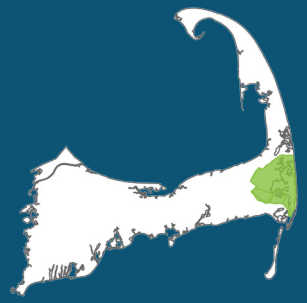
WATERSHED REPORT: LOWER CAPE

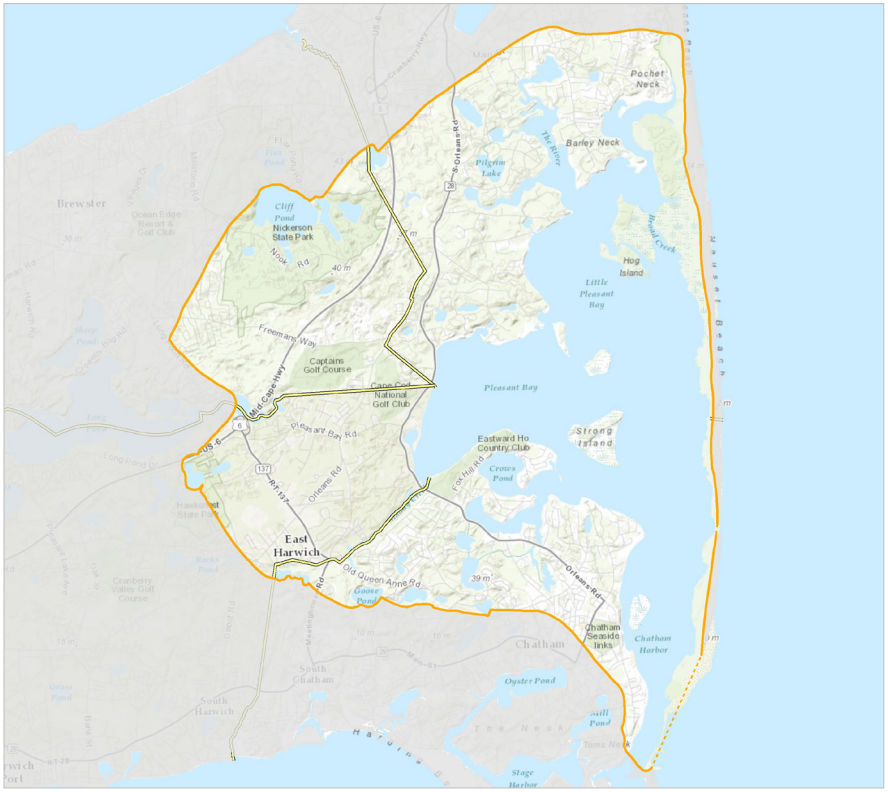
Pleasant Bay

CHATHAM, HARWICH, ORLEANS & BREWSTER



WATER THREAT LEVEL

HIGH



Pleasant Bay 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.

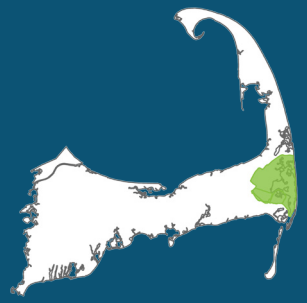
Percent contribution: the percent of attenuated nitrogen load that a town contributes to the watershed.

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.

Pleasant Bay

CHATHAM, HARWICH, ORLEANS & BREWSTER



WATER THREAT LEVEL
HIGH

Pleasant Bay is the largest marine embayment on Cape Cod with shoreline located in the Towns of Orleans, Harwich and Chatham. The system is designated under state surface water regulations as Outstanding Resource Waters that should not be allowed to degrade. Pleasant Bay is comprised of a large basin rimmed by numerous sub-embayments, including Ryder's Cove, Muddy Creek, Quanset Pond and Pochet Neck.

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 Pleasant Bay 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 been developed and approved. There are sixteen Total Nitrogen TMDLs and three Pollution Prevention TMDLs for individual sub-embayments within the Pleasant Bay system.

