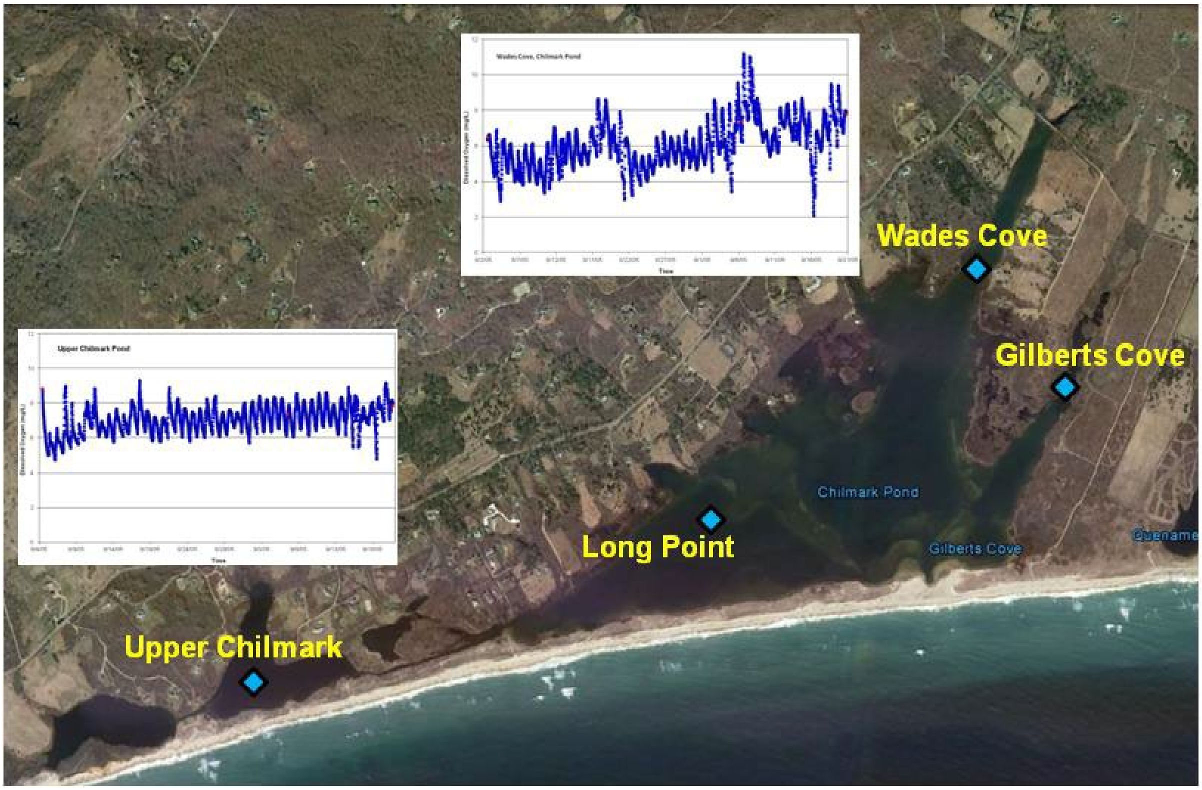
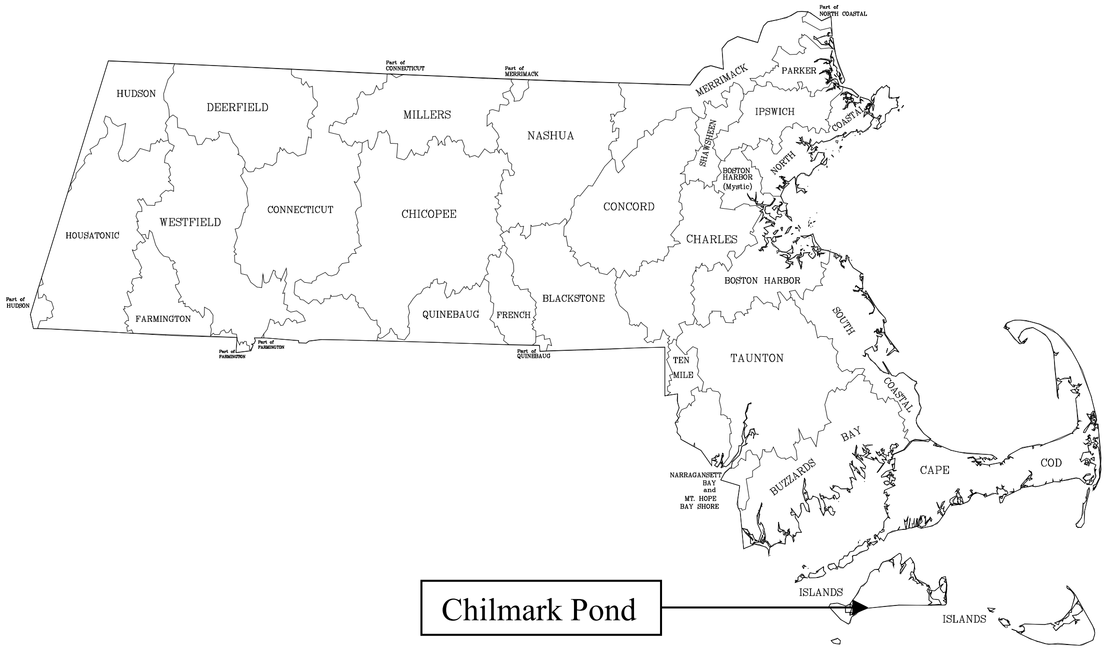
Final
Chilmark Pond Estuarine System
Total Maximum Daily Load
For Total Nitrogen
(CN 451.1)



COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENERGY AND ENVIRONMENTAL AFFAIRS
KATHLEEN THEOHARIDES, SECRETARY
MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION
MARTIN SUUBERG, COMMISSIONER
BUREAU OF WATER RESOURCES
KATHLEEN BASKIN, ASSISTANT COMMISSIONER

November 2019

Final
Chilmark Pond Estuarine System
Total Maximum Daily Load
For Total Nitrogen



Key Feature: Total Nitrogen TMDL for Chilmark Pond System
Location: United States Environmental Protection Agency (EPA) Region 1, Chilmark, MA
Land Type: New England Coastal

303d Listing: Chilmark Pond (Segment MA97-05) is listed in Category 5 of the Massachusetts Year 2014 Integrated List of Waters as impaired for fecal coliform.

Data Sources: University of Massachusetts – Dartmouth/School for Marine Science and Technology; US Geological Survey; Applied Coastal Research and Engineering, Inc.; Martha's Vineyard Commission; and Town of Chilmark.

Data Mechanism: Massachusetts Surface Water Quality Standards, Ambient Data and Linked Watershed Model

Monitoring Plan: Martha's Vineyard Commission/Town of Chilmark Water Quality Monitoring Programs with technical assistance by SMAST

Control Measures: Managed Pond Openings**,** Enhanced Wastewater Treatment, Agriculture Best Management Practices, Storm Water Management, Fertilizer Use By-laws.

Executive Summary

Problem Statement

Excessive nitrogen (N) originating from a variety of sources has added to the impairment of the environmental quality of Chilmark Pond. In general, excessive N in these waters is indicated by:

- Nitrogen enrichment and impairment of infaunal habitats (Section VII of MEP),
- Periodic decreases in dissolved oxygen concentrations that threaten aquatic life;
- Reductions in the diversity of benthic animal populations; and
- Periodic phytoplankton blooms

With proper management of N inputs these trends can be reversed. Without proper management, more severe problems might develop, including:

- Periodic fish kills;
- Unpleasant odors and scum;
- Benthic communities reduced to the most stress-tolerant species, or in the worst cases, near loss of the benthic animal communities.

Coastal communities, including Chilmark, rely on clean, productive, and aesthetically pleasing marine and estuarine waters for tourism, recreational swimming, fishing, and boating, as well as for commercial fin fishing and shellfishing. Failure to reduce and control N loadings could lead possible increases in macro-algae, a higher frequency of undesirable decreases in dissolved oxygen concentrations and fish kills, widespread occurrence of unpleasant odors and visible scum, and a complete loss of benthic macroinvertebrates throughout most of the system. As a result of these environmental impacts, commercial and recreational uses of Chilmark Pond waters will be greatly reduced.

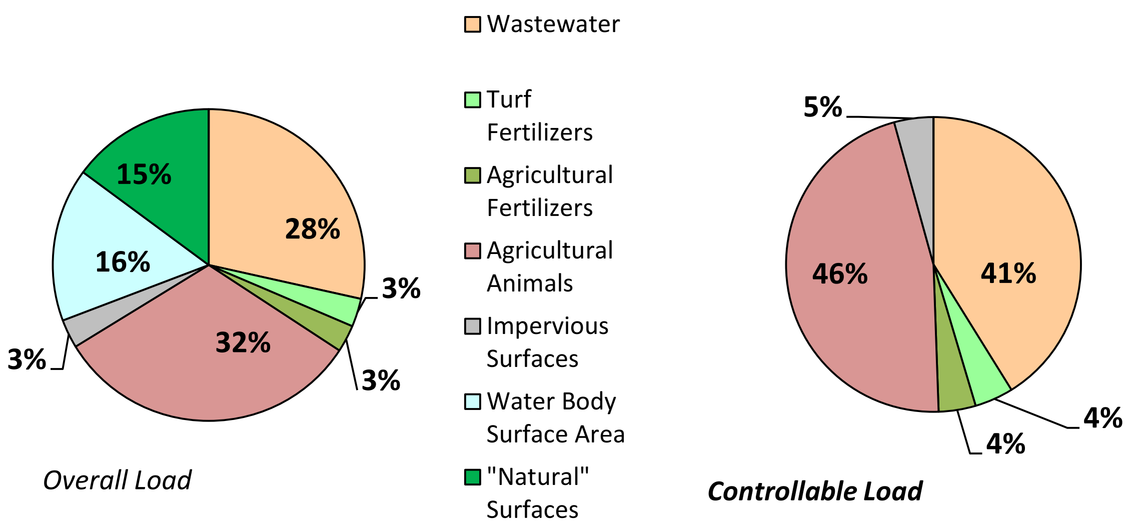
Sources of Nitrogen

Nitrogen enters the waters of coastal embayments/ponds from the following sources:

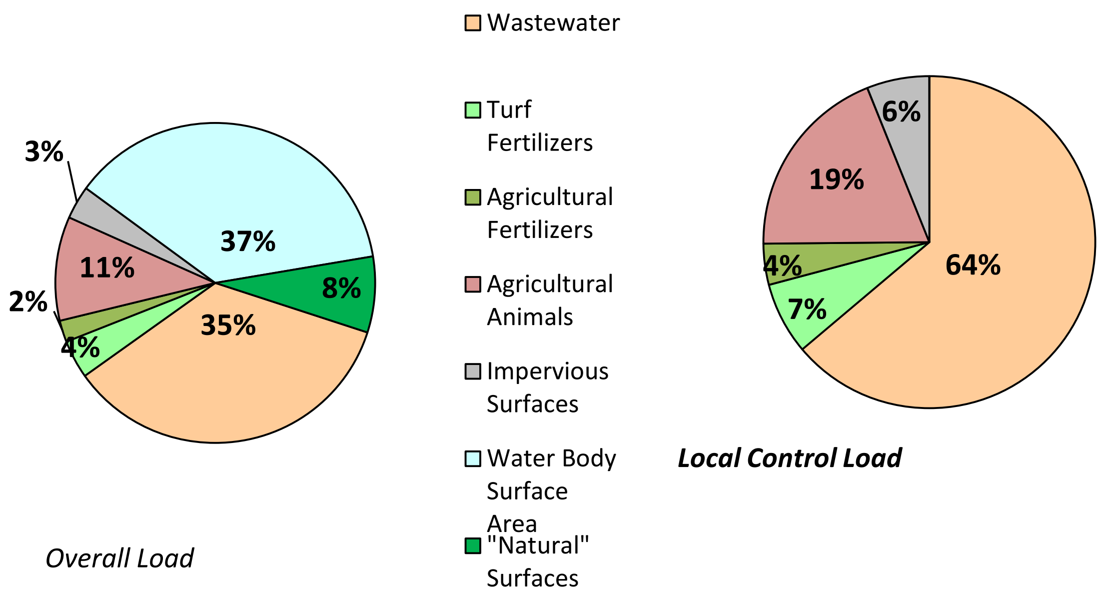
- The watershed
    - septic systems
    - runoff
    - fertilizers
    - agricultural activities
    - natural background
- Atmospheric deposition
- Nutrient-rich bottom sediments in the embayments/ponds

