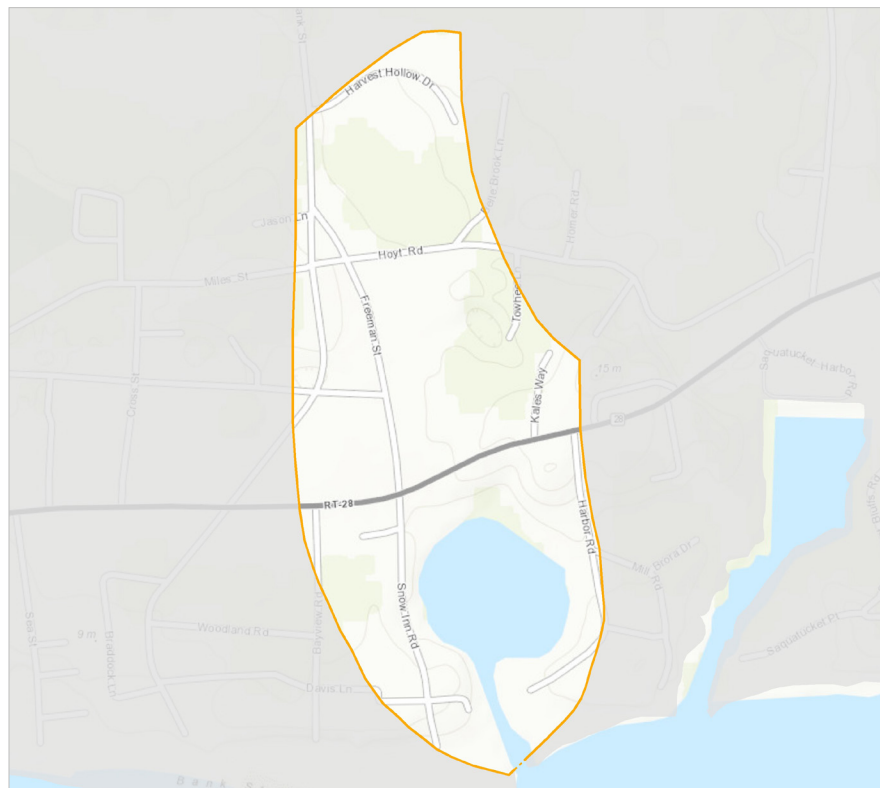
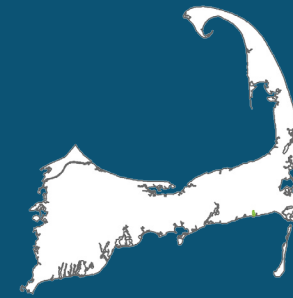


Wychmere Harbor

HARWICH

HIGH



Wychmere 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 (SMASST) 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.

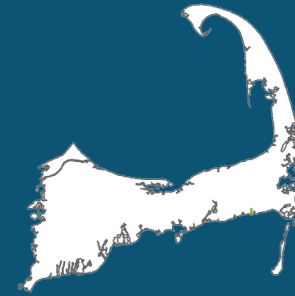
Reduction target: an approximation of the amount of nitrogen that needs to be removed from the watershed to achieve the threshold; this number is calculated by subtracting the threshold number from the attenuated total watershed load, and is for planning purposes only.

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.

Wychmere Harbor

HARWICH

HIGH

Wychmere Harbor is small embayment with shoreline located entirely in the Town of Harwich and with outlet to Nantucket Sound. The Harbor is a simple estuary located entirely within the Town of Harwich which is comprised of a small marina and a single outlet. Flushing with Nantucket Sound occurs through a canal bounded by jetties, which was dredged to be navigable in 1887. It 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 Wychmere Harbor system exceeds its critical threshold for nitrogen, resulting in impaired water quality. A MEP technical report has been completed and a draft Total Maximum Daily Load (TMDL) for nitrogen is pending.