- **MEP TECHNICAL REPORT STATUS:** Final, dated May 2006 (Note, an MEP Technical Memorandum on Muddy Creek was issued in June 2010)
- **TMDL STATUS:** Final TMDL, issued May 2007

Watershed nitrogen load characteristics were published in the 2006 MEP report for Pleasant Bay (with additional information provided in a 2010 memo), reflecting current conditions at the time of writing:

- **TOTAL ATTENUATED NITROGEN LOAD (MEP CHAPTER VIII):** 46,429 Kg/Y
- **SOURCES OF ATTENUATED WATERSHED NITROGEN LOAD:**
  - 75% Wastewater
  - 16% Fertilizer
  - 9% Stormwater From Impervious Surfaces

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:** 272 MGY
  - Treated Wastewater Flow: 17 MGY
  - Septic Flow: 255 MGY
- **TOTAL ATTENUATED NITROGEN LOAD (WMVP):** 48,210 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.

- **CHATHAM:** 34%
- **HARWICH:** 29%
- **ORLEANS:** 29%
- **BREWSTER:** 7%

The Pleasant Bay Composite Nitrogen Management Analysis prepared by the Pleasant Bay Alliance based on the wastewater and nitrogen management plans of Brewster, Chatham, Harwich, and Orleans included the following allocations: Brewster 13%, Chatham 34%, Harwich 22%, and Orleans 30%.

THE MEP RESTORATION SCENARIO

- **WATERSHED TOTAL ATTENUATED NITROGEN REDUCTION TARGET:** 36%
- **WATERSHED SEPTIC REDUCTION TARGET:** 52% (The scenario represents the aggregated sub-embayment percent removal targets from the MEP technical report)

PLEASANT BAY ESTUARY

- **EMBAYMENT AREA:** 6,162 acres
- **EMBAYMENT VOLUME:** 2,077 million cubic feet
- **2014 INTEGRATED LIST STATUS:** Category 4A
  - Category 4A: TMDL is completed
  - www.mass.gov/eea/docs/dep/water/resources/07v5/14list2.pdf

PLEASANT BAY WATERSHED

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

- **WATERSHED CHARACTERISTICS:**
  - Acres: 11,760
  - Parcels: 5,796
  - % Developed Residential Parcels: 79%
  - Parcel Density: 2 acres per parcel (approx.)

Freshwater Sources

PONDS

- **IDENTIFIED SURFACE WATERS:** 77
- **NUMBER OF NAMED FRESHWATER PONDS:** 42
- **PONDS WITH PRELIMINARY TROPHIC CHARACTERIZATION:** 24
- **2014 INTEGRATED LIST STATUS:** 7 listed for fecal coliform only

Water quality assessments have been critical to the 2010 implementation of alum treatments for Stillwater Pond and Lovers Lake, located in the Chatham portion of the Pleasant Bay watershed. Other detailed assessments include a water quality assessment and management recommendations for freshwater ponds in Brewster, some of which are located in the Pleasant Bay watershed, and a water quality assessment of Hawksnest Pond in Harwich, which contributes to Muddy Creek. Detailed assessments have also been conducted for Bakers Pond and Crystal and Pilgrim Lakes located in Orleans and within the Pleasant Bay watershed.

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

STREAMS

- **SIGNIFICANT FRESHWATER STREAM OUTLETS:** 3

  Tar Kiln Stream:
  - Average Flow: 2,763 cubic meters per day (m3/d)
  - Average Nitrate Concentrations: 0.35 milligrams per liter (mg/L)

  Kescayo Stream:
  - Average Flow: 981 m3/d
  - Average Nitrate Concentrations: 0.19 mg/L

  Pah Wah Stream:
  - Average Flow: 388 m3/d
  - Average Nitrate Concentrations: 0.19 mg/L

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:** 3
  - Brewster Water Department
  - Harwich Water Department
  - Orleans Water Department
- **GRAVEL PACKED WELLS:** 15
  - 8 have nitrate concentrations less than 1 mg/L
  - 3 have concentrations between 1 and 2.5 mg/L
  - 4 have no data available
- **SMALL VOLUME WELLS:** 2

Each of the town water departments and land trusts have acquired significant portions of land within wellhead protection areas for water quality protection which, together with adopted land use controls recommended from the 1978

Section 208 water quality plan, has resulted in excellent drinking water quality.