Figure ES-1 below indicates the percent contributions of the various sources of N to Chilmark Pond. Values are based on Table ES-1 and Table IV-2 from the Massachusetts Estuaries Project (MEP) *Linked Watershed-Embayment Model to Determine Critical Loading Threshold for the Chilmark Pond Embayment System, Town of Chilmark, MA, April 2015*, herein referred to as the MEP Technical Report (Howes *et. al*, 2015). Watershed nitrogen loads (Figure ES-1) for the Chilmark Pond system in the Town of Chilmark are comprised primarily of wastewater nitrogen (septic systems) and agricultural sources. Land-use and wastewater analysis found that approximately 50% of the *controllable* watershed nitrogen load (system-wide) was from agricultural activity (animals and fertilizers) while approximately 41% was from septic systems. Septic systems are the largest source of controllable nitrogen watershed load in East, or Lower, Chilmark Pond where septic systems and agriculture (animals and fertilizers) represent 64% and 23% of the controllable watershed nitrogen load, respectively. In West, or Upper, Chilmark Pond agriculture (animals and fertilizers) is the largest source of controllable watershed nitrogen load representing 61% of the total controllable load while septic systems comprise 32%. Lawn fertilizers contribute 4% of the controllable load in the whole system, 7% in the East Pond and 3% in the West Pond

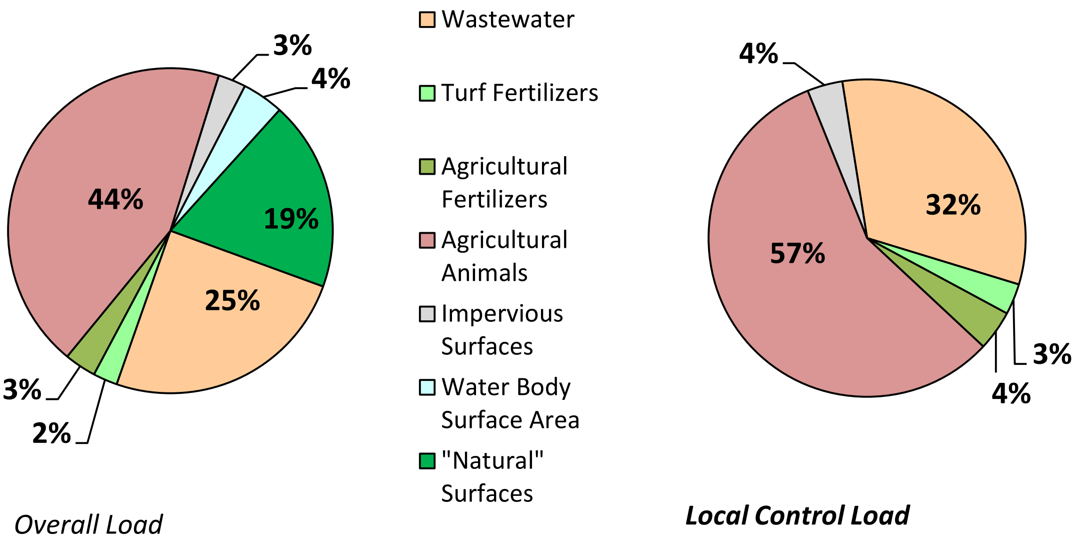
Figure ES-1: Percent Contributions of All Watershed Nitrogen Sources to Chilmark Pond Estuarine System



Chilmark Pond – Whole System



Lower (or East) Chilmark Pond



Upper (or West) Chilmark Pond

Target Threshold Nitrogen Concentrations and Loadings

Chilmark Pond is located entirely within the town of Chilmark on Martha's Vineyard. The total watershed N load that enters the estuary each day is 17.10 kg/day. This represents the total watershed load from natural surfaces, agriculture, fertilizer, land use runoff, and septic system loading. The average concentration of N in Chilmark Pond in 2004 was 0.61 mg/L (milligrams per liter of N) (average of yearly means at the stations collected in 2004 as reported in Table VI-1 of the MEP Technical Report and included in Appendix B of this report).

The MEP approach is typically to require a minimum of 3 years of data to establish a water quality baseline. However, water quality in the pond is presently managed by periodically opening an inlet to the ocean. The Chilmark Pond analysis requires that both periods when the inlet is open and closed be considered, so a two part approach was developed. In order to create a model that realistically simulates salinity and total nitrogen in response to flushing conditions, it was necessary to calibrate the model to actual measurements. For calibrating the breaching model, concurrent water quality and tide elevation records in a moderate frequency time series surrounding the opening was required. Only one year of data surrounding the 2004 opening was available to calibrate the model. The following period when the inlet is closed and Chilmark Pond behaves like a simple reservoir, a mass balance model is used which considers freshwater inputs and constituent mass flux into the pond. MEP has used this model for other periodically breached estuaries like Edgartown Great Pond and Tisbury Great Pond. Data from 2003, 2004, 2005, 2010 and 2012 were used to assess the overall water quality health (Howes *et al* 2015, pg. 5, 82-85).

In order to restore and protect this estuarine system, N loadings, and subsequently the concentrations of N in the water, must be reduced to levels below the thresholds that cause the observed environmental impacts. This concentration will be referred to as the *target threshold N concentration*. It is the goal of the TMDL to reach this target threshold N concentration, as it has been determined for each impaired waterbody segment. The MEP has determined that for this estuarine system a N concentration of 0.50 mg/L is required to restore benthic infauna habitat throughout Chilmark Pond and simultaneously attempt to restore a modest level of eelgrass habitat within the main basin which has been nonexistent over the past several decades (Howes *et. al* 2015, pg ES 9).

Within the Chilmark Pond Estuary the most appropriate sentinel "station" was to use the average of the 5 long-term monitoring stations (CHP1 through CHP5) distributed throughout Lower Chilmark Pond (main eastern basin), Gilberts Cove and Wades Cove. The average was selected because given the relatively long periods between openings, wind driven mixing and dispersion result in a relatively uniform total nitrogen concentration throughout the estuary. MEP has used this average approach in other open "single basin" estuaries that are only periodically opened to tidal flow (Howes *et. al* 2015 pg 118).

This document presents the TMDL for this water body and provides guidance to the town of Chilmark on possible ways to reduce the N loadings to within the recommended TMDL and protect the waters of this estuarine system.

Implementation

The primary goal of the TMDL implementation will be to restore benthic infauna habitat throughout Chilmark Pond. Benthic infauna habitat was chosen as the target for restoration as there is no historical evidence of eelgrass in the estuary back through the 1950's. To restore benthic habitat, load reduction focused on lowering average TN levels of stations within the main basin to 0.50 mg/L during the summer months. This goal was achieved by reducing the watershed loading to the pond and assuming the pond is breached three times a year. Watershed loading was reduced from present conditions until the combined time averaged TN concentration would remain below 0.50 mg/L during a 120-day period during the summer months. The threshold modeling assumptions include a successful spring breach, which remains open for 8 days and lowers the average pond TN concentration to 0.33 mg/L. The pond is also allowed to be closed for 120 days, which allows the time for the water level in the pond to rise. To achieve the threshold an approximate 37% reduction in septic loads to the pond from present conditions was required. This is but one example of a loading reduction that can achieve the threshold assuming the above mentioned breaching criteria can be met (MEP Tech Report, Howes *et al*. 2015, pg.121).

Agriculture (farms and farm animals) was found to contribute the largest controllable N load (50%) to this system (Figure ES-1). It is recommended that the watershed community of Chilmark implement agricultural best management practices (BMPs) with a goal of reducing N contribution from agricultural sources by 10% watershed-wide. Reducing agriculture N loads from the watershed, even by just 10%, will aid in meeting nutrient reduction targets within the estuaries and diminish the need for reductions in septic load. Massachusetts Department of Agricultural Resources, Plant Nutrient Application Requirements, 330 CMR 31.00, became effective December 2015. These regulations require basic plant nutrient applications for 10 or more acres and adherence to application and seasonal restrictions.

Local officials can explore other load reduction scenarios through additional modeling as part of their Comprehensive Water Resources Management Plan (CWRMP). Implementing best management practices (BMPs) to reduce N loadings from fertilizers and runoff where possible will also help to lower the total N load to this system. Methodologies for reducing N loading from septic systems, storm water runoff and fertilizers are provided in detail in the "MEP Embayment Restoration and Guidance for Implementation Strategies", available on the MassDEP website: https://www.mass.gov/files/documents/2016/08/rz/mepmain.pdf. The appropriateness of any of the alternatives will depend on local conditions and will have to be determined on a case-by-case basis using an adaptive management approach. It is important to note that the analysis of future nitrogen loading (build-out) to the Chilmark Pond estuarine system focuses upon additional shifts in land-use from forest/grasslands to residential and commercial development. The MEP analysis indicates that significant increases in nitrogen loading can also occur under present land-uses, due to shifts in occupancy, shifts from seasonal to year-round usage and increasing use of fertilizers. Therefore, watershed-estuarine nitrogen management must include management approaches to prevent increased nitrogen loading from both shifts in land-uses (new sources) and from loading increases under current land-uses.

The nitrogen loading to this system results primarily from on-site disposal of wastewater (septic systems), agriculture animals, and to a lesser extent fertilizer applications (residential and agricultural) and stormwater flows. Restoration of this system should focus on managing nitrogen loading within the watershed entering the estuary and inlet management to enhance the rate of nitrogen removal from the estuary via tidal flushing.

Table of Contents

List of Figures

List of Tables

Introduction

Section 303(d) of the Federal Clean Water Act requires each state (1) to identify waters that are not meeting water quality standards and (2) to establish Total Maximum Daily Loads (TMDLs) for such waters for the pollutants of concern. The TMDL allocation establishes the maximum loadings (of pollutants of concern) from all contributing sources that a water body may receive and still meet and maintain its water quality standards and designated uses, including compliance with numeric and narrative standards. The TMDL development process may be described in four steps, as follows:

1. Determination and documentation of whether or not a water body is presently meeting its water quality standards and designated uses.

2. Assessment of present water quality conditions in the water body, including estimation of present loadings of pollutants of concern from both point sources (discernable, confined, and concrete sources such as pipes) and non-point sources (diffuse sources that carry pollutants to surface waters through runoff or groundwater).

3. Determination of the loading capacity of the water body. EPA regulations define the loading capacity as the greatest amount of loading that a water body can receive without violating water quality standards. If the water body is not presently meeting its designated uses, then the loading capacity will represent a reduction relative to present loadings.

4. Specification of load allocations based on the loading capacity determination for non-point sources and point sources that will ensure that the water body will not violate water quality standards.

After public comment and final approval by the EPA, the TMDL will serve as a guide for future implementation activities. The MassDEP will work with the Town of Chilmark to develop specific implementation strategies to reduce N loadings and will assist in developing a monitoring plan for assessing the success of the nutrient reduction strategies.

In the Chilmark Pond embayment system the pollutant of concern for this TMDL (based on observations of eutrophication) is the nutrient nitrogen (N). Since nitrogen is the limiting nutrient in coastal and marine waters, as its concentration increases, so does plant productivity. This leads to nuisance populations of macro-algae and increased concentrations of phytoplankton and epiphyton that imperil the healthy ecology of the affected water bodies.

The TMDL for total N for the Chilmark Pond Embayment system is based primarily on data collected, compiled and analyzed by University of Massachusetts Dartmouth's School for Marine Science and Technology (SMAST), the Martha's Vineyard Commission, and the town of Chilmark, Chilmark Pond Association, as part of the Massachusetts Estuaries Project (MEP). The data were collected over a study period including the years 2003-2005, 2010 and 2012. For purposes of the water quality model only data collected in 2004 were used. The MEP Technical Report can be found at https://www.mass.gov/doc/chilmark-pond-embayment-system-chilmark-ma-2015. The MEP Technical Report presents the results of the analyses of this coastal embayment system using the MEP Linked Watershed-Embayment Nitrogen Management Model (Linked Model).

The analyses were performed to assist the watershed communities with decisions on current and future wastewater planning, wetland restoration, anadromous fish runs, shellfisheries, open-space and harbor maintenance programs. Critical elements of this approach are the assessments of water quality monitoring data, historical changes in eelgrass distribution, time-series water column oxygen measurements and benthic community structure that were conducted on this embayment. These assessments served as the basis for generating a N loading threshold for use as a goal for watershed N management. The TMDL is based on the site-specific target threshold N concentration generated for this embayment. Thus, the MEP offers a science-based management approach to support the wastewater management planning and decision-making process in the Town of Chilmark.

Description of Water Bodies and Priority Ranking

Watershed Characterization

The overall MEP watershed area to the Chilmark Pond Embayment System is 3,137 acres (Table III-1 of MEP Tech Report). The delineated contributory watershed includes five subwatersheds which were delineated for estimation of groundwater flows and nutrient export (Figure 1, Howes *et. al* 2015, pg. 24). The MEP team has estimated a total groundwater flow for the system of 25,354 m^3/day.