- **MEP TECHNICAL REPORT STATUS:** Final
- **TMDL STATUS:** Pending (Draft TMDLs issued April 2015)

Watershed nitrogen load characteristics were published in the 2010 MEP report for Wychmere Harbor, reflecting current conditions at the time of writing:

- **TOTAL ATTENUATED NITROGEN LOAD (MEP CHAPTER VIII):** 1,411 kg/Y
- **SOURCES OF ATTENUATED WATERSHED NITROGEN LOAD:**
 - 83% Septic Systems
 - 4% Fertilizer
 - 2% Wastewater Treatment Facilities
 - 6% Golf Course Fertilizers
 - 5% Cranberry Fertilizer

Since the MEP report, the Commission compiled the following updated water use and nitrogen loads using the regional wMVP database (see page 2), enabling a more current estimate of nitrogen loading. Towns have also submitted watershed characteristics that may differ from wMVP. Differences may be explained by different source years of water use data, or other assumptions. Both values are presented, when provided:

■ REGIONAL DATABASE (WMVP)

- See figure on page 1 for watershed boundary delineation
 - Total Wastewater Flow: 10 MGY (million gallons per year)
 - Treated Wastewater Flow: 0 MGY
 - Septic Flow: 10 MGY
 - Total Attenuated Nitrogen Load: 1,320 Kg/Y

■ TOWN OF HARWICH/CDM REPORTED VALUE

- Total Wastewater Flow: 16 MGY
- Treated Wastewater Flow: 8 MGY
- Septic Flow: 8 MGY

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.

- **HARWICH:** 100%

THE MEP RESTORATION SCENARIO

- **WATERSHED TOTAL ATTENUATED NITROGEN REDUCTION TARGET: 83%**
- **WATERSHED SEPTIC REDUCTION TARGET: 100%**
(The scenario represents the aggregated sub-embayment percent removal targets from the MEP technical report)

WYCHMERE HARBOR ESTUARY

- **EMBAYMENT AREA:** 14 acres
- **EMBAYMENT VOLUME:** 7 million cubic feet
- **2014 INTEGRATED LIST STATUS:** Not Listed
 - www.mass.gov/eea/docs/dep/water/resources/07v5/14list2.pdf

WYCHMERE HARBOR WATERSHED

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

characteristics that may differ from wMVP. Differences may be explained by changes due to development in the intervening years, or other assumptions. Both values are presented, when provided:

■ WATERSHED CHARACTERISTICS

Regional Database (wMVP):

- 107 Acres
- 152 Parcels
- 79% Residential Parcels
- 0.7 acres per parcel

Town of Harwich/CDM Reported Values:

- 101 Acres
- 123 Parcels
- 79% Residential Parcels
- 0.8 acres per parcel

Freshwater Sources

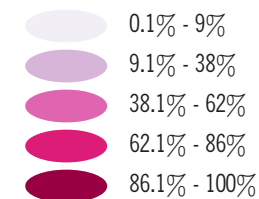
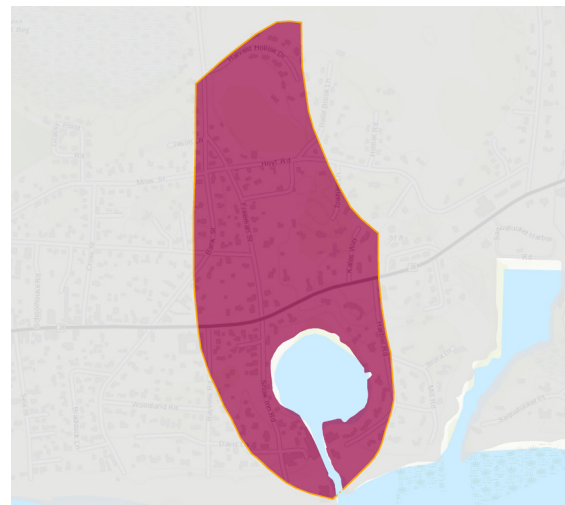
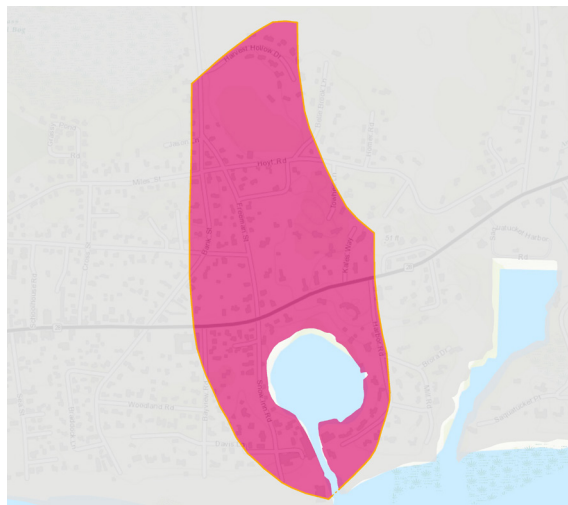
PONDS

- **IDENTIFIED SURFACE WATERS:** 1
- **NUMBER OF NAMED FRESHWATER PONDS:** 0
- **PONDS WITH PRELIMINARY TROPHIC CHARACTERIZATION:** 0
- **2014 INTEGRATED LIST STATUS:** None listed

STREAMS

- **SIGNIFICANT FRESHWATER STREAM OUTLETS:** 0

Stream data from MEP technical report.