Drinking water data from Cape Cod Commission and MassDEP data sources – nitrate values obtained from drinking water wells are from 2009-2012. The state and federal drinking water limit for nitrate is 10 mg/L. The Cape Cod Commission nitrate loading standard is 5 mg/l.

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 shown above as 36% of the total nitrogen load and 52% of the septic nitrogen load and, more specifically as the targeted amount of nitrogen reduction required by subwatershed in the following figures, Subwatersheds with Total Attenuated Watershed Removal Targets and Subwatersheds with Septic Attenuated Nitrogen Removal Targets.

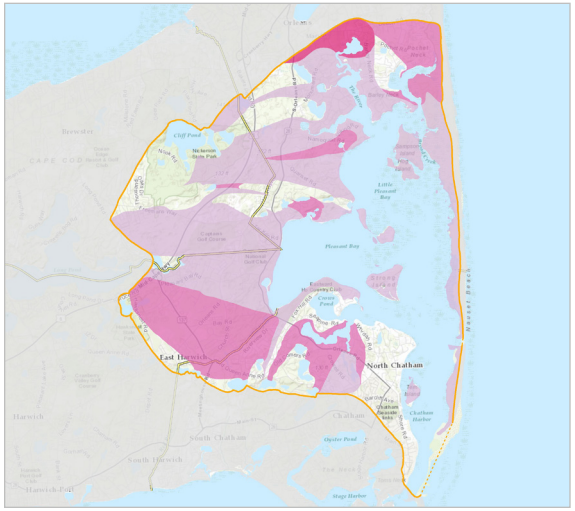
The nitrogen load from the watershed exceeds the nitrogen TMDL for Pleasant Bay, resulting in impaired water quality. The ecological health of a water body is determined from water quality, extent of eelgrass, assortment of benthic fauna, and dissolved oxygen and ranges from severe degradation, significantly impaired, moderately impaired, or healthy habitat conditions.

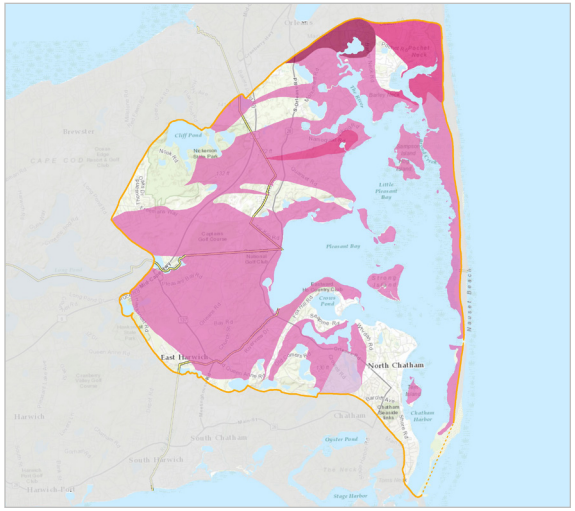
Headwater sub-embayments of Pleasant Bay are particularly impaired. Although well-flushed portions of the embayment system, such as Chatham Harbor, exhibit healthy habitat conditions, inland sub-embayments that receive less tidal flushing are experiencing moderate to severe habitat degradation.