The MEP project has assessed landuse in the Chilmark Pond embayment system using Town of Chilmark assessor's data and Martha's Vineyard Commission information. Landuse was summarized into seven categories including residential, commercial, multi-use, industrial, public (including rights of way), undeveloped and unknown/unclassified. The landuse summary follows Massachusetts Department of Revenue classifications (MassDOR 2012) and the public service category signifies tax exempt properties including land owned by government and private non-profits. The most common landuse categories in the Chilmark Pond watershed are residential (58%) and undeveloped (24%) (Howes *et. al* 2015, pg. 30).

Description of Waterbodies

The Chilmark Pond Embayment System is located entirely within the Town of Chilmark on the island of Martha's Vineyard, Massachusetts. This system is located on the south side of Martha's Vineyard and exchanges tidal water with the Atlantic Ocean through a single inlet within a barrier beach. The watershed to the Chilmark Pond estuary is entirely within the Town of Chilmark.

The Chilmark Pond Embayment System consists of a 178-241 acre (depending on the water level in the pond) coastal salt pond. The Chilmark Pond Embayment System is a complex coastal open water embayment comprised of a large main basin (lower Chilmark) and multiple sub-embayments. Upper Chilmark Pond is to the west of the main basin. Wades Cove and Gilberts Cove are small tributary coves located on the east side of the main basin. The system is maintained as an estuary by the periodic breaching of the barrier beach with a single temporary inlet. The estuary only occasionally receives tidal waters from the Atlantic Ocean into its main basin based on a schedule of openings set by the Town. Floodwater from the Atlantic Ocean enters the main basin of lower Chilmark Pond and circulates through channels and across flats making its way up into Wades Cove the primary tributary basin in this system) as well as into upper Chilmark Pond (west), which is connected to lower Chilmark Pond via Doctor's Creek, a narrow channel (Figure 2). Upper Chilmark Pond is really comprised of two basins which are connected by a very small shallow channel locally referred to as Interns Creek (Howes *et. al* 2015, pg. 92-93).

The western basin, upper Chilmark Pond, is currently fresh to slightly brackish and has been functionally separated from the estuary by coastal processes. Throughout this report, "Chilmark Pond" and the "main basin" refer to lower Chilmark Pond and are used interchangeably.

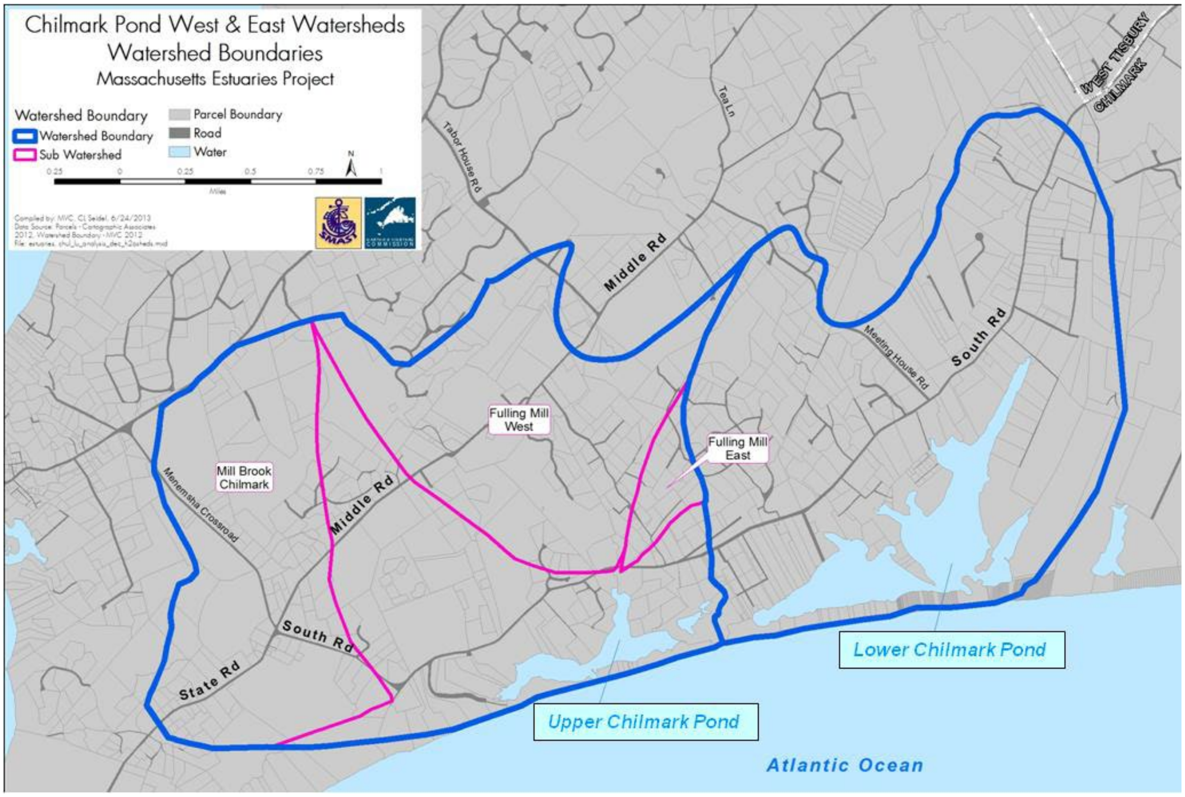


Figure 1: Chilmark Pond Watershed Area Delineation and sub-watershed delineations for the Chilmark Pond Embayment System (Upper and Lower) (excerpted from Howes *et. al* 2015, pg. 24)

For the MEP analysis, the Chilmark Pond estuarine system was partitioned into two general sub-embayment groups: 1) the eastern main basin including Wades Cove and Gilberts Cove and 2) the tributary western sub-basin (upper Chilmark Pond) (see Figure 2).

The Chilmark Pond embayment system periodically exchanges tidal water with the Atlantic Ocean through managed "breaching" of the barrier beach (South Beach). This great salt pond is opened to tidal exchange by excavating a trench through the barrier beach seasonally as the water levels in the pond rise sufficiently (by freshwater inflow) to provide sufficient hydraulic head to erode the desired channel to the sea. In addition to insufficient pond level, openings can be delayed due to poor hydrodynamic conditions in the near shore ocean (e.g. wave height and direction that result in rapid in-filling of the temporary inlet). Typically, pond water levels of one meter or greater above mean sea level are required, before a breach is attempted. Breaching of the pond is undertaken mainly as a means of controlling salinity levels in the pond and as a flood control measure. If the pond level is not periodically lowered, by breaching, groundwater levels in the adjacent watershed rise sufficiently to impact basements of houses bordering the pond, and at very high pond levels, parcels may be affected by direct flooding. At present, the number and duration of pond openings plays a fundamental role in the maintenance of nutrient related water quality and habitat health throughout this estuary. [MEP Tech Report, Howes *et. al*, pg. 3-4].

The absence of continuous tidal exchanges between the estuary and Atlantic Ocean allows for a greater increase in nitrogen level than in similar sized open estuaries per unit of watershed loading, which results in increased sensitivity of this system to watershed nitrogen loading compared to open tidal systems.

The multiple coves and sub-embayments to the Chilmark Pond Embayment System greatly increases the shoreline and decreases the travel time of groundwater (and its pollutants) from the watershed recharge areas to bay regions of discharge. As such, the Chilmark Pond estuary is particularly vulnerable to the effects of nutrient enrichment from the watershed, especially considering that circulation is mainly through wind driven mixing in the small tributary subembayments, the long shoreline of the pond and the only periodic flushing with "clean" Atlantic Ocean water. In particular, the Chilmark Pond Embayment System and its sub-embayments along the south shore of Martha's Vineyard are at risk of eutrophication (over enrichment) from nitrogen enriched groundwater and surface water flows and runoff from the watershed. A complete description of this estuarine system is presented in Chapters I and IV of the MEP Technical Report. [MEP Tech Report, Howes *et. al*, 2015 pg. 1-2].

A more complete description of this estuarine system is presented in Chapters I and IV of the MEP Technical Report (Howes *et. al* 2015). A majority of the information presented here on this estuarine system is drawn from the Technical Report. Chapters VI and VII of the MEP Technical Report provide assessment data that show that the Chilmark Pond system is impaired because of nutrients, low dissolved oxygen levels, elevated chlorophyll-*a* levels and benthic fauna habitat degradation.

The nature of enclosed embayments in populous regions brings two opposing elements to bear: 1) as protected marine shorelines they are popular regions for boating, recreation, and land development and 2) as enclosed bodies of water, they may not be readily flushed of the pollutants that they receive due to the proximity and density of development near and along their shores. The Chilmark Pond system is at risk of further eutrophication from high nutrient loads in the groundwater and runoff from the watershed.

This estuarine system has been assessed by DEP and is listed as a waterbody requiring a TMDL for fecal coliform (Category 5) in the Massachusetts 2014 Integrated List of Waters (MassDEP 2015). It was also found to be impaired for nutrients, low dissolved oxygen, elevated chlorophyll-*a*, and degradation of benthic fauna habitat during the course of the MEP study (Table 1).

Priority Ranking

The embayment addressed by this TMDL is determined to be a high priority based on three significant factors: (1) the initiative that the town has taken to assess the conditions of the entire estuarine system; (2) the support of the town to restore and preserve the embayment; and (3) the extent of impairment in the embayment. In particular, this embayment is at risk of further degradation from increased N loads entering through groundwater and surface water runoff from the increasingly developed watershed. In both marine and freshwater systems an excess of nutrients results in degraded water quality, adverse impacts to ecosystems and limits on the use of water resources. Observations are summarized in Table 2 and the Problem Assessment section below and detailed in Chapter VII- Assessment of Embayment Nutrient Related Ecological Health of the MEP Technical Report.

Table 1: Comparison of DEP and SMAST Impaired Parameters for Chilmark Pond

Waterbody Name	MassDEP Segment ID	MassDEP Segment Description	Class	2014 Integrated List Category	SMAST Impaired Parameter[1]	Size (acres)[1]
Chilmark Pond	MA97-05	South of South Road including Wades Cove and Gilberts Cove, Chilmark, Martha's Vineyard.	SA (SFO)	Fecal Coliform	Nutrients, Dissolved Oxygen, Chlorophyll *a*, Infaunal Animals	178 to 241

[1] As determined by the MEP Chilmark Pond Study and reported in the Technical Report; acreage size depends on the water level in the pond.

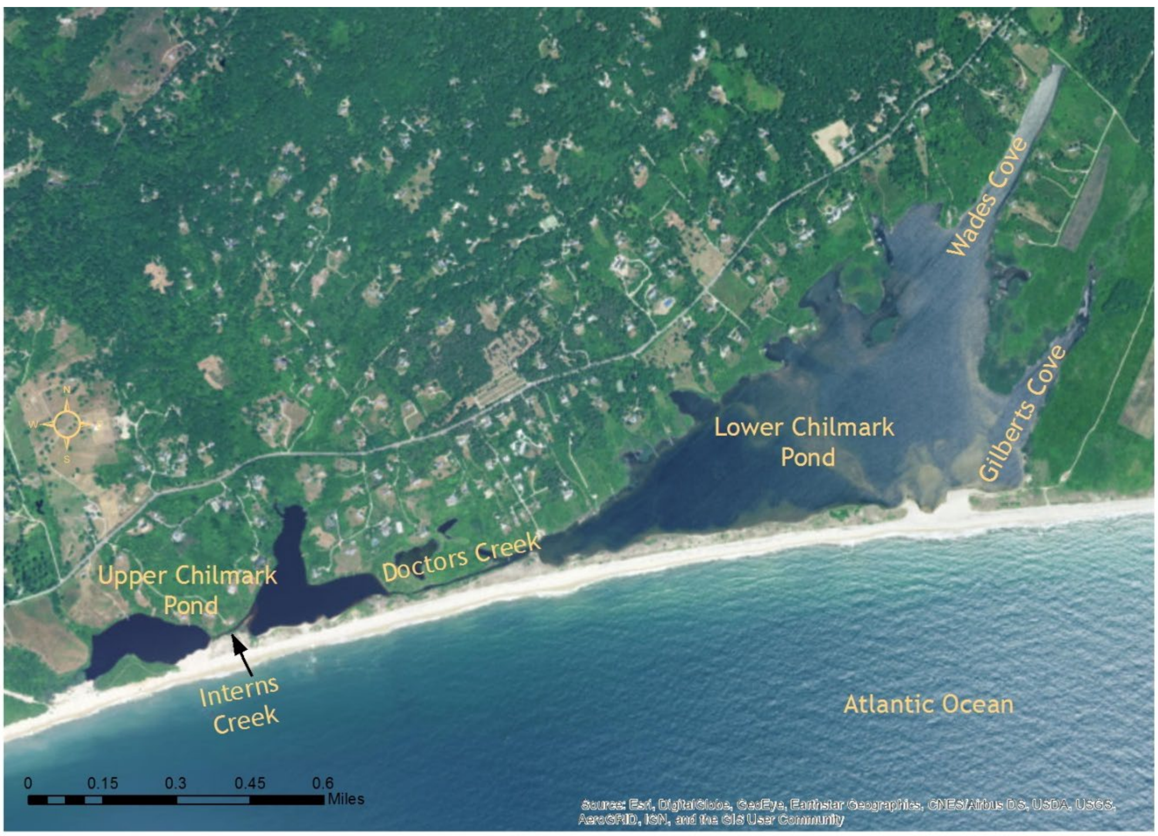


Figure 2: Overview of Chilmark Pond

Description of Hydrodynamics of the Chilmark Pond System

The MEP project has evaluated the tidal circulation and flushing characteristics of this embayment system using both direct measurements and the RMA-2 model, a well-established model for estuaries. Since the calibrated RMA-2 model simulated accurate two-dimensional hydrodynamics in the system, model results were used to compute a residence time for the entire estuary. The average volume calculated for Chilmark Pond is 30,013,150 ft^3 with a tidal prism of 6,699,878 ft^3 when the inlet is open. This results in a residence time of approximately 2.3 days. This modest residence time provides some confidence that the temporary channel allows enough exchange to significantly improve water quality during a typical breach event. [MEP Technical Report, Howes et. al 2015, pg. 81.]

