistent database of the nitrogen load entering each watershed. This data set includes estimates of wastewater, stormwater and fertilizer loads - similar to methodologies used by the MEP. Using this regionally consistent database, the Watershed MVP tool (wMVP) was developed so that different strategies (i.e., bookend scenarios) to reduce excess nitrogen load

could be evaluated. The Watershed Reports use the MEP recommendations for the required nitrogen load reductions necessary to meet the threshold loads (that serve as the basis for nitrogen management), and then use the wMVP and the regionally consistent database values to develop bookend scenarios. There are variations of load between the MEP and wMVP, primarily due to differences in comparing older and newer databases.

Terms Defined

Total nitrogen load: the nitrogen load from the watershed contributed by septic, wastewater, fertilizer, stormwater, golf course, landfill, and natural sources.

Attenuated nitrogen load: the nitrogen load from the watershed that reaches the embayment after the effect of natural attenuation in wetlands, ponds or streams.

Threshold: the amount of nitrogen that a water body can receive from its watershed and still meet water quality goals; this number is based on MEP technical reports or Total Maximum Daily Load (TMDL) reports.

Reduction target: an approximation of the amount of nitrogen that needs to be removed from the watershed to achieve the threshold; this number is calculated by subtracting the threshold number from the attenuated total watershed load, and is for planning purposes only.

Percent contribution: the percent of attenuated nitrogen load that a town contributes to the watershed.

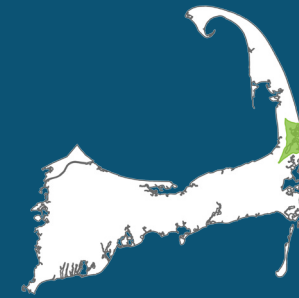
Kilogram responsibility: is calculated by applying the percent contribution to the reduction target and indicates the amount of nitrogen, in kg, that a community is responsible for addressing.

Total Maximum Daily Load: a regulatory term in the Clean Water Act, describing a value of the maximum amount of a pollutant that a body of water can receive while still meeting water quality standards. Establishing a TMDL is necessary when a water body has been listed on the 303D list of impaired waters.

Nauset Harbor

ORLEANS & EASTHAM

HIGH



The Nauset Harbor estuary and embayment system is located in the Towns of Eastham and Orleans. It is comprised primarily of two segments - Town Cove and Nauset Marsh. Sub-systems include Salt Pond, Nauset Bay, Woods Cove, and Mill Pond, which contribute to Nauset Marsh and Nauset Stream, and Rachel Cove, which contribute to Town Cove. The estuary supports a variety of recreational uses including boating, swimming, shell fishing and fin fishing.

The Problem

The Massachusetts Estuaries Project (MEP) technical report (available at <http://www.mass.gov/eea/agencies/massdep/water/watersheds/the-massachusetts-estuaries-project-and-reports.html>) indicates that the Nauset Harbor system exceeds its critical threshold for nitrogen, resulting in impaired water quality. A MEP technical report has been completed and a Total Maximum Daily Load (TMDL) for nitrogen has not yet been established.

- **MEP TECHNICAL REPORT STATUS:** Final
- **TMDL STATUS:** In Progress

Watershed nitrogen load characteristics were published in the 2012 MEP report for Nauset Harbor, reflecting current conditions at the time of writing:

- **TOTAL ATTENUATED NITROGEN LOAD (MEP CHAPTER VIII):** 19,414 Kg/Y
- **SOURCES OF ATTENUATED WATERSHED NITROGEN LOAD:**
 - Nauset Marsh
 - 83% Septic Systems
 - 6% Fertilizer
 - 9% Stormwater from Impervious Surfaces
 - 2% Landfill

- Town Cove
 - 86% Septic Systems
 - 5% Fertilizer
 - 8% Stormwater from Impervious Surfaces
 - 1% Landfill
- Salt Pond
 - 72% Septic Systems
 - 6% Fertilizer
 - 9% Stormwater from Impervious Surfaces
 - 13% Landfill

Since the MEP report, the Commission compiled the following updated water use and nitrogen loads using the regional wMVP database, enabling a more current estimate of nitrogen loading (see figure on page 1 for watershed boundary delineation):

- **TOTAL WASTEWATER FLOW:** 180.2 MGY (million gal per year)
 - Treated Wastewater Flow: 4.2 MGY
 - Septic Flow: 176 MGY
- **TOTAL ATTENUATED NITROGEN LOAD (wMVP):** 20,749 Kg/Y

CONTRIBUTING TOWNS

Percent contributions listed below are the aggregate sub-embayment contributions identified in Appendix 8C of the Cape Cod Section 208 Plan Update (contributions are based on attenuated load where available). See Appendix 8C for detailed

town allocations by sub-embayment. A portion of the land area in this watershed is within the boundaries of the Cape Cod National Seashore and any nitrogen load that results from Seashore controlled property is not within control of the towns.

- **ORLEANS:** 53%
- **EASTHAM:** 47%
- **BREWSTER:** <1%

Under existing conditions, the load contributed by Brewster is so small that reductions are not necessary at this time; however, growth management measures should be taken to ensure that the contribution does not increase. Contributions will be reevaluated at least every five years, based on updated data.

THE MEP RESTORATION SCENARIO

- **WATERSHED TOTAL ATTENUATED NITROGEN REDUCTION TARGET:** 47%
- **WATERSHED SEPTIC REDUCTION TARGET:** 55%
(The scenario represents the aggregated sub-embayment percent removal targets from the MEP technical report)

NAUSET HARBOR ESTUARY

- **EMBAYMENT AREA:** 1,513 acres
- **EMBAYMENT VOLUME:** 596 million cubic feet
- **2014 INTEGRATED LIST STATUS:** Category 2
 - Category 2: Attaining some uses; other uses not assessed
 - www.mass.gov/eea/docs/dep/water/resources/07v5/14list2.pdf

NAUSET HARBOR WATERSHED

General watershed characteristics according to the current wMVP regional database (see figure on page 1 for watershed boundary) follow.