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)

DRINKING WATER SOURCES

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

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 total maximum daily load (TMDL) and/or MEP technical report. In watersheds where a MEP technical report has been completed, but there is no finalized TMDL the need is defined by the critical nitrogen loading values as put forth in the MEP report. These were referred to above as 100% of the septic load and 83% of the total load for Wychmere Harbor. The MEP technical reports also provide a specific 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).

The nitrogen load from the watersheds exceeds the critical nitrogen thresholds, resulting in impairment of water quality in all three Harbors. 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:

- **WYCHMERE HARBOR**
 - Overall Ecologic Condition: Moderately to Significantly Impaired
- Sentinel Station:
- Total Nitrogen Concentration Threshold: 0.50 mg/L
 - Total Nitrogen Concentration Existing: 0.81 mg/L
(As reported at the MEP sentinel water-quality monitoring station)

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 Wychmere Harbor, the Town of Harwich has 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)

Wychmere Harbor Nitrogen Sources	Total Attenuated Watershed Nitrogen Load (kg-N/yr)
Wastewater ¹	1,042
Fertilizer ²	139
Stormwater	120
Other ³	19
TOTAL WATERSHED LOAD	1,320
Total Watershed Threshold	241
TOTAL ATTENUATED LOAD TO BE REMOVED	1,079

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.

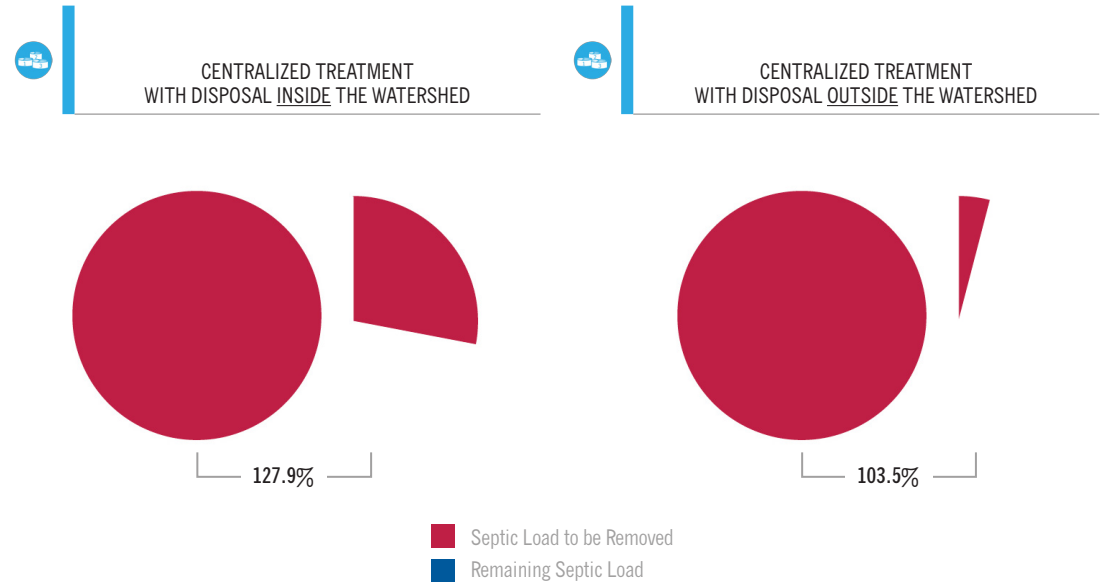
Traditional & Non-Traditional Scenarios

Non-Traditional

UNIT OF APPLIED TECHNOLOGY	ATTENUATED NITROGEN REMOVED IN KG/Y
 25 % Nitrogen Reduction - Fertilizer Management	35
 25 % Nitrogen Reduction - Stormwater Mitigation	30
 1,400 Linear Feet - Permeable Reactive Barrier (PRB) (Capture load calculated by wMVP: 771 kg/Y)	559
 7 Acres - Fertigation - Cranberry Bogs	84
 500 Square Feet - Floating Constructed Wetlands	200
 23 Units - Ecotoilets (UD & Compost)	58
 35 Units - I & A Systems	58
 19 Units - Enhanced I & A Systems	58
TOTAL	1,082

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

Traditional



Assumes load to be collected and treated is disposed in the watershed, requiring additional collection to offset the load.