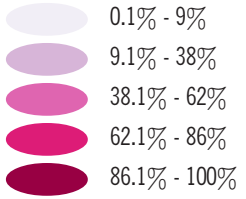
MEP ECOLOGICAL CHARACTERISTICS AND WATER QUALITY

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

- **OVERALL ECOLOGIC CONDITION:** Healthy to Severely Degraded
- **MEETINGHOUSE POND AND OUTLET:** Significantly Impaired
- **LONNIES POND:** Moderately to Significantly Impaired
- **AREYS POND AND OUTLET:** Significantly Impaired to Severely Degraded
- **THE RIVER:** Moderately Impaired
- **PAW WAH POND:** Significantly Impaired
- **QUANSET POND:** Significantly Impaired







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)

- **ROUND COVE:** Moderately to Significantly Impaired
- **UPPER MUDDY CREEK:** Severely Degraded
- **LOWER MUDDY CREEK:** Significantly Impaired
- **BASSING HARBOR – RYDERS COVE:** Moderately Impaired
- **BASSING HARBOR – CROWS POND:** Moderately Impaired
- **BASSING HARBOR – LOWER BASIN:** Healthy to Moderately Impaired
- **BASSING HARBOR – FROST FISH CREEK:** Significantly Impaired
- **POCHET:** Healthy
- **LITTLE PLEASANT BAY:** Moderately Impaired
- **PLEASANT BAY:** Moderately Impaired
- **CHATHAM HARBOR:** Healthy
- **SENTINEL STATION:**
  - Total Nitrogen Concentration Threshold: 0.16 mg/L
  - Total Nitrogen Concentration Existing: 0.18 mg/L (As reported at the MEP sentinel water-quality monitoring station)

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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 Pleasant Bay, the Towns of Chatham, Harwich, Orleans, and Brewster have done additional and more detailed planning. The Pleasant Bay Composite Nitrogen Management Analysis prepared by the four-town Pleasant Bay Alliance provides an assessment of the combined effect of the four towns' wastewater and nitrogen management plans.

TOTAL ATTENUATED NITROGEN LOAD VALUES (FROM WMVP)

Pleasant Bay Nitrogen Sources	Total Attenuated Watershed Nitrogen Load (kg-N/yr)
Wastewater[1]	33,502
Fertilizer[2]	6,372
Stormwater	6,136
Other[3]	2,199
TOTAL WATERSHED LOAD	48,210
Total Watershed Threshold[4]	28,910
TOTAL ATTENUATED LOAD TO BE REMOVED	19,300

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. 4. The total watershed threshold represents the aggregated threshold for Pleasant Bay. This includes the updated Muddy Creek threshold from the 2010 MEP Technical Report.

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

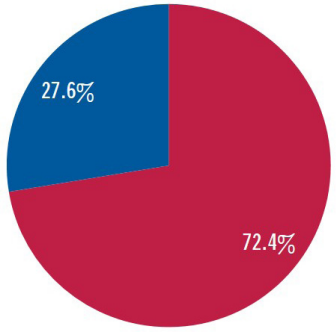
Traditional & Non-Traditional Scenarios

Non-Traditional

UNIT OF APPLIED TECHNOLOGY	ATTENUATED NITROGEN REMOVED IN KG/Y
25 % Nitrogen Reduction - Fertilizer Management	1,597
25 % Nitrogen Reduction - Stormwater Mitigation	1,541
1,000 Linear Feet - Permeable Reactive Barrier (PRB) (Capture load calculated by wMVP: 896.6 kg/Y)	650
150 Acres - Fertigation - Turf	600
10 Acres - Fertigation - Cranberry Bogs	120
Inlet Widening	1,930
22 Acres - Aquaculture/Oyster Beds	5,238
9 Acres - Coastal Habitat Restoration	880
2,063 Square Feet - Floating Constructed Wetlands	713
547 Units - Ecotoilets (UD & Compost)	1,213
839 Units - I & A Systems	1,213
466 Units - Enhanced I & A Systems	1,213
TOTAL	**17,263**[1]

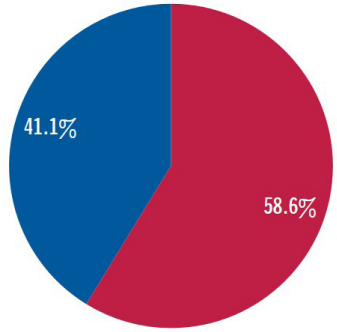
Traditional

CENTRALIZED TREATMENT WITH DISPOSAL INSIDE THE WATERSHED

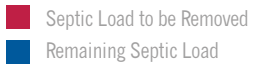


Assumes load to be collected and treated is disposed in the watershed, requiring additional collection to offset the load. Reductions as a result of sewering reflect return wastewater loads treated to 10 parts per million (ppm).