- **WATERSHED CHARACTERISTICS**
 - Acres: 4,751
 - Parcels: 3,276
 - % Developed Residential Parcels: 78%
 - Parcel Density: 1.5 acres per parcel (approx.)

Freshwater Sources

PONDS

- **IDENTIFIED SURFACE WATERS:** 34
- **NUMBER OF NAMED FRESHWATER PONDS:** 9
- **PONDS WITH PRELIMINARY TROPHIC CHARACTERIZATION:** 9
- **2014 INTEGRATED LIST STATUS:** None listed

The Nauset Harbor watershed shares Baker and Cliff ponds with the Pleasant Bay watershed. The Towns of Eastham and Orleans have benefited from Barnstable County funded ponds assessments through the Cape Cod Commission and the School of Marine Science and Technology (SMST) at UMASS Dartmouth. Orleans has an active citizens group, the Orleans Ponds Coalition, that provides sampling, education and advocacy. Eastham also has an active Water Quality Advisory Board that coordinates freshwater pond assessment and restoration efforts.

Eastham and Orleans have participated in the Pond and Lake Stewardship (PALS) program that has helped establish baseline water quality.

STREAMS

- **SIGNIFICANT FRESHWATER STREAM OUTLETS:** 1
Nauset Stream:
 - Average Flow: 1,871 cubic meters per day (m³/d)
 - Average Nitrate Concentrations: 0.15 milligrams per liter (mg/L)

Due to the highly permeable soils present in the Nauset Marsh and Town Cove estuaries the majority of freshwater contributions are from groundwater discharge.

Stream data from MEP technical report. Nitrate concentrations higher than 0.05 mg/L background concentrations, evident in public supply wells located in pristine areas, provide evidence of the impact of non-point source pollution on the aquifer and receiving coastal water bodies.

DRINKING WATER SOURCES

- **WATER DISTRICTS:** 1
 - Orleans Water Department
- **GRAVEL PACKED WELLS:** 0
- **SMALL VOLUME WELLS:** 40

Orleans provides public water to a small number of Eastham properties. Eastham is primarily served by private wells. A municipal system is in development for a portion of town.

Drinking water data from Cape Cod Commission and MassDEP data sources.

Degree of Impairment and Areas of Need

For the purposes of the Section 208 Plan Update, areas of need are primarily defined by the amount of nitrogen reduction required as defined by the TMDL and/or MEP technical report. These are listed above as 47% of the total load and 55% of the septic load and, more specifically, as the targeted amount of nitrogen reduction required by subwatershed (see the figures: Subwatersheds with Total Attenuated Watershed Removal Targets and Subwatersheds with Septic Attenuated Nitrogen Removal Targets). Subwatershed removals range from 75% for Town Cove (as depicted by the polygon in the lower portion of the Septic Attenuated Nitrogen Removal Targets figure) to 100% for Salt Pond (as depicted by the polygon in the upper portion of the Septic Attenuated Nitrogen Removal Targets figure).

The nitrogen load from the watershed exceeds the threshold for Nauset Harbor, resulting in impaired water quality. The

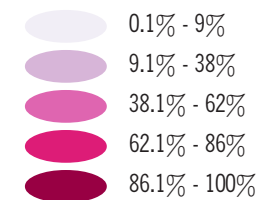
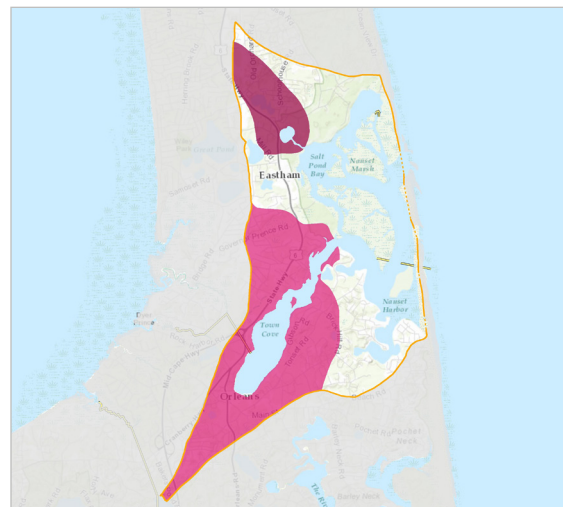
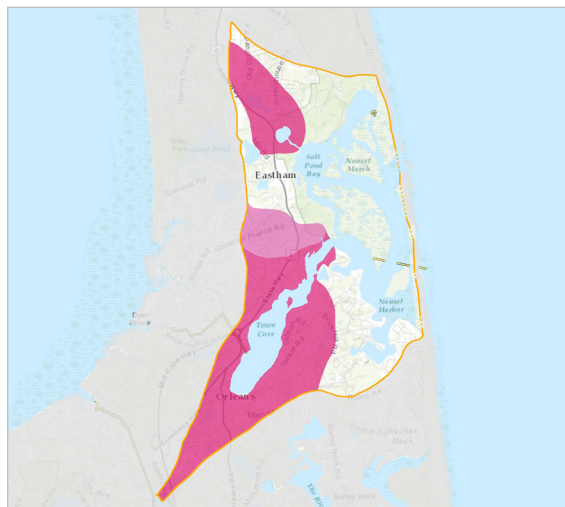
upper head waters are particularly impaired. Although the lower portions of the embayment are healthy, due to the severe conditions of the upper headwaters, the Nauset Harbor system is categorized as significantly impaired. The ecological health of a water body is determined from water quality, extent of eelgrass, assortment of benthic fauna, and dissolved oxygen and ranges from severe degradation, significantly impaired, moderately impaired, or healthy habitat conditions.