Problem Assessment

Water quality problems associated with development within the watershed result primarily from septic systems and agriculture activities and to a lesser extent from runoff and fertilizers. The water quality problems affecting nutrient-enriched embayments generally include periodic decreases of dissolved oxygen, decreased diversity of benthic animals and periodic phytoplankton blooms. In the most severe cases, habitat degradation could lead to periodic fish kills, unpleasant odors and scums and near loss of the benthic community and/or presence of only the most stress-tolerant species of benthic animals. The Chilmark Pond estuary is particularly vulnerable to the effects of nutrient enrichment from the watershed, due to its very limited tidal exchange and that circulation is mainly through wind driven mixing in the small tributary sub-embayments. In particular, the Chilmark Pond Estuary is subject to cultural eutrophication from nitrogen enriched groundwater and surface water flows and runoff from its watershed.

The year round resident population of the Town of Chilmark has increased by almost 250% over the past five decades and the watershed of Chilmark Pond has had development of seasonal and year round single-family homes (Figure 3). Based on the buildout assessment completed for this review, there are 228 potential additional residential dwellings within the Chilmark Pond watershed. Many of the parcels assigned additional development at buildout already have agricultural uses (*e.g.*, parcels assigned as developable residential parcels by the town assessor, but currently used as pasture or for hay). Existing agricultural loads were removed if the parcel was identified as having additional residential development in the buildout scenario. Overall, MEP buildout additions within the entire Chilmark Pond System watershed will increase the unattenuated loading rate by 3%. At the time of the data collection, 100% of the parcels in the Chilmark Pond watershed relied on privately maintained septic systems for on-site treatment and disposal of wastewater.

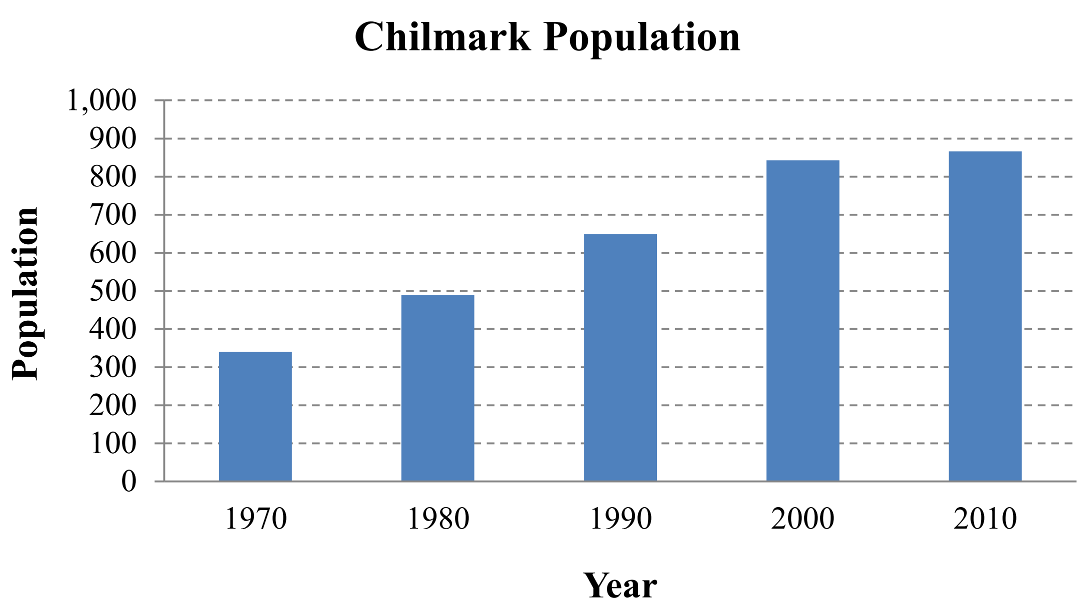


Figure 3: Chilmark Residential Population

Coastal communities, including Chilmark, rely on clean, productive and aesthetically pleasing marine and estuarine waters for tourism, recreational swimming, fishing, and boating, as well as commercial fin fishing and shellfishing. The continued degradation of this coastal embayment, as described above, could significantly reduce the recreational and commercial value and use of these important environmental resources.

Habitat and water quality assessments were conducted on this estuarine system based upon water quality monitoring data, analysis of historical changes in eelgrass distribution, time-series water column dissolved oxygen and chlorophyll-*a* measurements, benthic community structure assessments and sediment characteristics.

The Chilmark Pond system is showing a moderate level of nitrogen enrichment, moderately/significantly impaired benthic animal habitats, regions of periodic moderate oxygen depletion and phytoplankton blooms (Table 2). Each of the estuarine basins, specifically Lower Chilmark Pond (east), Wades Cove and Gilberts Cove are showing moderate-significant levels of impairment related to their elevated chlorophyll-*a* levels and moderate periodic oxygen depletions. While the benthic community throughout the system is characterized by high numbers of individuals, the numbers of species, diversity and evenness are low, indicative of a community under ecological stress. Reducing nitrogen concentrations in the estuary will result in the restoration of dissolved oxygen and chlorophyll a to levels supportive of benthic habitat. There is no documented or reported eelgrass in this estuary over at least the last 60 years based on numerous sources including; long-time residents, the Martha's Vineyard Commission, the Chilmark Pond Association, and the Chilmark/West Tisbury Shellfish Propagation Agent (Howes *et. al* 2015).

Given the historic lack of eelgrass coverage in this system the MEP project determined the ecological health of the system relative to benthic infauna. Infaunal survey results in the Chilmark Pond Embayment System indicate that the nitrogen management should be targeted to restore degraded infaunal habitat found in the tributary coves (Howes *et. al* 2015, pg. 110). The MEP tech report found nitrogen reductions are required for restoration of the embayment system and note that "it should be emphasized that reducing nitrogen enrichment can be achieved by reducing nitrogen inputs and/or increasing the rate of nitrogen loss through enhanced tidal exchange" (Howes *et. al* 2015, pg. 110).

The oxygen records show that the sub-embayments of Chilmark Pond, specifically Wades Cove, receive significant watershed nitrogen loads relative to their volumes and turnover rates and consequently have the largest daily oxygen excursions, a nutrient related response. Further, Wades Cove, and to a lesser extent, Gilberts Cove, show high to moderate levels of oxygen depletion and stress to animals. The largest oxygen depletions were observed in the Long Point portion of the main basin and Wades Cove, which receives large quantities of groundwater and surface water transported nutrient load from the watershed. When the Pond is opened by breaching the barrier beach to allow tidal flows, the observed spatial pattern is that the level of oxygen depletion and chlorophyll-*a* and total nitrogen levels increase with increasing distance from the tidal inlet. This temporary inlet opening serves to lower pond and associated groundwater levels, but also provides the most promising mechanism for restoration of pond habitats, presently impaired due to nitrogen enrichment, by exchanging nitrogen and organic matter enriched pond waters with high quality waters of the Atlantic Ocean (Howes *et. al* 2015, pg. 115-116).

Table 2: General Summary of Conditions Related to the Major Indicators of Habitat Impairment Observed in the Chilmark Pond System (excerpted Howes *et. al*. 2015, pg. 117).

Health Indicator	**Lower (East) Chilmark Pond**	**Wades Cove**	**Gilberts Cove**
Dissolved Oxygen	oxygen frequently >6 mg/L, 88% of record and rarely <4 mg/L 2% of record, generally 6-10 mg/L; WQMP >5 mg/L [**MI**]	oxygen depletion frequently <6 mg/L, 50% , >5 mg/L 21% of record, infrequent brief excursions to <4 mg/L. [**MI**]	oxygen depletion infrequently <5 mg/L 8%, rare very brief excursions to <4 mg/L. [**H/MI**]
Chlorophyll *a*	high summer chlorophyll levels generally ~20 ug/L, averaging 33 ug/L at mooring site, average level in summer, large blooms to 80 ug/L during mooring period; WQMP was 8.6-8.9 ug/L, stations CHP-3 & 5 with bloom years >20 ug/L. Large blooms not a consistent summer phenomenon.[**MI/SI**]	high summer chlorophyll levels generally ~20 ug/L, averaging 33 ug/L at mooring site, average level in summer, large blooms to 80 ug/L during mooring period; WQMP was 8.6-8.9 ug/L, stations CHP-3 & 5 with bloom years >20 ug/L. Large blooms not a consistent summer phenomenon.[**MI/SI**]	moderate summer chlorophyll levels generally <10 ug/L, averaging 8 ug/L at mooring site, mean summer WQMP generally ~5 ug/L, 2005 bloom year ~25 ug/L.[**MI**]
Macroalgae	generally very sparse drift algae and no apparent algal mat, some Ruppia.[**H**]	generally very sparse drift algae and no apparent algal mat, some Ruppia.[**H**]	generally very sparse drift algae and no apparent algal mat, some Ruppia.[**H**]
Eelgrass Loss	no evidence that this basin historically supported eelgrass habitat	no evidence that this basin historically supported eelgrass habitat	no evidence that this basin historically supported eelgrass habitat
Benthic Fauna	moderate-high numbers of individuals, low # species, low diversity & Evenness, dominated by organic enrichment species (Streblospio, Amphipods), some stress tolerant opportunists (Tubificids, Capitella,7% of organisms) [**MI/SI**]	high numbers of individuals (~500), low # species (11), low diversity (H'=2.2) & moderate Evenness (0.66), dominated by organic enrichment species, some stress tolerant opportunists (Tubificids, Capitella, 13% of organisms) [**MI/SI**]	high numbers of individuals (>600), low # species (7), low diversity (H'=1.5) & Evenness (0.54), dominated by a few organic tolerant species (Amphipods), but very few opportunists (Tubificids+Capitella= 4% of organisms) [**MI/SI**]
Overall Health	Moderate-Significant Impairment, primarily due to periodic D.O. depletion and large phytoplankton blooms, benthic animal communities contain few species with low diversity and Evenness, with some stress indicator species, macroalgae absent. [**MI/SI**]	Moderate-Significant Impairment, primarily due to periodic D.O. depletion and large phytoplankton blooms, benthic animal communities contain few species with low diversity and Evenness, with some stress indicator species, macroalgae absent. [**MI/SI**]	Moderate Impairment, only moderate oxygen depletion and chlorophyll levels, with summer averages ~8 ug/L (i.e. <10ug/L) few species and low diversity dominated by amphipod mat, but with very few opportunistic stress indicator species, macroalgae absent.[**MI**]

H - Healthy habitat conditions, **MI** – Moderately Impaired, **SI** – Significantly Impaired - considerably and appreciably changed from normal conditions, **SD** – Severely degraded
These terms are more fully described in MEP report "Site-Specific Nitrogen Thresholds for Southeastern Massachusetts Embayments: Critical Indicators" December 22, 2003.
https://www.mass.gov/doc/massachusetts-estuaries-project-interim-report-on-site-specific-nitrogen-thresholds-for
WQMP indicates Martha's Vineyard Commission Water Quality Monitoring Project

Pollutant of Concern, Sources and Controllability

In Chilmark Pond, as in most marine and coastal waters, the limiting nutrient is nitrogen (N). Nitrogen concentrations above those expected naturally contribute to undesirable water quality and habitat conditions (such as described above).