CENTRALIZED TREATMENT WITH DISPOSAL OUTSIDE THE WATERSHED



Assumes that the load to be collected and treated is removed from the watershed so no offset is required.



1. When sewering, already proposed by the Chatham CWMP, in the amount of 10,097 kg/yr is combined with this non-traditional scenario removal of 17,263 kg/yr, the resulting total removal is 27,360 kg/yr. Reductions as a result of sewering reflect return wastewater loads treated to 10 parts per million (ppm). In this scenario the non-traditional scenario overachieves because the scenario targets removals are based on separate thresholds for each sub-watershed. Fertilizer and stormwater credits cause over-achievement in sub-watershed where no NT interventions are proposed and where Chatham proposes to sewer.

Town of Chatham Local Progress

The Chatham Comprehensive Wastewater Management Plan (CWMP) of 2009 is the first town-wide plan on Cape Cod to be completed that incorporates the state and federal total maximum daily loads (TMDLs) to restore coastal water quality for several large coastal embayments. The town completed the necessary treatment facility upgrades in 2010 and the main sewer trunk line construction in 2012. Phase II sewer expansions into the Stage Harbor watershed system were completed in Fall 2015.

The Chatham Wastewater Treatment Facility (WWTF), located on an 80-acre parcel on Sam Ryder Road, recently underwent a major upgrade as part of phase 1 of the CWMP. The facility has a permitted capacity of 1.0 million gallons per day (MGD) (annual average) and 2.3 MGD (peak day) and four sand beds. Two sand beds were constructed during the major upgrade and two were existing sand beds that were rehabilitated as part of the upgrade. The permit requires a discharge limit of 10 milligrams per liter (mg/L) with an annual limit of 9.132 pounds/year, which corresponds to an annual average discharge of 3 mg/L.

The upgrade to the WWTF included several improvements to its sludge processing capabilities. Dewatered sludge is discharged and taken off site for disposal. The site also accepts septage collected from Chatham parcels only.

In 2013 Chatham signed an agreement with the Town of Harwich to further evaluate the possibility of using a portion of the treatment capacity in Chatham to serve the eastern portion of Harwich, which is part of the shared Pleasant Bay watershed. The potential sharing of the facility is allowed by condition in the Development of Regional Impact (DRI) approval of the Chatham CWMP.

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

Chatham has also been a lead town, along with Harwich, in the effort to improve circulation in Muddy Creek with a culvert-widening project that would likely reduce nitrogen removal requirements. The project received local, state, and federal support and was completed in May 2016. In addition, the town was a recipient of a technical assistance grant through the Southeast New England Coastal Watershed Restoration Program (SNEP) and a stormwater best management practice (BMP) was constructed in the Oyster Pond watershed in 2016.

Through the Pleasant Bay Alliance, the Town of Chatham 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.

At the Spring 2017 Town Meeting, Chatham voted to fund design and construction of phase 1D of the CWMP, a cost of $31,000,000, and to execute an IMA with the Town of Harwich to accept wastewater flow from Harwich to be treated at the Chatham WWTF.

Town of Chatham Watershed Scenario Details

Pleasant Bay	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)
Traditional Scenario									13,015
Centralized Sewer (With Disposal Outside the Watershed)			3,002	389,864	13,015				

NOTES: The load reduced reflects sewering proposed by the Chatham CWMP. The proposed sewering was assessed using wMVP and the scenario shown above reflects that assessment.