MEP ECOLOGICAL CHARACTERISTICS AND WATER QUALITY

The MEP report provides the following characterization of the estuary's health:

- **OVERALL ECOLOGIC CONDITION:** Healthy to Significantly Impaired
- **NAUSET MARSH**
- **NAUSET MARSH:** Healthy

- **NAUSET BAY:** Healthy
- **SALT POND BAY:** Significantly Impaired
- **TOWN COVE:** Significantly Impaired
- **SALT POND:** Significantly Impaired
- **WOOD COVE:** Significantly Impaired
- **MILL POND:** Significantly Impaired
- **SENTINEL STATION:**
 - Total Nitrogen Concentration Threshold: 0.45 mg/L
 - Total Nitrogen Concentration Existing: 0.53 mg/L (As reported at the MEP sentinel water-quality monitoring station)



Subwatersheds with Total Attenuated Watershed Removal Targets

(Left) Benthic and atmospheric loads directly on embayments are not included.

Subwatersheds with Septic Attenuated Nitrogen Removal Targets

(Right)

Traditional & Non-Traditional Scenarios

SCENARIO DEVELOPMENT

Through the 208 Stakeholder process, the Commission developed “bookend” scenarios – one looking at a possible solution using traditional collection and treatment, the other examining a possible suite of non-traditional technologies – to address the nitrogen management needs in each watershed. These bookend scenarios provide guidance for communities as they continue to discuss alternatives, priorities, and opportunities for identifying well-considered solutions that will address communities’ needs and interests.

REGIONAL DATA

In preparation for this effort, the Commission collected regionally consistent data for the purposes of watershed scenario development. Both parcel data and water use data was identified and collected for the entire region. While the scientific basis for planning is the thresholds identified in the MEP technical reports, each report uses data from different years, and in some cases the MEP data used are 10 or more years old. In addition, there are watersheds on Cape Cod without the benefit of an MEP report; therefore, similar data was not available for planning purposes.

The updated regional data set was used to estimate wastewater, stormwater and fertilizer loads, using the same methodologies as the MEP. This approach allows for a reevaluation of existing development, which may have changed

in the last 10 years. Parcel data included in the regional database is from 2010-2012 and water use data is from 2008-2011, depending on the water supplier and based on best available data. This approach allows for regionally consistent watershed scenario development.

WATERSHED SCENARIOS

The watershed scenarios that follow outline possibilities for the watershed. A series of non-traditional technologies that might be applicable are included, as well as the amount of residential load that would need to be collected if a traditional collection system and treatment facility was implemented. The pie charts show the load to be collected for treated effluent disposal both inside and outside the watershed.

Site specific analyses of collection areas may result in the need to collect wastewater from more or fewer parcels to meet the nitrogen reduction target. The scenarios presented are conceptual and are meant to inform discussions regarding effective and efficient solutions; they are not specific recommendations and should be viewed as resource information for additional and more detailed wastewater management planning.

In Nauset Harbor, the Towns of Orleans and Eastham have done additional and more detailed planning. Included in the last section of this report is a description of their efforts, along with details of plans developed to date.

TOTAL ATTENUATED NITROGEN LOAD VALUES (FROM WMVP)

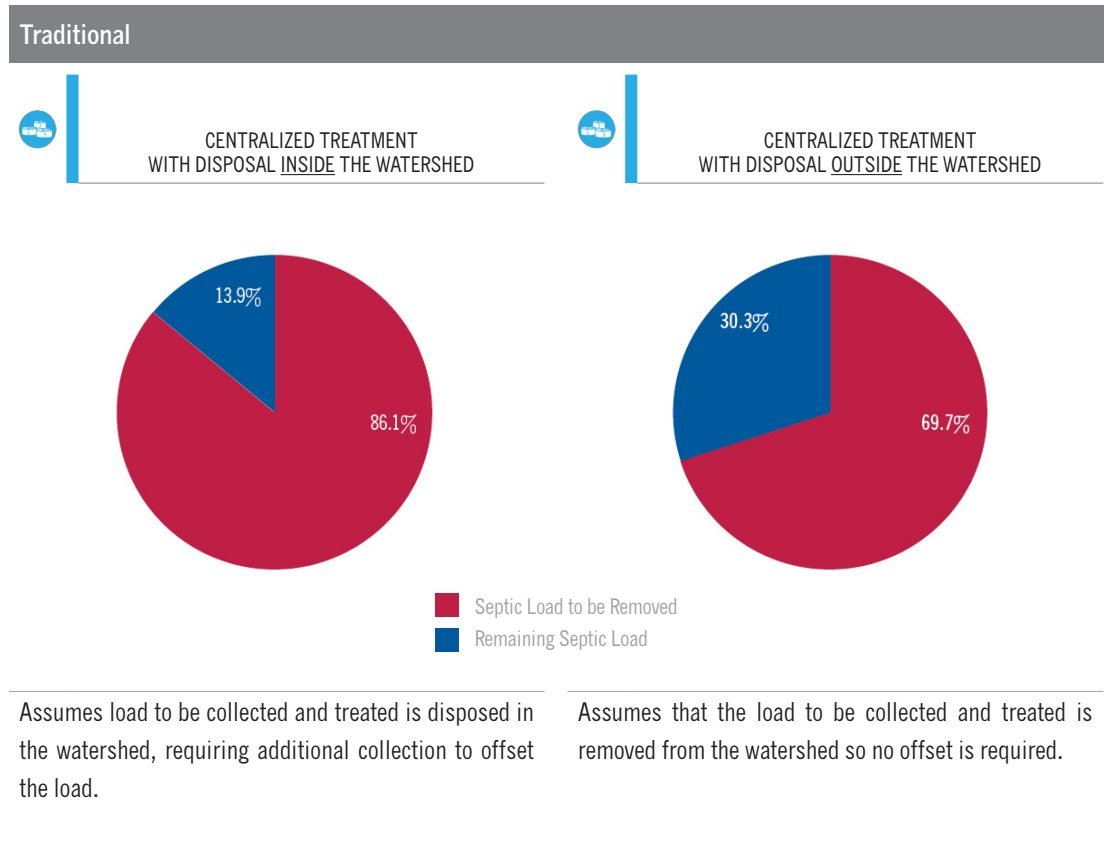
Nauset Harbor Nitrogen Sources	Total Attenuated Watershed Nitrogen Load (kg-N/yr)
Wastewater ¹	14,986
Fertilizer ²	1,338
Stormwater	3,296
Other ³	1,128
TOTAL WATERSHED LOAD	20,749
Total Watershed Threshold	10,334
TOTAL ATTENUATED LOAD TO BE REMOVED	10,415

1. Includes nitrogen loads from septic systems and wastewater treatment facilities.
2. Includes nitrogen loads from lawns, cranberry bogs, and golf courses.
3. Includes nitrogen loads from landfills and atmospheric deposition to vacant land.