Chilmark Pond has had extensive data collected and analyzed through the MEP, with the cooperation and assistance from the town of Chilmark and the Martha's Vineyard Commission (MVC). Data collection included both water quality and hydrodynamics as described in Chapters I, IV, V, and VII of the MEP Technical Report. These investigations revealed that loadings of nutrients, especially N, are much larger than they would be under natural conditions and, as a result, the water quality has deteriorated. Figure 4 illustrates the sources and percent contributions of N into Chilmark Pond.

The level of "controllability" of each source, however, varies widely as shown in Table 3. Cost/benefit analyses will have to be conducted for all possible N loading reduction methodologies in order to select the optimal control strategies, priorities, and schedules.

The estuarine reaches of Chilmark Pond consist of a main basin (Lower Chilmark Pond) and two tributary coves (Wades, Gilberts). The western basin (upper Chilmark Pond) has been separated from the main estuary by overwash and is freshwater to brackish and not part of the MEP analysis.

Description of the Applicable Water Quality Standards

The Water Quality Classification of Chilmark Pond is SA (Shellfishing open). Water quality standards of particular interest to the issues of cultural eutrophication are dissolved oxygen, nutrients, aesthetics, and excess plant biomass and nuisance vegetation. Massachusetts currently has narrative standards for nutrients (nitrogen and phosphorus) for waters of the Commonwealth such that "all surface waters shall be free of nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed site specific criteria developed in a TMDL or otherwise, established by the department" (MassDEP 2007). A more through explanation of applicable standards can be found in Appendix A.

Thus, the assessment of eutrophication is based on site-specific information within a general framework that emphasizes impairment of uses and preservation of a balanced indigenous flora and fauna. This approach is recommended by the US Environmental Protection Agency in their draft Nutrient Criteria Technical Guidance Manual for Estuarine and Coastal Marine Waters (Environmental Protection Agency, 2001). The Guidance Manual notes that lakes, reservoirs, streams and rivers may be subdivided by classes, allowing reference conditions for each class and facilitating cost-effective criteria development for nutrient management. However, individual estuarine and coastal marine waters tend to have unique characteristics and development of individual water body criteria is typically required.

Table 3: Sources of Nitrogen and their Controllability

Nitrogen Source	Degree of Controllability at Local Level	Reasoning
Agricultural fertilizer and animal wastes	Moderate	These nitrogen loadings can be controlled through appropriate agricultural Best Management Practices (BMPs).
Atmospheric deposition to the estuary surface	Low	It is only through region- and nation-wide air pollution control initiatives that significant reductions are feasible. Local control although helpful is not adequate.
Atmospheric deposition to natural surfaces (forests, fields, freshwater bodies) in the watershed	Low	Atmospheric deposition (loadings) to these areas cannot adequately be controlled locally. However, the N from these sources might be subjected to enhanced natural attenuation as it moves toward the estuary.
Fertilizer	Moderate	Lawn and golf course fertilizer and related N loadings can be reduced through BMPs, bylaws and public education.
Landfill	Moderate	Related N loadings can be controlled through appropriate BMP and management techniques.
Natural Background	None	Background load if the entire watershed was still forested and contained no anthropogenic sources. It cannot be controlled.
Septic system	High	Sources of N can be controlled by a variety of case-specific methods including: sewering and treatment at centralized or decentralized locations, transporting and treating septage at treatment facilities with N removal technology either in or out of the watershed, or installing N-reducing on-site wastewater treatment systems.
Sediment	Low	N loadings are not feasibly controlled on a large scale by such measures as dredging. However, the concentrations of N in sediments, and thus the loadings from the sediments, will decline over time if sources in the watershed are removed, or reduced to the target levels discussed later in this document. In addition, increased dissolved oxygen will help keep N from fluxing.
Stormwater runoff from impervious surfaces	Moderate	This nitrogen source can be controlled by BMPs, bylaws and stormwater infrastructure improvements and public education. Stormwater NPDES permit requirements help control stormwater related N loadings in designated communities.

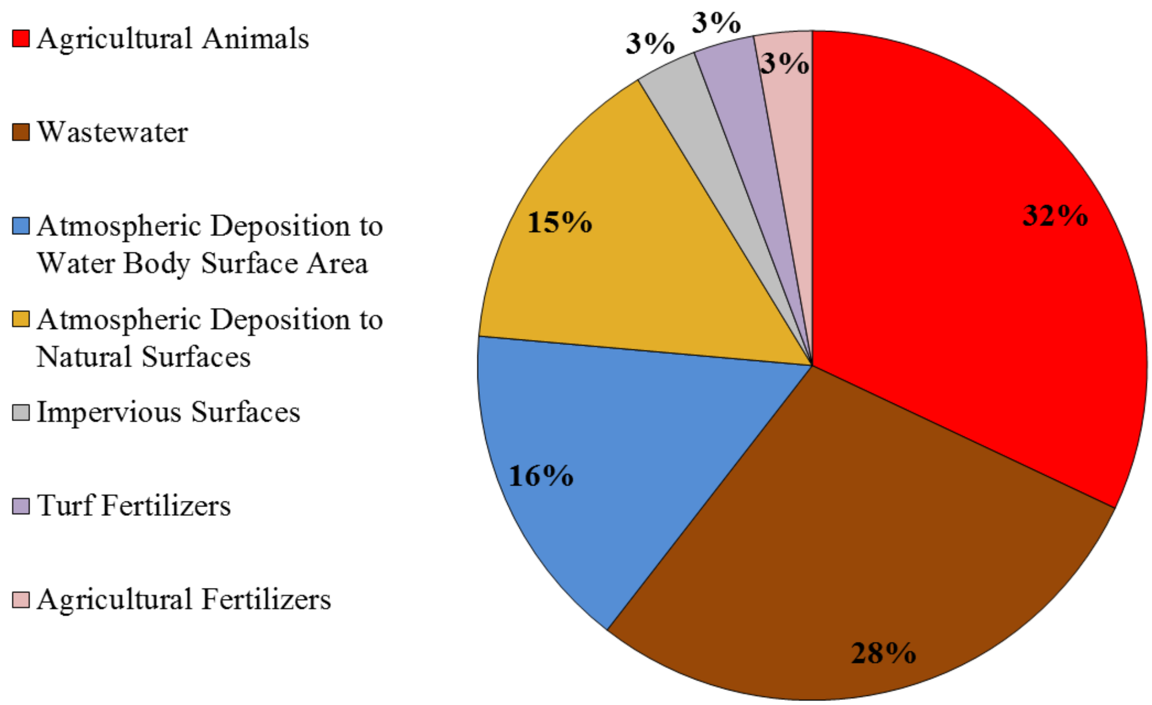


Figure 4: Percent Contributions of Watershed Nitrogen Sources to Chilmark Pond.

Methodology - Linking Water Quality and Pollutant Sources

Extensive data collection and analyses have been described in detail in the MEP Technical Report. These data were used by SMAST to assess the loading capacity of each sub-embayment. Physical (Chapter V), chemical, and biological (Chapters IV, VII, and VIII) data were collected and evaluated. The primary water quality objective was represented by conditions that:

1) Prevent algal blooms;

2) Protect benthic communities from impairment or loss; and

3) Maintain dissolved oxygen concentrations that are protective of the estuarine communities.

The details of the data collection, modeling and evaluation are presented and discussed in Chapters IV, V, VI, VII and VIII of the MEP Technical Report. The main aspects of the data evaluation and modeling approach of this study are summarized below.

The core analytical method of the Massachusetts Estuaries Project is the Linked Watershed-Embayment Management Modeling Approach. It fully links watershed inputs with embayment circulation and N characteristics and is characterized as follows:

- Requires site specific measurements within the watershed and each sub-embayment;

- Uses realistic “best-estimates” of N loads from each land-use (as opposed to loads with built-in “safety factors” like Title 5 design loads);

- Spatially distributes the watershed N loading to the embayment;

- Accounts for N attenuation during transport to the embayment;

- Includes a 2D or 3D embayment circulation model depending on embayment structure;

- Accounts for basin structure, tidal variations, and dispersion within the embayment;

- Includes N regenerated within the embayment;

- Is validated by both independent hydrodynamic, N concentration, and ecological data;

- Is calibrated and validated with field data prior to generation of “what if” scenarios.

The Linked Model has previously been applied to watershed N management in numerous embayments throughout Southeastern Massachusetts. In these applications it became clear that the model can be calibrated and validated and has use as a management tool for evaluating watershed N management options.

The Linked Model, when properly calibrated and validated for a given embayment, becomes a N management planning tool as described in the model overview below. The model can assess solutions for the protection or restoration of nutrient-related water quality and allows testing of management scenarios to support cost/benefit evaluations. In addition, once a model is fully functional it can be refined for changes in land-use or embayment characteristics at minimal cost. Also, since the Linked Model uses a holistic approach that incorporates the entire watershed, embayment and tidal source waters, it can be used to evaluate all projects as they relate directly or indirectly to water quality conditions within its geographic boundaries. It should be noted that this approach includes high-order, watershed and sub-watershed scale modeling necessary to develop critical nitrogen targets for each major sub-embayment. The models, data and assumptions used in this process are specifically intended for the purposes stated in the MEP Technical Report, upon which this TMDL is based. As such, the Linked Model process does not contain the type of data or level and scale of analysis necessary to predict the fate and transport of nitrogen through groundwater from specific sources. In addition, any determinations related to direct and immediate hydrologic connection to surface waters are beyond the scope of the MEP’s Linked Model process.

The Linked Model provides a quantitative approach for determining an embayment's: (1) N sensitivity; (2) N threshold loading levels (TMDL); and (3) response to changes in loading rate. The approach is fully field validated and unlike many approaches, accounts for nutrient sources, attenuation, and recycling and variations in tidal hydrodynamics (Figure I-3 of the MEP Technical Report). This methodology integrates a variety of field data and models, specifically:

• Monitoring - multi-year embayment nutrient sampling[1];

• Hydrodynamics;
  - Embayment bathymetry (depth contours throughout the embayment)
  - Site-specific tidal record (timing and height of tides)
  - Water velocity records (in complex systems only)
  - Hydrodynamic model

• Watershed N Loading;
  - Watershed delineation
  - Stream flow (Q) and N load
  - Land-use analysis (GIS)
  - Watershed N model

• Embayment TMDL – Synthesis;
  - Linked Watershed-Embayment N Model
  - Salinity surveys (for linked model validation)
  - Rate of N recycling within embayment
  - Dissolved oxygen record
  - Macrophyte survey
  - Eelgrass and Infaunal surveys

Application of the Linked Watershed-Embayment Model

The approach developed by the MEP for applying the linked model to specific embayments for the purpose of developing target threshold N loading rates includes:

1) Selecting one or two stations or sampling locations within the embayment system located close to the inland-most reach or reaches which typically has/have the poorest water quality within the system. These are called "sentinel" stations. For Chilmark Pond, the average of five stations (CHP1-CHP5) distributed throughout the main eastern basin were selected to represent a single sentinel station;

2) Using site-specific information and a minimum of three years of sub-embayment-specific[1] data to select target threshold N concentrations for each sub-embayment. This is done by refining the draft target threshold N concentrations that were developed as the initial step of the MEP process. The target threshold N concentrations that were selected generally occur in higher quality waters near the mouth of the embayment system;

3) Running the calibrated water quality model using different watershed N loading rates, to determine the loading rate which will achieve the target threshold N concentration at the sentinel station. Differences between the modeled N load required to achieve the target

[1] In the case of Chilmark Pond, water quality data was collected in 2003-2005, 2010, 2012 to assess overall water quality. However for purposes of water quality modeling of the pond breach (which allowed circulation with the Atlantic Ocean) only data collected in 2004 was used for the RMA-4 model and selection of the target sentinel station concentration.

threshold N concentration, and the present watershed N load represent N management goals for restoration and protection of the embayment system as a whole.

Previous sampling and data analyses and the modeling activities described above resulted in four major outputs that were critical to the development of the TMDL.

Two outputs are related to N **concentration**:

- the present N concentrations in the sub-embayments;
- site-specific target threshold N concentrations.

Two outputs are related to N **loadings:**

- the present N loads to the sub-embayments;
- load reductions necessary to meet the site specific target threshold N concentrations.

In summary, meeting the water quality standards (for dissolved oxygen, nutrients) by reducing the N concentration (and thus the N load) at the sentinel station(s), the water quality goals will be met throughout the entire system.

A brief overview of each of the outputs follows.