Town of Harwich Local Progress

The Town of Harwich submitted its Draft Comprehensive Wastewater Management Plan (CWMP) for review in 2013 and its Final CWMP Single Environmental Impact Report (SEIR) in March 2016. The Massachusetts Environmental Policy Act (MEPA) Unit issued its certificate on May 13, 2016. Since 2007, Harwich wastewater planning efforts have been coordinated predominantly by the Wastewater Implementation Committee (WIC) and Board of Selectmen (BOS).

The recommended plan detailed in the CWMP was developed by the WIC and BOS working closely with their consultant, CDM Smith, Inc., and includes a core system of collection and conveyance utilizing two centralized treatment facilities. Implementation of the plan is phased over 40 years and was chosen as the preferred scenario because it allows for multiple effluent recharge sites in different watersheds, allows for easier phasing with adaptive management, presents a regional solution between the Towns of Harwich and Chatham (and potentially Dennis in the future), and reduces the overall size of the facilities in Harwich. Wastewater collection in the Pleasant Bay watershed will be done through a community partnership with Chatham to treat wastewater generated and collected in the Pleasant Bay watershed at the existing Chatham treatment facility. Treated effluent would initially be recharged at the Chatham facility but may, in the future, be conveyed back to East Harwich for recharge depending on water quality results. Sewer system construction in the Pleasant Bay watershed is proposed to be completed over phases 2, 3 and 8, as defined in the CWMP.

Harwich is also a lead town, along with Chatham, in a shared effort to improve circulation in Muddy Creek (part of the Pleasant Bay watershed) with a culvert-widening project that is projected to reduce nitrogen removal requirements.

The CWMP allows infrastructure components to be implemented, results monitored and the later program phases adapted as needed. The plan includes recommended non-infrastructure program components which include fertilizer and stormwater management programs, potential land use changes, open space acquisition, and several community involved conservation and pollution reduction programs.

Through the Pleasant Bay Alliance, the Town of Harwich 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.

At the Spring 2017 Town Meeting, Harwich voted to fund design of a portion of phase 2 of the CWMP and the cost to implement the Chatham IMA and purchase capacity at the Chatham treatment facility for a total cost of $9,035,000. In addition, Harwich voted to fund the Cold Brook restoration project (also part of phase 2 of the CWMP) in the amount of $2,000,000.

Town of Harwich Watershed Scenario Details

Pleasant Bay	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)
Traditional Scenario									8,700
Centralized Sewer			538	111,652	8,700				

NOTES:

* Average daily flow collected includes buildout and estimated inflow and infiltration.

** Scenario details received from the town did not include load reduction.

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

Pleasant Bay	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									9,136
Fertilizer Management	25%	931							
Centralized Sewer*			372	110,000	4,052				
Permeable Reactive Barrier (PRB)						Not Reported		614	
Aquaculture/Oyster Beds						Not Reported		396	
Coastal Habitat Restoration						Not Reported		1,401	
I & A Systems			Not Reported		1,742				

NOTES:

* This information is at buildout conditions.

Town of Brewster Local Progress

In 2009, the Town of Brewster formed a Comprehensive Water Planning Committee (CWPC). The CWPC was charged with coordinating the efforts of the Town staff and consultants. The Town chose to pursue development of an Integrated Water Resources Management Plan (IRWMP) because it wanted to closely evaluate drinking water and freshwater pond issues in addition to coastal water quality impairments.

Phase I of the IRWMP was completed in 2011. As a result the Town initiated a number of intermediate projects to expand the Town's data and understanding of water quality. In January 2013, Phase II of the IRWMP was issued. The report recommends a number of alternatives for coastal nitrogen reduction in the Pleasant Bay watershed, including innovative/alternative (I/A) and cluster systems, fertilizer reduction, irrigation wells to recycle and reduce groundwater concentrations, permeable reactive barriers, and alternative toilets.