Traditional & Non-Traditional Scenarios

Non-Traditional		ATTENUATED NITROGEN REMOVED IN KG/Y
UNIT OF APPLIED TECHNOLOGY		
25 % Nitrogen Reduction - Fertilizer Management		334
25 % Nitrogen Reduction - Stormwater Mitigation		824
3,285 Linear Feet - Permeable Reactive Barrier (PRB) (Capture load calculated by wMVP: 4,413.8 kg/Y)		3,200
38 Acres - Fertiligation - Turf		150
7 Acres - Aquaculture/Oyster Beds		1,750
2,250 Square Feet - Floating Constructed Wetlands		900
233 Units - Ecotoilets (UD & Compost)		592
1,929 People Per Year - UD School or Public Facility		901
571 Units - I & A Systems		947
303 Units - Enhanced I & A Systems		904
TOTAL		10,502

A summary of the approach and methodology that was applied using non-traditional technologies follows at the end of this report.



Town of Eastham Local Progress

The town of Eastham completed a town-wide needs assessment in March 2009. The needs assessment concluded that a new public water supply system to protect public health was an overriding concern.

The spring 2014 Town Meeting approved \$45.8 million to fund a scaled back version of the full town-wide water system. The Cape Cod Commission approved this project as a Development of Regional Impact (DRI) in February 2015.

In May 2015 Eastham staff, along with their consultant (GHD), met with Commission staff to discuss the 208 planning process, decision support tools, and scenario development for their watersheds, the beginnings of a shift toward wastewater planning after a necessary focus on securing a clean drinking water supply for residents.

Eastham shares the watershed to the Nauset estuary with the town of Orleans and is willing to have further discussions about potential opportunities to share the wastewater treatment facility proposed in the approved Orleans Comprehensive Wastewater Management Plan (CWMP). The town has sent a representative to each of the Orleans Water Quality Advisory Panel meetings, as they discussed potential scenarios in 2014 and early 2015. The town of Eastham is actively pursuing the protection and restoration of its freshwater ponds. The town completed a town-wide assessment and is pursuing in-pond restoration efforts. Alum

treatments for Herring Pond and Great Pond are complete and others are under consideration.

In the fall of 2014, Eastham adopted local nitrogen-oriented fertilizer management regulations consistent with the Cape-wide Fertilizer Management District of Critical Planning Concern (DCPC).

Eastham is a member of the Orleans, Brewster and Eastham Ground Water Protection District which, until June 1, 2016, operated the Tri-Town Septage Treatment Facility in Orleans. The member towns voted to decommission and remove the facility, which is expected to take place in 2017.

In addition, Eastham staff are working with the Commission and the Cape Cod National Seashore on a number of other projects to address nitrogen in their watersheds. The Commission is assisting the town to modify a design for stormwater management along Route 6 and to conduct hydrogeologic modeling at a previously identified site for a permeable reactive barrier.

Eastham submitted conceptual watershed scenarios based on discussions with the Commission, use of available decision support tools, and ongoing local water quality planning efforts. Those scenarios are included in this report.

At the Spring 2017 Town Meeting, Eastham voted to fund wastewater planning and pilot projects in the amount of \$150,000, as part of their Capital Plan.

Town of Eastham Watershed Scenario Details

The Eastham approach for nitrogen management for Nauset Harbor Embayment System focuses on the Town Cove and Salt Pond subwatersheds which include:

- Town Cove, including: Town Cove; Mary Chase Gauge; and Nauset Stream
- Salt Pond, including: Salt Pond; Ministers Pond; and Depot Pond

The following management approaches are based on the Draft Technical Memorandum No. 3 for Salt Pond and the Draft Technical Memorandum No. 4 for Town Cove currently under development for the Town of Eastham (References 1 and 2 respectively). These technical memorandums on Eastham's hybrid evaluations for these two subwatersheds are being developed as part of the Town's wastewater planning efforts. As these efforts are currently under development, the findings have not been completed and therefore the Town has not formally accepted any findings. The following information presents the approaches that are currently being considered and evaluated for economic viability. At this time no costs are being presented until the Town has the opportunity to comment on the proposed hybrid approaches and the two above referenced technical memorandums are finalized. Approaches identified below are based on updates to the Town's Interim Needs Assessment Report and Alternatives Screening Analysis report summarized in Technical Memorandums 1 and 2 (References 3 and 4).

In addition, the Town of Eastham has the following regulations in place to manage nitrogen in Town that are considered part of any alternative or hybrid approach:

- Fertilizer Bylaw: the Town of Eastham voted to adopt a Board of Health regulation on the content and application of fertilizer to turf on November 20, 2014 (see Reference 5). This regulation incorporates current Best Management Practices, which are deemed essential in this effort to protect the public health and aid in achieving compliance with the Total Maximum Daily Loads (TMDL) for the Towns water resources prescribed by the Commonwealth of Massachusetts while allowing reasonable use of fertilizers for the enhancement of turf quality.
- Board of Health Regulations: requirements for Nitrogen Reducing Septic Systems in Environmentally Sensitive Areas (see Reference 6). The use of nitrogen-reducing septic systems is required as a condition of any of the following variances in any lot determined to be an environmentally sensitive area:
 - Less than 100 feet separation distance exists between a drinking water supply well and a soil absorption system
 - Soil absorption system is located less than 100 feet from a salt marsh or any marine surface water, or fresh surface water body
 - When the lot is defined an environmentally sensitive area any setback reduction is requested
 - Distance to adjusted high groundwater is less than

5 feet

- Massachusetts Estuaries Project at Nauset Estuary: The Towns of Eastham and Orleans are working together to expand water quality monitoring for Nauset Estuary. Over the next three years, Eastham and Orleans will collect water samples from 15 stations in order to provide current water quality data. The data will be used to recalibrate or update the Massachusetts Estuary Program Model.
- Public Education Newsletter: updates to the Town's wastewater management planning efforts are posted on the Town's website and available at Town Hall (see Reference 7). Another newsletter that is planned to update the public will discuss the hybrid evaluations and watershed reports.