Nitrogen concentrations in the embayment

1) Observed "present" conditions:

Table 4 presents the average nitrogen concentrations of N measured in this system from data collected at one station in 2004. The model calibration was conducted using 2004 data since the model calibration requires concurrent water quality and tide elevation records in a moderate frequency time series before and after a breaching. This approach has been successfully applied in other periodically breached estuaries like Edgartown Great Pond, Tisbury Great Pond and Sesechacha Pond. The average total nitrogen concentration at Wades Cove Upper (CHP-1) station was at 0.608 mg/L (range from 0.45 – 0.74 mg/L, Howes *et. al* 2015, Table VI-3). See Figure 5 for station locations. The overall mean and standard deviation are presented in Appendix B, Table B-1 (reprinted from Table VI-1 of the MEP Technical Report).

Table 4: Observed Present Nitrogen Concentrations and Sentinel Station Threshold Nitrogen Target Concentration for Chilmark Pond.

Sub-Embayment	Station	**Mean**[1] (mg/L N)	Standard Deviation	Number Samples	Target Threshold Nitrogen Concentration (mg/L) [2]
Lower Chilmark Pond	CHP1	0.61	0.119	4	**0.50**

[1] The average of four samples collected from CHP-1 collected in 2004 (Howes *et. al* 2015, Table VI-1).

[2] Sentinel Stations as shown in Figure 5. Sentinel "station" is the average of the 5 long-term monitoring stations (CHP1 through CHP5)

2) Modeled site-specific target threshold N concentrations:

A major component of TMDL development is the determination of the maximum concentrations of N (based on field data) that can occur without causing unacceptable impacts to the aquatic environment. This is called the *target threshold nitrogen concentration*. Prior to conducting the analytical and modeling activities described above, SMAST selected appropriate nutrient-related environmental indicators and tested the qualitative and quantitative relationship between those indicators and N concentrations. The Linked Model was then used to determine site-specific target threshold N concentrations by using the specific physical, chemical and biological characteristics of each sub-embayment.

The approach for determining nitrogen loading rates which will maintain acceptable habitat quality throughout an embayment system is to first identify a sentinel location within the embayment and second to determine the nitrogen concentration within the water column which will restore that location to the desired habitat quality. The sentinel location is selected such that the restoration of that one site will necessarily bring the other regions of the system to acceptable habitat quality levels. Once the sentinel site and its target threshold nitrogen concentration are determined, the MEP study modeled nitrogen loads until the targeted nitrogen concentration was achieved.

As listed in Table 4 above, the site-specific target threshold N concentration is 0.50 mg/L at the average of the 5 long-term monitoring stations (CHP1-5) (Figure 5). This average approach has been used in other open "single basin" estuaries that are only periodically open to tidal flow throughout the MEP region. The average was selected because given the relatively long periods between openings, dispersion and wind driven mixing result in a relatively uniform total nitrogen concentration throughout the estuary. In addition, the benthic animal community is also generally uniform in numbers of organisms and species composition (dominated by an amphipod, *Leptocheirus* and *Streblospio*). It appears that the estuarine reaches of Chilmark Pond are presently functioning as a single basin with of relatively uniform nitrogen levels and habitat quality (VIII.2 MEP Tech Report Pg. 118-119). The findings of the analytical and modeling investigations to determine this target threshold nitrogen concentration for the estuarine system are discussed below.

The Chilmark Pond System is presently considered moderately impacted with a poor infaunal community as well as oxygen depletion, elevated chlorophyll-*a* and total nitrogen; all of which indicate aquatic health degradation due to nitrogen enrichment (Table 2). Given the lack of documented eelgrass, the restoration of infaunal habitats was chosen as a principal goal for nutrient management. The MEP project has found that "the measured levels of oxygen depletion and enhanced chlorophyll-*a* levels follows the spatial pattern of total nitrogen levels in this system, and the parallel variation in these water quality parameters is consistent with watershed based nitrogen enrichment and only periodic tidal flows" (Howes *et. al* 2015, pg. 114).

The MEP project has found that "the results of the infauna survey and complete absence of eelgrass coverage within the Chilmark Pond Embayment System indicates that the nitrogen management threshold analysis needs to aim for lowering nitrogen enrichment for restoration of infaunal habitat in the tributary coves showing moderate-high impairment of benthic habitat. Reduction in nitrogen enrichment is required for restoration. It should be emphasized that reducing nitrogen enrichment can be achieved by reducing nitrogen inputs and/or increasing the rate of nitrogen loss through enhanced tidal exchange." (Howes *et. al* 2015, pg. 117)

Figure 5: Chilmark Pond Long Term Monitoring Stations. Sentinel "station" is the average of the 5 long-term monitoring stations (CHP1-5) (excerpted from Howes *et. al* 2015, pg 109)

The MEP project target nitrogen load was calculated to restore benthic infauna in the Chilmark Pond System as well as attempt to restore "a modest level of eelgrass habitat" (Howes *et. al* 2015, pg. 120). Given the observed relationship between total nitrogen levels and benthic impairment, the MEP technical team concluded that a healthy infaunal habitat could be supported in Chilmark Pond at an upper limit of 0.50 mg/L N during the summer when impacts are greatest.

The MEP project found elevated total nitrogen concentrations (~0.74 mg/L) which are "Consistent with the observed lack of eelgrass beds and impaired benthic animal habitat" (Howes *et. al* 2015, pg. 120). The chosen nitrogen threshold concentration of 0.50 mg/L has been chosen in a number of embayments studied by the MEP project including Eel Pond, Seine Pond in the Parkers River System, upper Bass River, upper Great Pond as well as Rands Harbor and Fiddlers Cove.

Nitrogen loadings to the embayment

1) Present loading rates:

In the Chilmark Pond System overall the highest N loading from ***controllable*** sources is from on-site wastewater treatment systems (septic systems) and agriculture animals. The septic system loading is 6.142 kg N/day and the agricultural load (animals and fertilizers) is 6.657 kg N/day within the Chilmark Pond watershed. The total N loading from all sources is 17.641 kg N/day. A further breakdown of N loading by source is presented in Table 5. The data on which Table 5 is based can be found in Table ES-1 of the MEP Technical Report.

As previously indicated, the present N loadings to Chilmark Pond must be reduced in order to restore conditions and to avoid further nutrient-related adverse environmental impacts. The critical final step in the development of the TMDL is modeling and analysis to determine the loadings required to achieve the target threshold N concentrations.

Table 5: Present Attenuated Nitrogen Loadings to Chilmark Pond System

Sub-embayment	Natural Background Watershed Load[1] (kg N/day)	Present Land Use Load[2] (kg N/day)	Present Septic System Load (kg N/day)	Present Direct Atmospheric Deposition[3] (kg N/day)	Present Net Benthic Flux (kg N/day)	Present Total Nitrogen Load[4] (kg N/day)
Lower Chilmark Pond	0.899	2.411	3.075	3.260	-0.273	8.473
Upper Chilmark Pond	3.019	8.545	3.068	0.655	-3.100	9.169
System Total	3.918	10.96	6.142	3.915	-3.373	17.641

1- Assumes entire watershed is forested (i.e. no anthropogenic sources)
2- Includes agriculture, fertilizers, runoff, and atmospheric deposition to lakes and natural surfaces (non-wastewater loads)
3 Includes atmospheric deposition to the estuary surface only.
4 Sum of all N sources; present land use, fertilizer, runoff, septic systems, agricultural animals, impervious surface, water body surface area and natural surfaces, atmospheric deposition and sediment flux loadings.

2) Nitrogen loads necessary for meeting the site-specific target threshold N concentrations:

The main goals of the threshold load scenario tested during the threshold analysis were to restore benthic infauna habitat throughout Chilmark Pond and simultaneously attempt to restore a modest level of eelgrass habitat within the main basin which has been nonexistent over the past several decades. To restore benthic habitat, load reduction focused on lowering average TN levels of the five stations within the main basin to 0.50 mg/L during the summer months. This goal was achieved by reducing the watershed loading to the pond and assuming the pond is breached three times a year. Watershed loading was reduced from present conditions until the combined time averaged TN concentration would remain below 0.50 mg/L during a 120-day period during the summer months. The threshold modeling assumptions include a successful spring breach, which remains open for 8 days and lowers the average pond TN concentration to 0.33 mg/L. The pond is also allowed to be closed for 120 days, which allows the time for the water level in the pond to rise. To achieve the threshold a 30% septic reduction from present conditions was required in the septic load to the pond. This is but one example of a loading reduction that can achieve the threshold assuming the above mentioned breaching criteria can be achieved (Howes *et. al* 2015, pg. ES 9).

It is important to note that the analysis of future nitrogen loading (build-out) to the Chilmark Pond estuarine system focuses upon additional shifts in land-use from forest/grasslands to residential and commercial development. However, the MEP analysis indicates that significant increases in nitrogen loading can occur under present land-uses, due to shifts in occupancy, shifts from seasonal to year-round usage and increasing use of fertilizers. Therefore, watershed-estuarine nitrogen management must include management approaches to prevent increased nitrogen loading from both shifts in land-uses (new sources) and from loading increases of current land-uses. The overarching conclusion of the MEP analysis of the Chilmark Pond estuarine system is that restoration will necessitate a reduction in the present (Chilmark 2010) nitrogen inputs and management options to negate additional future nitrogen inputs (Howes *et. al* 2015, pg. 9).

The target threshold nitrogen concentration developed by SMAST (Section VIII.2 in the MEP Technical Report) and detailed above was used to determine the amount of total nitrogen mass loading reduction required for restoration of benthic habitats in the Chilmark Pond system. Tidally averaged total nitrogen concentrations were used to calibrate the water quality model (Section VI in the MEP Technical Report). Modeled watershed nitrogen loads were sequentially lowered using reductions in septic effluent discharges only until the nitrogen levels reached the target nitrogen threshold level. This scenario also requires the breaching conditions as described above.

Table 6 includes the present and target threshold watershed N loadings to Chilmark Pond and the percentage reduction necessary to meet the target threshold N concentration at the sentinel station (from Table ES-2 of the MEP Technical Report). These values represent only one of a suite of potential reduction approaches that need to be evaluated by the Town of Falmouth. The presentation is to establish the general degree and spatial pattern of reduction that will be required for restoration of this N impaired embayment. Other alternatives may also achieve the desired target threshold N concentration as well and can be explored using the MEP modeling approach.

Given the relatively low watershed nitrogen load to the Chilmark Pond estuarine basins, it may be difficult to lower TN levels by ~0.2 mg/L to meet the threshold. This is consistent with the MEP measurements of periodically opened basins and systems with significantly restricted tidal flows, such as Rushy Marsh Pond and Farm Pond. In such cases increases in the amount, duration or frequency of tidal exchange, generally through openings is needed to lower the level of nitrogen enrichment and restore the impaired habitats. This will likely be the case for Chilmark Pond, as well (MEP Tech Report, Howes *et. al*, pg. 120).

It is very important to note that load reductions can be produced through a variety of strategies: reduction of any or all sources of N; increasing the natural attenuation of N within the freshwater systems; and modifying the tidal flushing regime. This scenario establishes the general degree and spatial pattern of reduction that will be required for restoration of the N impaired portions of this system. Nitrogen enrichment of the Chilmark Pond Estuary stems from the combination of watershed nitrogen load and the absence of tidal exchange with offshore waters except during "dredged' openings by the Town. More frequent or prolonged openings has the same effect of lowering nitrogen loads, relative to relieving nitrogen related habitat impairments. The town of Chilmark should take any reasonable actions to reduce the controllable N sources.

Table 6: Present Watershed Nitrogen Loading Rates (Attenuated), Calculated Loading Rates that are Necessary to Achieve Target Threshold Nitrogen Concentrations and the Percent Reductions of the Existing Loads Necessary to Achieve the Target Threshold Loadings

Sub-embayment	Present Attenuated Watershed Load[1] (kg/day)	Target Threshold Watershed Load[2] (kg/day)	Watershed Load Reductions Needed to Achieve Threshold Loads	
			kg N/day	% change
Lower Chilmark Pond	5.485	4.255	1.230	22.4%
Upper Chilmark Pond	12.212	10.54	1.672	13.7%
System Total	17.697	14.795	2.902	16.4%

1- composed of natural background, fertilizer, runoff, septic system atmospheric deposition and benthic flux loadings
2- Target threshold watershed load is the maximum load from the watershed to meet the embayment target threshold N concentration identified in Table 3 above.

Total Maximum Daily Loads

As described in EPA guidance, a total maximum daily load (TMDL) identifies the loading capacity of a water body for a particular pollutant. EPA regulations define loading capacity as the greatest amount of loading that a water body can receive without violating water quality standards. The TMDLs are established to protect and/or restore the estuarine ecosystem, including benthic infauna, the leading indicator of ecological health, thus meeting water quality goals for aquatic life support. Because there are no "numerical" water quality standards for N, the TMDL for the Chilmark Pond system is aimed at determining the loads that would correspond to specific N concentrations determined to be protective of the water quality and ecosystems. Bioavailable nutrients - such as nitrogen - in point and non-point discharges can stimulate algal growth, which then die and are eaten by bacteria, depleting oxygen in the water through the process of decomposition. Reducing the bioavailability of nitrogen in the estuarine system through the implementation of this TMDL will result in less algal growth, which will ensure chlorophyll-a levels are reduced and dissolved oxygen levels increase.