The watershed nitrogen threshold cannot be met by collecting 100% of the septic load in the watershed and returning the treated load to the watershed.

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

The watershed nitrogen threshold cannot be met by collecting 100% of the septic load in the watershed and disposing the treated load outside the watershed.

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. Proposed sewerage in the Wychmere Harbor watershed is part of phase 6 of the CWMP, to be completed by 2042.

The plan also 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.

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

Wychmere 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									1,100
Centralized Sewer			129	34,976	1,100				

NOTES:




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

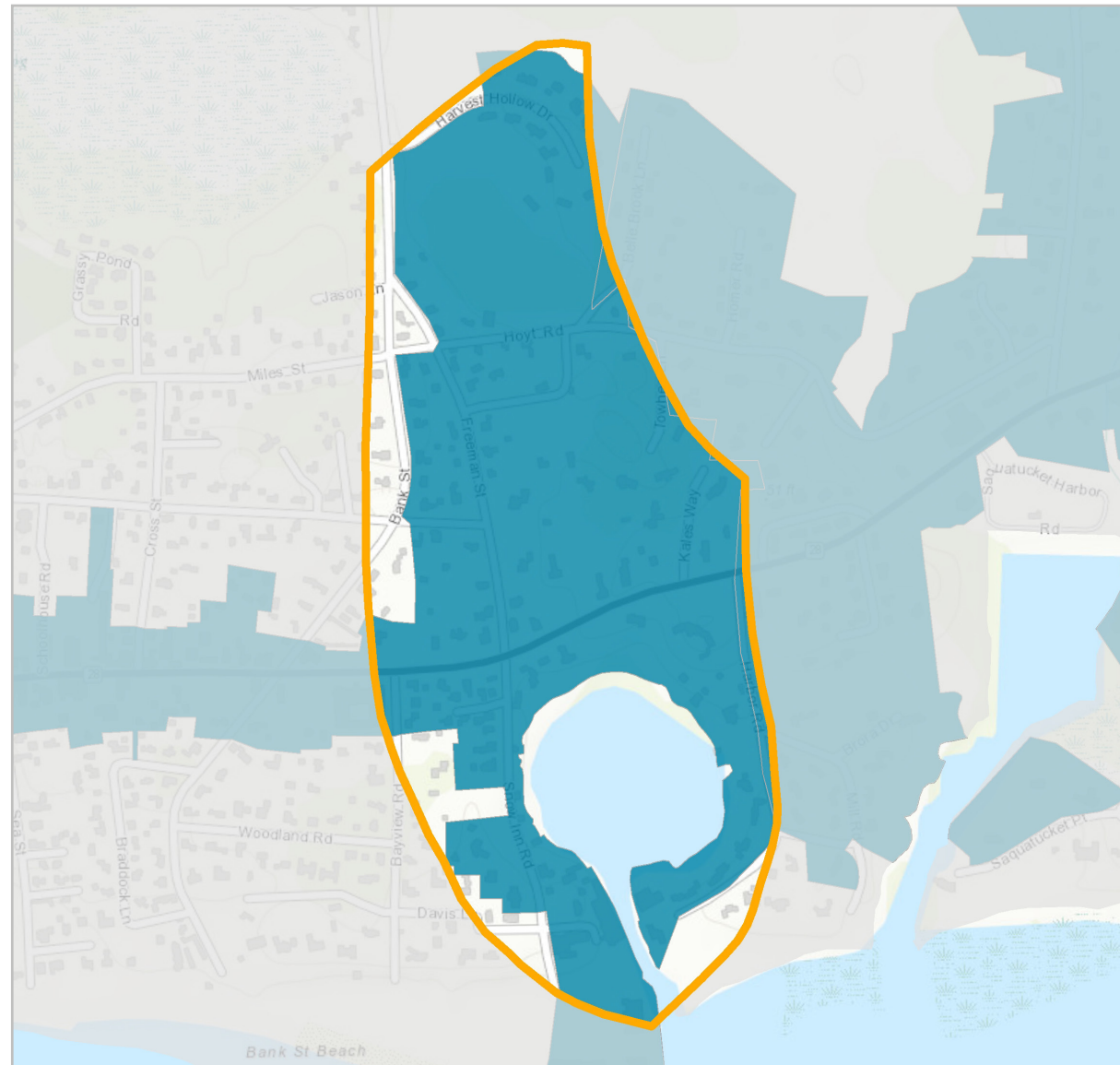
Scenario Maps

Wychmere Harbor Watershed
Scenario
HARWICH

Representative locations of conceptually
proposed infrastructure

Legend

-  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.