Traditional Approach (Eastham Focus)

The following information is based on the Draft Hybrid Evaluations currently under development for Salt Pond and Town Cove. These evaluations have not been finalized, and therefore the approaches outlined below are subject to change based on the final recommendations and Town decision-making process.

Town of Eastham Watershed Scenario Details Continued

SALT POND

Several “Traditional Approaches” were evaluated and considered several different levels of sewerage and recharge, such as:

- Cape Cod Commission “Bookend Evaluation”, with wastewater collected and then recharged inside/outside the watershed representing an 81% nitrogen removal.
- Modified traditional “Bookend Evaluation” to address Ministers Pond and representing a 95% nitrogen removal, likely in conjunction with a regional facility within the Town of Orleans, Ma.
- Recharge within the Salt Pond watershed, representing a 100% nitrogen removal. However, for the purpose of this document, recharge within the Salt Pond watershed was considered the most feasible option based on the state of the Town of Orleans planning efforts focused on a reduced wastewater treatment facility footprint and limited recharge capacity.

TOWN COVE

Several “Traditional Approaches” were evaluated and considered several different levels of sewerage and recharge, such as:

- Cape Cod Commission “Bookend Evaluation”, with wastewater collected and then recharged inside the watershed representing an 81% nitrogen removal.
- Wastewater treatment as part of the Salt Pond approach
- Regional solution of an Eastham collection system with treatment at the Town of Orleans proposed wastewater treatment facility if capacity is available and an agreement between the Towns could be developed.

Any sewerage done in the upper reaches of the Town Cove watershed should be evaluated in combination with what is done with the Salt Pond subwatershed.

Refer to References 1 and 2 for additional detail on both Salt Pond and Town Cove traditional approaches.

Non-Traditional Approach (Estuary Focus)

The Cape Cod Commission developed two possible approaches outlined below, however neither approach was specific enough to the Eastham portions of Town Cove or Salt Pond and therefore are not considered further. Non-traditional approaches are included as part of the draft hybrid approaches being developed to manage nitrogen in these specific watersheds as discussed in the Hybrid Approach section below.

APPROACH 1 NON-TRADITIONAL BOOKEND

- 50% fertilizer nitrogen load reduction
- 50% stormwater nitrogen load reduction
- 3.1 miles of Permeable Reactive Barrier
- 10 acres of fertigation
- 5 acres of aquaculture/oyster beds
- 2,500 cubic feet of floating constructed wetlands
- 27 homes with ecotoilets
- Urine diversion toilets to serve 402 people
- 60 residential I/A systems
- 3 residential advanced I/A systems

APPROACH 2 NON-TRADITIONAL BOOKEND

- 25% fertilizer nitrogen load reduction
- 25% stormwater nitrogen load reduction
- 3.1 miles of Permeable Reactive Barrier
- 10 acres of fertigation
- 5 acres of aquaculture/oyster beds
- 3 acres of coastal habitat restoration
- 2,500 cubic feet of floating constructed wetlands
- 67 homes with ecotoilets
- Urine diversion toilets to serve 556 people
- 46 residential I/A systems

Refer to References 1 and 2 for additional detail on both Non-Traditional Bookends

Town of Eastham Watershed Scenario Details Continued

Hybrid Approach (Eastham Focus)

The following information is based on the Final Hybrid Evaluations developed by GHD Inc. for Salt Pond and Town Cove. Although these evaluations have been finalized, the approaches outlined below are subject to change based on the final recommendations and Town decision making processes.

SALT POND

Two hybrid approaches were identified for Salt Pond and are summarized in the following subsections.

SALT POND HYBRID 1

This approach includes the following:

- 2,300 linear feet of PRB located at the Cape Cod National Seashore (CCNS) Salt Pond Visitor Center site
- Shellfish propagation within Salt Pond approximately 2.9 to 12.2 acres of shellfish bed required to support 1.5-2.5 million shellfish (oysters or quahogs respectively).
- Fertilizer and stormwater reductions of approximately 20% of the nitrogen load from these sources.
- Upgrade of the CCNS On-site treatment system

SALT POND HYBRID 2

This approach includes the following:

- Construction of a small collection system and treatment facility with recharge within the watershed to service approximately 180 properties.
- 2,300 linear feet of PRB located at the CCNS Salt Pond Visitor Center site
- Shellfish propagation within Salt Pond approximately <1 to 1.7 acres of shellfish bed required to support 200,000 to 340,000 shellfish (oysters or quahogs respectively).
- Fertilizer and stormwater reductions of approximately 20% of the nitrogen load from these sources.

TOWN COVE

Four hybrid approaches were identified for Town Cove and are summarized in the following subsections.

TOWN COVE HYBRID 1A

This approach is outlined as follows:

- Shellfish propagation within Town Cove approximately 5.7 to 23.8 acres of shellfish bed required to support 2.9 to 4.8 million shellfish (oysters or quahogs respectively).
- Fertilizer and stormwater reductions of approximately 20% of the nitrogen load from these sources.
- Up to 130 individual I/A systems - approximately 77% of the properties between the boundaries

of Route 6 and the Town Cove shoreline in the Town Cove subwatershed.