The effort includes detailed analyses and mathematical modeling of land use, nutrient loads, water quality indicators and hydrodynamic variables (including residence time) for each sub-embayment. The results of the mathematical model are correlated with estimates of impacts on water quality including negative impacts on benthic infauna (the primary indicator), as well as dissolved oxygen, chlorophyll and eelgrass.

The TMDL can be defined by the equation:

TMDL = BG + WLAs + LAs + MOS

Where:

TMDL = loading capacity of receiving water
BG = natural background
WLAs = portion allotted to point sources
LAs = portion allotted to (cultural) non-point sources
MOS = margin of safety

Background Loading

Natural background N loading is included in the loading estimates. It is accounted for in this study but not defined as a separate component. Background loading was calculated on the assumption that the entire watershed is forested with no anthropogenic sources of N. Readers are referred to Table ES-1 of the MEP Technical Report for estimated loading due to natural conditions.

Waste Load Allocations

Waste load allocations identify the portion of the loading capacity allocated to existing and future point sources of wastewater. EPA interprets 40 CFR 130.2(h) to require that allocations for NPDES regulated discharges of stormwater be included in the waste load component of the TMDL. For purposes of the Chilmark Pond TMDL, there are no NPDES regulated areas for the discharges of stormwater in the watershed. However, MassDEP also considered the nitrogen load reductions from impervious areas adjacent to the waterbody necessary to meet the target nitrogen concentrations in the WLA. Since the majority of the N loading from the watershed comes from septic systems and agriculture, and to a lesser extent, fertilizers, and storm water that infiltrates into the groundwater, the allocation of N for any stormwater pipes that discharge directly to this embayment is insignificant but is estimated here for completeness.

For purposes of the Chilmark Pond Estuarine System TMDL, MassDEP also considered the nitrogen load reductions from regulated MS4 sources necessary to meet the target nitrogen concentrations. In estimating the nitrogen loadings from impervious sources, MassDEP considered that most stormwater runoff from impervious surfaces in the watershed is not discharged directly into surface waters, but, rather, percolates into the ground. The geology on Cape Cod and the Islands consists primarily of glacial outwash sands and gravels, and water moves rapidly through this type of soil profile. A systematic survey of stormwater conveyances on the Islands has never been undertaken. Nevertheless, most catch basins on the Islands are known to MassDEP to have been designed as leaching catch basins in light of the permeable overburden. MassDEP, therefore, recognized that most stormwater that enters a catch basin in these areas will percolate into the local groundwater table rather than directly discharge to a surface waterbody.

As described in the Methodology Section (above), the Linked Model accounts for storm water loadings and groundwater loading in one aggregate allocation as a non-point source. However, MassDEP also considered that some stormwater may be discharged directly to surface waters through outfalls. In the absence of specific data or other information to accurately quantify stormwater discharged directly to surface waters, MassDEP assumed that all impervious surfaces within 200 feet of the shoreline, as calculated from MassGIS data layers, would discharge directly to surface waters, whether or not it in fact did so. MassDEP selected this approach because it considered it unlikely that any stormwater collected farther than 200 feet from the shoreline would be directly discharged into surface waters. Although the 200 foot approach provided a gross estimate, MassDEP considered it a reasonable and conservative approach given the lack of pertinent data and information about stormwater collection systems on Martha's Vineyard. The calculated stormwater WLA based on the 200 foot buffer for the whole embayment system is 0.02 kg/day or less than 0.01% of the total unattenuated watershed N load of 20.70 kg/day to the embayment (see Appendix B for details). This conservative load is negligible when compared to other sources.

Load Allocations

Load allocations identify the portion of loading capacity allocated to existing and future nonpoint sources. In the case of the Chilmark Pond System sub-embayments studied, the controllable nonpoint source loadings are primarily from on-site subsurface wastewater disposal systems and agriculture (Figure 4, above, and Figure 6, below). Additional N sources include stormwater runoff (except from impervious cover within 200 feet of the waterbody which is defined above as part of the waste load as discussed above) and N from turf fertilizers. Finally, there are nonpoint sources of N that are not feasibly controllable from nutrient-rich sediments, atmospheric deposition (to both freshwater and estuarine waterbodies and natural surfaces), and natural background

Stormwater that is subject to the EPA Phase II Program is considered a part of the wasteload allocation, rather than the load allocation. As presented in Chapter IV, V, and VI, of the MEP Technical Report, on Cape Cod the vast majority of stormwater percolates into the aquifer and enters the embayment system through groundwater, thus defining the stormwater in pervious areas to be a component of the non-point source load allocation. As discussed above, even though there are measureable directly connected impervious areas in these systems, the wasteload allocation for stormwater was determined to be insignificant when compared to the overall controllable N load. Accordingly, this TMDL accounts for stormwater loadings and groundwater loadings in one aggregate allocation as a non-point source, thus combining the assessments of wastewater and stormwater for the purpose of developing control strategies. Continued Phase II Program implementation in Chilmark, new studies and possibly further modeling will identify what portion of the stormwater load may be controllable through Best Management Practices (BMPs).

Sediment loading rates incorporated into the TMDL are different than the existing sediment flux rates because projected reductions of N loadings from the watershed will result in reductions of nutrient concentrations in the sediments, and therefore, over time, reductions in loadings from the sediments will occur. Benthic flux of nitrogen from bottom sediments is a critical (but often overlooked) component of nitrogen loading to the shallow estuarine systems, therefore determination of the site specific magnitude of this component was also performed (see Section VI of the MEP Report).

Benthic N flux is a function of N loading and particulate organic N (PON). Projected benthic fluxes are based upon projected PON concentrations and watershed N loads and are calculated by multiplying the present N flux by the ratio of projected PON to present PON using the following formulae:

Projected N flux = (present N flux) (PON projected / PON present)

When: $PON\ projected = (R_{load})\ (D_{PON}) + PON_{present\ offshore}$

When $R_{load} =$ *(projected N load) / (Present N load)*

And D_{PON} is the PON concentration above background determined by:

$D_{PON} = (PON_{present\ embayment} - PON_{present\ offshore})$

Benthic loading is affected by the change in watershed load. Since there was a negative benthic flux (nutrient uptake) recorded in both lower and upper Chilmark Pond under present conditions, a more conservative approach was used for Chilmark Pond in the TMDL by assuming zero benthic flux in the future. This conservative approach was used and is considered part of the margin of safety in the TMDL. Since benthic loading varies throughout the year and the values shown represent "worst case" summertime conditions, loading rates are presented in kilograms per day.

The loadings from atmospheric sources incorporated into the TMDL are the same rates presently occurring because, as discussed above, significant control of atmospheric loadings at the local level is not considered feasible.

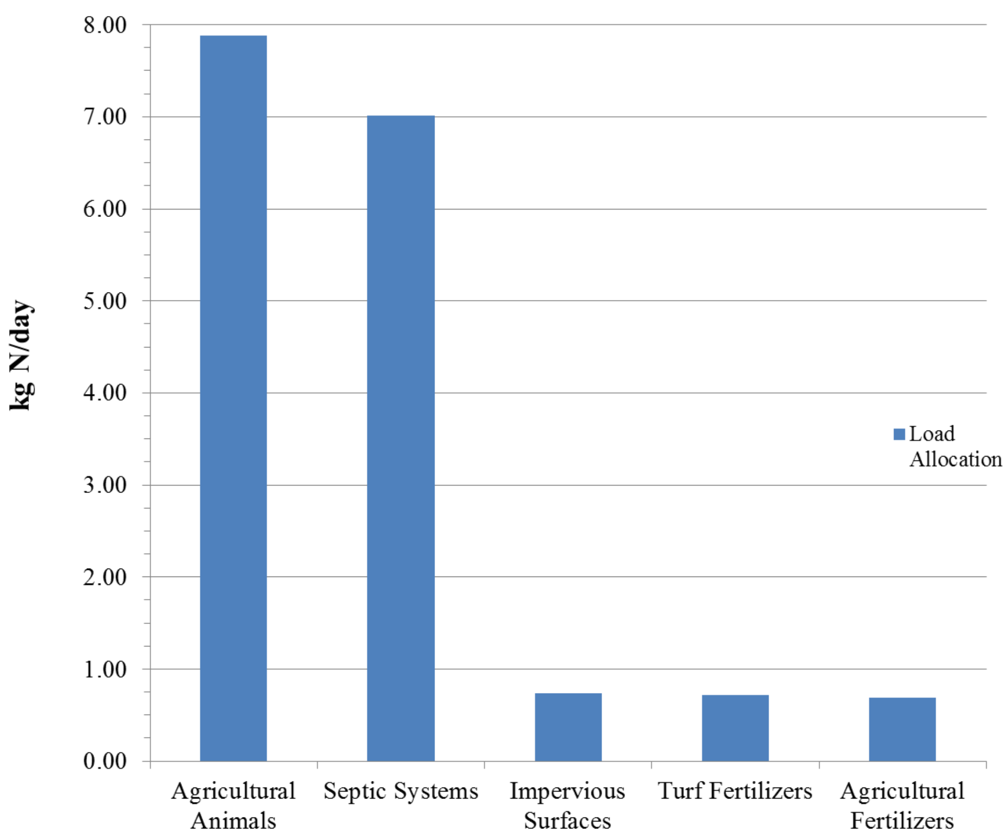


Figure 6: Controllable Unattenuated Nitrogen Loading Sources to the Chilmark Pond Estuarine System (note the marginal wasteload allocation is not depicted (<0.02 kg/day, Table IV-2, MEP Technical Report)

Margin of Safety

Statutes and regulations require that a TMDL include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality [CWA para 303 (d)(20(c), 40C.G.R. para 130.7(c)(1)].The MOS must be designed to ensure that any uncertainties in the data or calculations used to link pollutant sources to water quality impairment modeling will be accounted for in the TMDL and ensure protection of the beneficial uses. The EPA's 1991 TMDL Guidance explains that the MOS may be implicit, i.e., incorporated into the TMDL through conservative assumptions in the analysis, or explicit, i.e., expressed in the TMDL as loadings set aside for the MOS. An explicit MOS quantifies an allocation amount separate from other Load and Wasteload Allocations. An explicit MOS can incorporate reserve capacity for future unknowns, such as population growth or effects of climate change on water quality. An implicit MOS is not specifically quantified but consists of statements of the conservative assumptions used in the analysis. The MOS for the Chilmark Pond Estuarine System TMDL is implicit. MassDEP used conservative assumptions to develop numeric model applications that account for the MOS. These assumptions are described below, and they account for all sources of uncertainty, including the potential impacts of changes in climate.

While the general vulnerabilities of coastal areas to climate change can be identified, specific impacts and effects of changing estuarine conditions are not well known at this time (http://www.mass.gov/eea/waste-mgnt-recycling/air-quality/climate-change-adaptation/climate-change-adaptation-report.html). Because the science is not yet available, MassDEP is unable to analyze climate change impacts on streamflow, precipitation, and nutrient loading with any degree of certainty for TMDL development. In light of these uncertainties and informational gaps, MassDEP has opted to address all sources of uncertainty through an implicit MOS. MassDEP does not believe that an explicit MOS approach is appropriate under the circumstances or will provide a more protective or accurate MOS than the implicit MOS approach, as the available data simply does not lend itself to characterizing and estimating loadings to derive numeric allocations within confidence limits. Although the implicit MOS approach does not expressly set aside a specific portion of the load to account for potential impacts of climate change, MassDEP has no basis to conclude that the conservative assumptions that were used to develop the numeric model applications are insufficient to account for the lack of knowledge regarding climate change.

Conservative assumptions that support an implicit MOS:

1. Use of conservative data in the linked model

The watershed N model provides conservative estimates of N loads to the embayment. Nitrogen transfer through direct groundwater discharge to estuarine waters is based upon studies indicating negligible aquifer attenuation and dilution, i.e. 100% of load enters embayment. This is a conservative estimate of loading because studies have also shown that in some areas less than 100% of the load enters the estuary. In this context, "direct groundwater discharge" refers to the portion of fresh water that enters an estuary as groundwater seepage into the estuary itself, as opposed to the portion of fresh water that enters as surface water inflow from streams, which receive much of their water from groundwater flow. Nitrogen from the upper watershed regions which travel through ponds or wetlands almost always enters the embayment via stream flow and is directly measured (over 12-

16 months) to determine attenuation. In these cases, the land-use model has shown a slightly higher predicted N load than the measured discharges in the streams/rivers that have been assessed to date. Therefore, the watershed model as applied to the surface water watershed areas again presents a conservative estimate of N loads because the actual measured N in streams was lower than the modeled concentrations.