The Town of Brewster has submitted the IWRMP to the Cape Cod Commission for a 208 consistency review. The goals of Phase III are to:

- Evaluate the Pleasant Bay nitrogen management alternatives identified in the Phase II report and select a preferred plan with recommendations for what Brewster needs to do to restore water quality within Pleasant Bay;
- Finalize recommended stormwater regulations developed in Phase II;
- Encourage proper management of stormwater, septic systems, fertilizers and other potential pollutants that impact Brewster's Ponds (e.g., new regulations);
- Continue with current outreach activities (e.g., website, brochure);
- Facilitate communication between the CWPC, the Cape Cod Commission, the public, and with other Town boards and agencies involved in the project.

The Town is continuing its efforts toward drinking water protection through bylaws and the Brewster Water Protection District of Critical Planning Concern (DCPC). A number of specific opportunities for stormwater treatment have been identified and conceptual designs have been developed. There are a number of freshwater pond protection strategies that are also recommended.

In the fall of 2014, Brewster adopted local nitrogen-oriented fertilizer management regulations consistent with the Cape-wide Fertilizer Management DCPC.

Brewster 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 2015, the Town completed a Pleasant Bay Nitrogen Alternatives Analysis report describing a recommended plan of non-traditional technologies to reduce nitrogen loading from existing development. Three of these approaches have already been implemented and reduce the nitrogen input from Brewster's portion of the Pleasant Bay Watershed by approximately 50%. They include fertilizer reductions at the Town-owned Captains Golf Course, the recapture of nitrogen through the golf course irrigation wells, and the adoption of a fertilizer bylaw. In addition, shellfish propagation was identified in the report as an option to meet the remaining load reduction.

Since 2015, the Town has worked with its other watershed Towns through the Pleasant Bay Alliance to evaluate shellfish aquaculture and propagation activities that the Town cannot take on its own given its limited access to the Bay. The Town facilitated discussions on this topic in the fall of 2015 through a District Local Technical Assistance (DLTA) grant from the Cape Cod Commission. No immediate opportunities to incorporate shellfish management into the Town's plans were identified, however, Brewster remains open to future cooperation with its neighboring Towns to increase shellfish propagation in Pleasant Bay. Ongoing work with the Pleasant Bay Alliance and Brewster's three neighboring communities in the Pleasant Bay watershed has resulted in an assessment of 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.

The Town is currently investigating the potential to utilize nitrogen reducing leach field technologies to meet the remainder of its nitrogen obligation for Pleasant Bay.

Town of Brewster Watershed Scenario Details

Pleasant Bay	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									1,905
Fertilizer Management[1]	50%	155							
Fertilizer Reduction - Golf Course[2]						151	Acres	932	
Fertigation - Golf Course[3]						151	Acres	227	
Aquaculture/Oyster Beds						3.36	Acres	591	

These systems are currently being tested at the Massachusetts Septic System Test Center. A new Board of Health regulation could be used to implement the construction of these systems, perhaps at the time of a property transfer when a septic system inspection is required under the State Environmental Code Title 5 (314 CMR 15.00).

In a June 2016 letter to the Commission Brewster provided an update on watershed planning. The information in this letter, along with information from the IWRMP, was used to inform the watershed reports for Brewster watersheds.

The "preferred alternative" in the IRWMP Alternatives Analysis Report is the scenario included in this report.

NOTES:

1. Expected reduction from Residential Fertilizer Bylaw (bylaw adopted at Nov 2014 Town Meeting).
2. From actual fertilizer application reductions already taken at Captain's golf course since the time of the MEP report completion.
3. Removal based on actual pumping and nitrogen concentration data.