TOWN COVE HYBRID 1B

This approach is outlined as follows:

- Shellfish propagation within Town Cove approximately 1.1 to 4.7 acres of shellfish bed required to support 560,000 to 940,000 shellfish (oysters or quahogs respectively)
- Fertilizer and stormwater reductions of approximately 20% of the nitrogen load from these sources.
- Up to 360 individual I/A systems - approximately 100% of the properties in the Town Cove watershed (not including Nauset Stream or Mary Chase Gauge).

TOWN COVE HYBRID 2A

This approach is outlined as follows:

- Wastewater collection system for approximately 200 properties within the Town Cove, Nauset Stream and Mary Chase Gauge subwatersheds with recharge outside of the watershed but within the Town of Eastham boundaries or to a regional facility in Orleans.
- Shellfish propagation within Town Cove approximately 3.8 to 15.8 acres of shellfish bed required to support 1.9 to 3.2 million shellfish (oysters or quahogs respectively).
- Fertilizer and stormwater reductions of approximately 20% of the nitrogen load from these sources.

Town of Eastham Watershed Scenario Details Continued

TOWN COVE HYBRID 2B

This approach could include the following:

- Wastewater collection system for approximately all the properties within Mary Chase Gauge and Nauset Stream subwatersheds (approximately 280 properties) with recharge outside of the watershed to an in Eastham option.
- Wastewater collection system for approximately 30 properties in the Nauset Marsh subwatershed (located along Route 6) to offset removal needs from the Town Cove subwatershed.
- Wastewater collection system for approximately 180 properties in the Salt Pond subwatershed (in place of the Salt Pond only hybrid approaches).
- Fertilizer and stormwater reductions of approximately 20% of the nitrogen loads from these sources from Mary Chase Gauge, Nauset Stream, Town Cove and Salt Pond subwatersheds.
- Shellfish propagation within Town Cove approximately 2.2 to 9 acres of shellfish bed required to support 1.1 to 1.8 million shellfish (oysters or quahogs respectively).
- 1,150 linear feet of PRB located at the CCNS Salt Pond Visitor Center site.

For the hybrid evaluations listed above, nitrogen management approaches may adjust prior to or during implementation through the adaptive management process. Therefore, the

distribution of technologies may shift as the Town selects the most appropriate solutions.

Additional detail on hybrid approaches for both Salt Pond and Town Cove are available as cited in References 1 and 2.

References

1. Final Technical Memorandum No. 3 – Initial Hybrid Approach for Salt Pond (currently under development)
2. Final Technical Memorandum No. 4 – Initial Hybrid Approach for Town Cove (currently under development)
3. Technical Memorandum No. 1 – Update to Wastewater and Nitrogen Management Needs Assessment; GHD Inc.; February 10, 2015
4. Technical Memorandum No. 2 – Update to Wastewater and Nitrogen Management Alternatives Screening Analysis; GHD Inc.; February 10, 2015
5. Town of Eastham, Massachusetts Fertilizer Bylaw, Approved 11/2014, http://www.easthamma.gov/Public_Documents/EasthamMA_Health/FertilizerRegulation/
6. Town Eastham Board of Health Regulations, Section I.E. Environmentally Sensitive Area, http://www.easthamma.gov/Public_Documents/EasthamMA_Health/healthinfo/BOHRegulations2014.pdf
7. Public Outreach Newsletter – “Wastewater Management Planning Project – Newsletter” Spring 2016

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Town of Orleans Local Progress

The Orleans Comprehensive Wastewater Management Plan (CWMP) was approved by Massachusetts Environmental Policy Act (MEPA) and the Cape Cod Commission in 2011 and provides a strategy for wastewater management to achieve reductions of its share of nitrogen loading to restore and protect Orleans's coastal embayments. The CWMP also addresses freshwater ponds and areas with septic system problems associated with frequent pumping, intensity of use and mounded systems. It provides modest capacity for expanded residential housing in the commercial district and includes an adaptive management approach for its implementation.

The town received its MEPA certificate on the Final Environmental Impact Review (FEIR) and a Development of Regional Impact (DRI) approval in 2011. The town has since engaged independent consultants to review the use of alternative sewer collection technologies and the Massachusetts Estuaries Project findings about the Nauset Marsh. The town received significant input from the community as the board of selectmen considers its appropriate next steps.

The town appropriated \$1.045 million at the spring 2014 Town Meeting for engineering, planning and hydrogeologic studies necessary for the development of septage, wastewater, groundwater and stormwater management plans needed to maintain and protect the water resources of the town by integrating the CWMP with a new Adaptive Management Plan

and components of the Cape-wide Section 208 Water Quality Management Plan.

The town established a Water Quality Advisory Panel (WQAP) that included diverse representation and professional facilitation, consistent with the 208 planning process. The WQAP established a consensus plan for moving forward that includes reduction, remediation, and restoration strategies and is expected to achieve a 40% cost savings over the original CWMP. In 2015, Town Meeting appropriated an additional \$1 million to further investigate potential disposal sites and locations for innovative remediation and restoration solutions identified in the consensus plan. Those investigations are underway. An additional \$691,000 was approved by voters in May 2016 to fund an Amended Water Quality Management Plan and associated Adaptive Management Plan. Development of those plans are in progress. A Preliminary Amended Comprehensive Wastewater Management Plan (ACWMP) was published in January 2017. The preliminary ACWMP provides updates reflecting additional planning and engineering efforts undertaken in 2015 and 2016.

Orleans is a member of the Orleans, Brewster and Eastham Ground Water Protection District which, until June 1, 2016, operated the Tri-Town Septage Treatment Facility in Orleans. The member towns voted to decommission and remove the facility, which took place in May of 2016. Through the Pleasant Bay Alliance, the Town of Orleans has been working with their three neighboring communities in the Pleasant Bay

watershed to assess the combined effect of the four towns' wastewater and nitrogen management plans. This has resulted in the development of the Pleasant Bay Composite Nitrogen Management Analysis.

In the fall of 2014, Orleans added phosphorus to its local fertilizer management regulations consistent with the Cape-wide Fertilizer Management District of Critical Planning Concern (DCPC).

Orleans requested that the Commission use the consensus plan scenarios as its watershed report submission.

In June 2016, Orleans received \$15,000 from the Commission for implementation of shellfish/aquaculture demonstration project in Lonnie's Pond. Funding was part of \$142,149 in local grants made by the Commission in support of 208 Plan implementation.

At the Spring 2017 Town Meeting, Orleans voted to fund continued implementation of its water quality management plan in the amount of \$3,733,660 and demolition of the Tri-Town Facility in the amount of \$870,000.

Town of Orleans Watershed Scenario Details






Nauset Harbor	CREDITS		REDUCTION TECHNOLOGIES			REMEDIATION AND RESTORATION TECHNOLOGIES			REMOVAL
NAME OF TECHNOLOGY	% Nitrogen Reduction	Load Reduction (kg-N/yr)	# Properties / Units	Flow Collected (gpd)	Load Reduction (kg-N/yr)	# Units Proposed	Unit Metric	Load Reduction (kg-N/yr)	Total Scenario Load Reduction (kg-N/yr)
Scenario									5,239
Fertilizer Management	25%	160							
Centralized Sewer			Not Reported	63,781	3,024				
Permeable Reactive Barrier (PRB)						Not Reported		566	
Aquaculture/Oyster Beds						Not Reported		600	
Coastal Habitat Restoration						Not Reported		760	
I & A Systems			Not Reported		129				

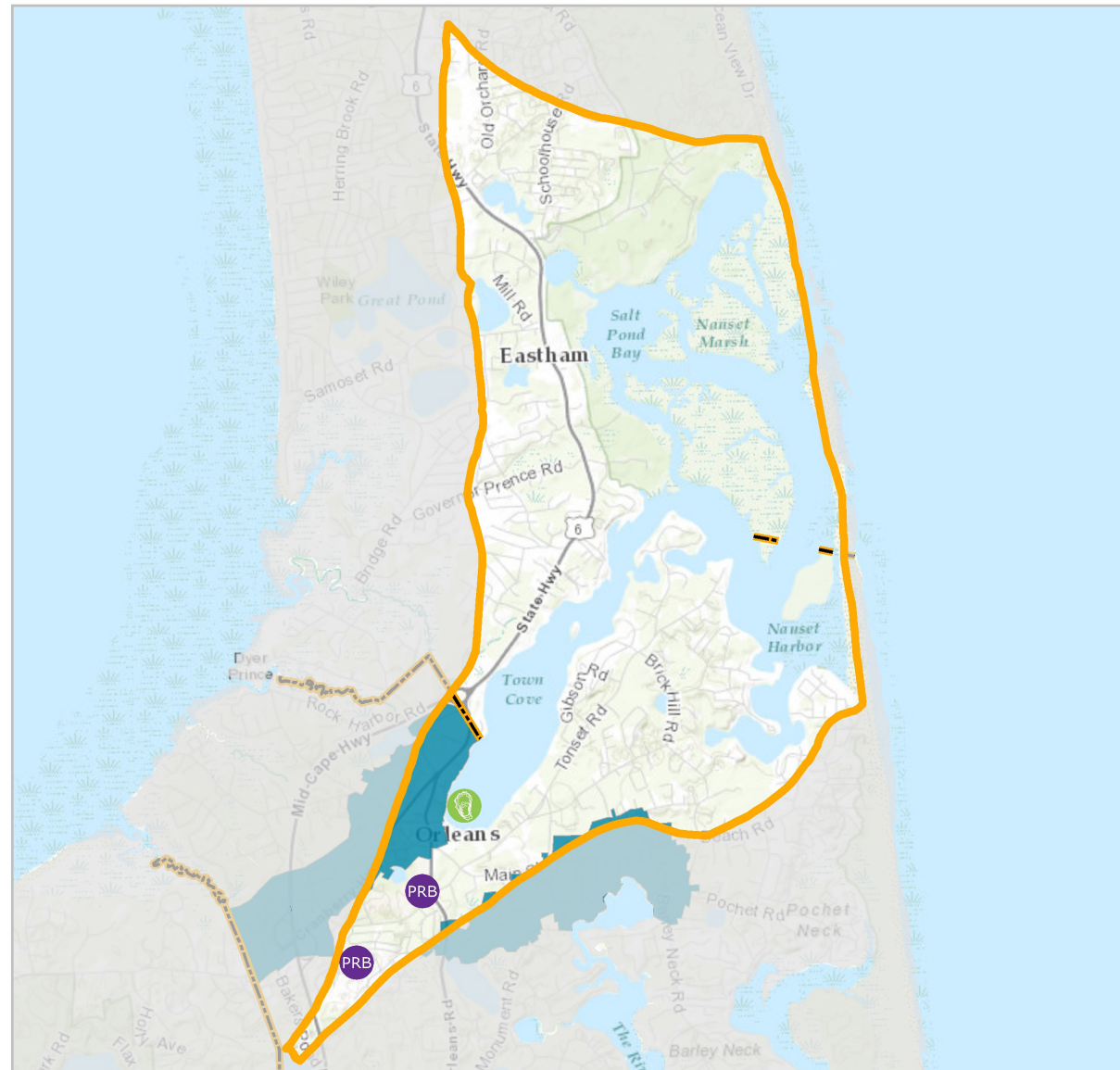
Scenario Maps

Nauset Harbor Watershed
Scenario
ORLEANS

Representative locations of conceptually proposed infrastructure

Legend

-  Permeable Reactive Barrier
-  Aquaculture
-  Town Lines
-  Embayment Watersheds
-  Proposed Sewershed



Methodology for Selecting Non-Traditional Technology Scenarios

This section summarizes the approach and methodology that was applied during the 208 Update to develop plans for reducing nitrogen loading to estuaries using non-traditional (NT) technologies. It includes descriptions of regional credits for stormwater and fertilizer reductions, regional screening for potential sites for several technologies, and site-specific analyses for others. Nitrogen attenuation rates for each technology were derived from the Technologies Matrix. The nitrogen thresholds for each embayment were determined from the Massachusetts Estuaries Project (MEP).