Scenario Maps

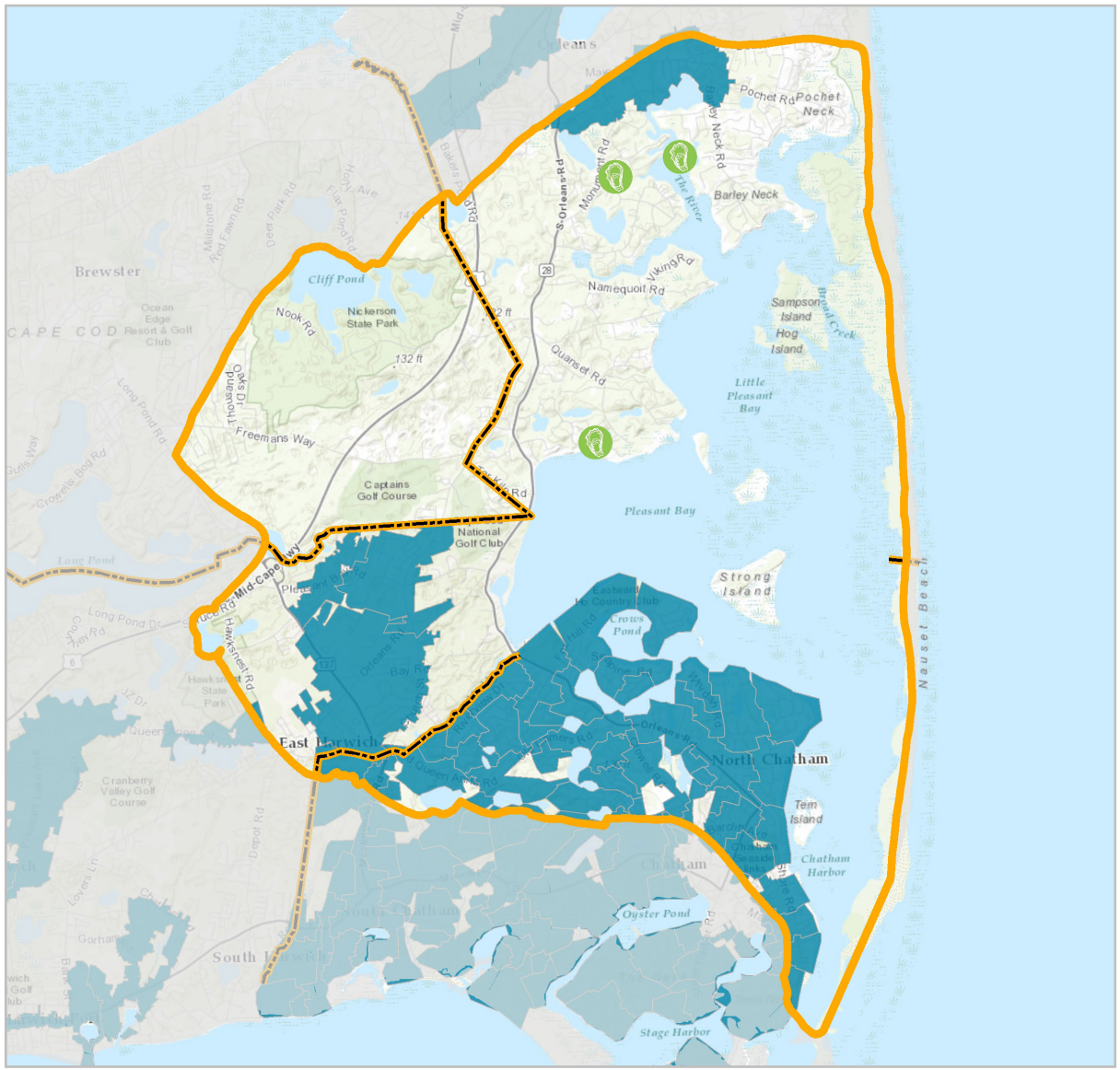
Pleasant Bay Watershed Scenario

CHATHAM,HARWICH,ORLEANS&BREWSTER

Representative locations of conceptually proposed infrastructure

Legend

- 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).

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 are noted below, based on the Technologies Matrix or newer data. The nitrogen thresholds for each embayment were determined from the Massachusetts Estuaries Project (MEP).

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.