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Regional credits were developed for potential stormwater retrofits and fertilizer reductions. They were calculated as a percent reduction of existing nitrogen loads as identified in the MEP reports and updated GIS data developed by the Cape Cod Commission.

- **STORMWATER MANAGEMENT:** Most Cape communities have already begun the process of identifying significant untreated stormwater discharges and developing appropriate mitigation projects. With the prospect of the MS4 regulatory requirements it was assumed that additional mitigation efforts would be implemented. Based upon the evidence developed by the University of New Hampshire Stormwater Center that several vegetated stormwater management practices (including bioretention and constructed wetlands) are able to achieve nitrogen reductions of 50% or more and the assumption that only a portion (estimated at 50%) of identified sites would be retrofitted a 25% nitrogen reduction credit was assumed for each watershed. Specific locations and number of locations were not identified; this was deferred to individual towns to consider as part of the suite of nitrogen management strategies.
- **FERTILIZER REDUCTIONS:** Based upon the success of most Cape Cod towns to implement either regulatory or non-regulatory fertilizer management programs and the efforts of the Cape Cod Extension Service in

educating homeowners a 25% reduction in fertilizer applications was assumed for each watershed.

Regional GIS screening methods were developed to identify locations for some non-traditional technologies. A GIS viewer was developed as an on-line tool for staff and consultants to utilize during the watershed planning process.

- **CONSTRUCTED WETLANDS/ PHYTOREMEDIATION:** A GIS-based screening method was developed by the Cape Cod Commission to identify and rank parcels of land that have potential for the location of constructed wetlands and phytoremediation. The ranking utilized parcel size and ownership, depth to groundwater, suitable soils, distance from wetlands, and undeveloped parcels. A nitrogen removal rate of 500 kg/Y/acre and 532 kg/Y/acre was used for Constructed Wetlands and Phytoremediation, respectively.
- **PERMEABLE REACTIVE BARRIERS (PRBS):** A GIS-based screening method was developed to identify existing roads that are proximate to receiving waters, downgradient of high density development, run perpendicular to groundwater flow (to have the highest potential to intercept nutrients in groundwater), and where the depth to groundwater is relatively shallow to maximize the area of saturated thickness treated in the aquifer.

Methodology for Selecting Non-Traditional Technology Scenarios

■ **FERTIGATION WELLS:** Golf courses were mapped to identify areas where fertigation wells could be utilized to recapture nitrogen-enriched groundwater and re-apply it to the managed turf areas to serve both irrigation and fertilization needs. Most golf courses were assumed to be eighteen holes with a fertilized area of 75 acres. Fertigation water was assumed to have an average concentration of 5 mg/liter. An uptake/attenuation rate of 80% was applied resulting in an assumed nitrogen reduction of 300 kg/year for each golf course with effectively located fertigation wells. In some cases other irrigated areas (such as athletic fields and cemeteries) were identified as potential fertigation locations. Assuming the use of 730 gpd/acre for turf areas, a nitrogen removal rate of 4 kg/y/acre was used for fertigation of turf areas. Assuming a higher flow rate of 2,200 gpd/acre for cranberry bogs, a 12 kg/y/acre removal rate was used for fertigation of cranberry bogs.

The MVP tool and other site-specific tools were utilized to quantify nitrogen load reductions for several potential NT interventions.

■ **PERMEABLE REACTIVE BARRIERS:** for each PRB that was identified during the prior GIS-screening process an approximate capture area was identified using available water table maps and the wMVP tool. Upgradient contributing areas were digitized within wMVP and the nitrogen load was calculated. A nitrogen

reduction of 72.5% was applied (calculated as an average of the reported attenuation range from the Technologies Matrix).

■ **CONSTRUCTED WETLANDS (WITH COLLECTION):** Constructed wetlands were considered as a tertiary, polishing treatment for existing wastewater treatment plants. This included small-scale wastewater treatment systems. A nitrogen removal rate of 500 kg/Y/acre was used.

■ **AQUACULTURE/OYSTER REEFS:** Potential areas for aquaculture and/or oyster reef restoration were considered based upon discussions with town representatives and review of maps to identify potential areas for these operations without significant conflicts to navigation. In some cases actual recent aquaculture expansions were included where they were developed after the MEP reports were prepared. An assumption of 1 million oysters per acre was used with a nitrogen removal rate of 250 kg/Y/acre.

■ **FLOATING CONSTRUCTED WETLANDS:** Potential areas for floating wetlands were considered in areas where no conflicts with navigation or swimming areas were identified. A nitrogen removal rate of 0.4 kg/Y/sq foot was used.

■ **INLET WIDENING AND COASTAL HABITAT RESTORATION:** Only considered in areas where these projects were identified by towns or state agencies and where detailed hydrologic investigations and modeling

had been performed due to wide variations in nitrate load reduction, flushing impacts, impacts on flooding, and costs (dredging only, replacing infrastructure, removing and replacing roadways or bridges, etc.). Nitrogen removal rates were based on MEP or other studies.

■ **INNOVATIVE & ALTERNATIVE SEPTIC SYSTEMS AND ECOTOILETS:** In most cases specific locations for these technologies were not identified. Rather general estimates for the percent adoption were provided based upon discussions with the stakeholder groups and their views on potential adoption rates. In some watersheds a 5% adoption rate was included based upon this stakeholder input. In a limited number of instances specific locations for these technologies were included based upon town input and suggestions. A nitrogen removal rate of 1.658 kg/Y for each system was used for I&A Septic Systems, and 2.984 kg/Y for enhanced I&A systems. A removal rate of 2.542 kg/Y was used for each home installation of an Ecotoilet, and 0.467 kg/Y for installation of urine diversion toilets in public settings.

Finally, the locations of specific technologies were discussed during the 208 stakeholder engagement process. Stakeholders across the Cape 'groundtruthed' potential NT locations and NT scenarios were adjusted accordingly.