The hydrodynamic and water quality models have been assessed directly. In the many instances where the hydrodynamic model predictions of volumetric exchange (flushing) have also been directly measured by field measurements of instantaneous discharge, the agreement between modeled and observed values has been between 85%-90%. For Chilmark Pond the difference between the measured pond level and a broad crested weir model used to stimulate pond levels during a breach event had an R^2 of 0.85. For the water quality model, it was possible to conduct a quantitative assessment of the model results as fitted to a baseline dataset -the computed root mean squared (RMS) error was 0.02 mg/l, which demonstrates a good fit between modeled and measured data for this system. Since the water quality model incorporates all of the outputs from the other models, this excellent fit indicates a high degree of certainty in the final result. The high level of accuracy of the model provides a high degree of confidence in the output so less of a margin of safety is required.

Similarly, the water column N validation dataset was also conservative. The model is calibrated to measured water column N and validated to salinity. However, the model predicts average summer N concentrations. The very high or low measurements are marked as outliers. The effect is to make the N threshold more accurate and scientifically defensible. If a single measurement two times higher than the next highest data point in the series raises the average 0.05 mg N/L, this would allow for a higher "acceptable" load to the embayment. Marking the very high outlier is a way of preventing a single and rare bloom event from changing the N threshold for a system. This effectively strengthens the data set so that a higher margin of safety is not required.

Finally, the predicted reductions of the amount of N released from the sediments are most likely underestimates, i.e. conservative. The reduction is based solely on a reduced deposition of PON due to lower primary production rates under the reduced N loading in these systems. As the N loading decreases and organic inputs are reduced it is likely that rates of coupled remineralization-nitrification, denitrification and sediment oxidation will increase. It was also conservatively assumed that the negative benthic flux in lower and upper Chilmark Pond (-0.273 and -3.10 kg/day N, respectively) does not exist under future loading conditions and as such was designated as "0" for purposes of the TMDL.

Benthic regeneration of N is dependent upon the amount of PON deposited to the sediments and the percentage that is regenerated to the water column versus being denitrified or buried. The regeneration rate projected under reduced N loading conditions was based upon two assumptions:(1) PON in the embayment in excess of that of inflowing tidal water (boundary condition) results from production supported by watershed N inputs; and (2) Presently enhanced production will decrease in proportion to the reduction in the sum of watershed N inputs and direct atmospheric N input. The latter condition would result in equal embayment versus boundary condition production and PON levels if watershed N loading and direct atmospheric deposition could be reduced to zero (an impossibility of course). This proportional reduction assumes that the proportion of remineralized N will be the same as under present conditions, which is almost certainly an underestimate. As a result, future N regeneration rates are overestimated which adds to the margin of safety.

Finally, decreases in air deposition through continuing air pollution control efforts are unaccounted for this TMDL and provide another component of the margin of safety.

2. Conservative sentinel station/target threshold nitrogen concentration

Conservatism was used in the selection of the sentinel station and target threshold N concentration. Since there are no unimpaired infaunal animal habitat areas remaining in the Chilmark Pond Estuary, comparisons to the soft bottom basins of other nearby estuarine systems were relied upon for setting the nitrogen threshold for healthy infaunal habitat at a nitrogen level of TN <0.50 mg/L. Utilizing the average of the 5 long term monitoring stations (CHP1-5), meeting the target threshold N concentration will result in benthic and infaunal habitat improvement throughout the system.

3. Conservative approach

The target loads were based on tidally averaged N concentrations on the outgoing tide which is the worst case condition because that is when the N concentrations are the highest. The N concentrations will be lower on the flood tides; therefore, this approach is conservative.

The linked model accounted for all stormwater loadings and groundwater loadings in one aggregate allocation as a nonpoint source and this aggregate load is accounted for in the load allocation. The method of calculating the WLA in the TMDL for impervious cover within the 200 foot buffer area of the waterbody was conservative as it did not disaggregate this negligible load from the modeled stormwater LA, hence this approach further enhances the MOS.

In addition to the margin of safety within the context of setting the N threshold levels described above, a programmatic margin of safety also derives from continued monitoring of this embayment to support adaptive management. This continuous monitoring effort provides the ongoing data to evaluate the improvements that occur over the multi-year implementation of the N management plan. This will allow refinements to the plan to ensure that the desired level of restoration is achieved.

Seasonal Variation

Since the TMDLs for the waterbody segments are based on the most critical time period, i.e. the summer growing season, the TMDLs are protective for all seasons. The daily loads can be converted to annual loads by multiplying by 365 (the number of days in a year). Nutrient loads to the embayment are based on annual loads for two reasons. The first is that primary production in coastal waters can peak in both the late winter-early spring and in the late summer-early fall periods. Second, as a practical matter, the types of management necessary to control the N load do not lend themselves to intra-annual manipulation since a considerable portion of the N is from non-point sources. Thus, calculating annual loads is most appropriate, since it is difficult to control non-point sources of N on a seasonal basis and N sources can take considerable time to migrate to impacted waters.

TMDL Values for the Chilmark Pond System

As outlined above, the total maximum daily loadings of N that would provide for the restoration and protection of the embayment were calculated by considering all sources of N grouped by natural background, point sources and non-point sources. A more meaningful way of presenting the loadings data from an implementation perspective is shown in Table 7.

In this table N loadings from the atmosphere and from nutrient rich sediments are listed separately from the target watershed threshold loads. The watershed load is composed of atmospheric deposition to freshwater and natural surfaces along with locally controllable N from on-site subsurface wastewater disposal systems, farm animals, storm water runoff, and fertilizer sources. In the case of the Chilmark Pond system, the TMDL was calculated by projecting reductions in locally controllable septic systems and assuming a minimum of three breaches of the barrier beach each year. The threshold modeling assumptions include a successful spring breach which remains open for 8 days and lowers the average pond TN concentration to 0.33 mg/L. The pond is also allowed to be closed for 120 days, which allows the time for the water level in the pond to rise.

The target load identified in this table represents one alternative loading scenario to achieve that goal but other scenarios may be possible and approvable as well. It must be demonstrated however, that any alternative implementation strategies will be protective of the entire embayment system. Once again the goal of this TMDL is to achieve the identified target threshold N concentration at the identified sentinel station.

Table 7: The Nitrogen Total Maximum Daily Load for the Chilmark Pond System

Sub-embayment	Target Threshold Watershed Load[1] (kg N/day)	Atmospheric Deposition (kg N/day)	Sediment Flux Net[2] (kg N/day)	TMDL[3] (kg N/day)
Lower Chilmark Pond	4.255	3.260	0	7.515
Upper Chilmark Pond	10.540	0.655	0	11.195
System Total	14.795	3.915	0	**18.71**

[1] Target threshold watershed load is the load from the watershed needed to meet the embayment target threshold nitrogen concentration identified in Table 3.
[2] Projected sediment N loadings obtained by reducing the present loading rates (Table 5) proportional to proposed watershed load reductions and factoring in the existing and projected future concentrations of PON. Negative fluxes set to zero.
[3] Sum of target threshold watershed load, atmospheric deposition load and sediment (benthic) load.

Implementation Plans

The critical element of this TMDL process is achieving the sentinel station specific target threshold N concentration presented in Table 4. This is necessary for the restoration and protection of water quality and benthic invertebrate habitat within the Chilmark Pond System. In order to achieve these target threshold N concentrations, N loading rates must be reduced throughout the Chilmark Pond system. Table 7 lists the target threshold watershed N load for this system.

Septic Systems:
Because the majority of controllable N load is from agriculture and individual septic systems for private residences, the Comprehensive Water Resources Management Plan (CWRMP) should assess the most cost-effective options for achieving the target threshold N watershed loads, including but not limited to, treatment for N control of sewage and septage at either centralized or de-centralized locations, and denitrifying systems for all private residences. The CWRMP should include a schedule of the selected strategies and estimated timelines for achieving those targets. However, the MassDEP realizes that an adaptive management approach may be used to observe implementation results over time and allow for adjustments based on those results. If a community chooses to implement TMDL measures without a CWRMP it must demonstrate that these measures will achieve the target threshold N concentration. (Note: Communities that choose to proceed without a CWRMP will not be eligible for State Revolving Fund 0% loans.)

Table 8 (from Table VIII-2 of the MEP Technical Report) summarizes the present loadings from septic systems and the reduced loads that would be necessary to achieve the target threshold N concentration in the Chilmark Pond system under the scenario modeled here. An approximately 37% reduction in attenuated septic loads from present conditions is required in the septic load to the pond to achieve the threshold requirements. The septic only nutrient reduction scenario does not incorporate reductions from other watershed nutrient loads such as agricultural loads.

Table 8: Summary of the Present Septic System Loads and the Loading Reductions that would be Necessary to Achieve the TMDL by Reducing Septic System Loads Alone (excerpted from Howes *et. al* 2015)

Sub-embayment	Present Attenuated Septic N Load (kg/day)	Threshold (kg/day)	Threshold Septic Load % Change
Lower Chilmark Pond	3.074	1.884	38.7%
Upper Chilmark Pond	3.068	1.995	35.0%
Total	6.142	3.879	36.8%

The above modeling results provide one scenario of achieving the threshold level for the sentinel site within the estuarine system. This example does not represent the only method for achieving this goal. The town of Chilmark is encouraged to evaluate other load reduction scenarios and take any reasonable steps to reduce the controllable N sources.

Agriculture:
Agriculture is a major contributor of N load to this system and MassDEP believes it is reasonable to try to reduce the agricultural contributions through the implementation of feasible agricultural best management practices (BMPs) with a goal of reducing N contribution from agricultural sources by

10% watershed-wide. An additional model run by SMAST may help determine the potential benefits of agricultural reductions as well as septic load reduction. This will help focus agricultural BMP implementation activities to areas that will most effectively reduce N loads.
All of the towns on Martha's Vineyard adopted identical fertilizer regulations in the spring of 2014. This regulation provides for a reduction of nitrogen and phosphorus going into the Island's Water Resources by means of an organized system of education, licensure, regulation of practice, and enforcement. The regulation is intended to contribute to the island's ability to protect, maintain, and ultimately improve the water quality in all its water resources and assist in achieving compliance with any applicable water quality standards relating to controllable nitrogen and phosphorus (http://mvboh.org/fertilizer.html). In addition, Massachusetts Department of Agricultural Resources, Plant Nutrient Application Requirements, 330 CMR 31.00, became effective December 2015. These regulations require basic plant nutrient management plans for 10 or more acres and adherence to application and seasonal restrictions which will reduce the agricultural TN load entering the Chilmark Pond Estuarine System.

Stormwater:
It should be noted that although the Chilmark Pond watershed contains no Phase II stormwater communities, the Chilmark Board of Health has adopted "Stormwater Management Regulations" that have the same intentions as the Phase II Stormwater Regulations by providing adequate protection against pollutants, flooding, siltation, and other drainage problems.

Climate Change:
MassDEP recognizes that long-term (25+ years) climate change impacts to southeastern Massachusetts, including the area of this TMDL, are possible based on known science. Massachusetts Executive Office of Energy and Environmental Affairs 2011Climate Change Adaptation Report: https://www.mass.gov/service-details/2011-massachusetts-climate-change-adaptation-report predicts that by 2100 the sea level could be from 1 to 6 feet higher than the current position and precipitation rates in the Northeast could increase by as much as 20 percent. However, the details of how climate change will affect sea level rise, precipitation, streamflow, sediment and nutrient loading in specific locations are generally unknown. The ongoing debate is not about whether climate change will occur, but the rate at and the extent to which it will occur and the adjustments needed to address its impacts. EPA's 2012 Climate Change Strategy (https://www.epa.gov/sites/production/files/2015-03/documents/epa_2012_climate_water_strategy_full_report_final.pdf) states: "Despite increasing understanding of climate change, there still remain questions about the scope and timing of climate change impacts, especially at the local scale where most water-related decisions are made." For estuarine TMDLs in southeastern Massachusetts, MassDEP recognizes that this is particularly true, where water quality management decisions and implementation actions are generally made and conducted at the municipal level on a sub-watershed scale.

EPA's Climate Change Strategy identifies the types of research needed to support the goals and strategic actions to respond to climate change. EPA acknowledges that data are missing or not available for making water resource management decisions under changing climate conditions. In addition, EPA recognizes the limitation of current modeling in predicting the pace and magnitude of localized climate change impacts and recommends further exploration of the use of tools, such as atmospheric, precipitation and climate change models, to help states evaluate pollutant load impacts under a range of projected climatic shifts.

In 2013, EPA released a study entitled, "Watershed modeling to assess the sensitivity of streamflow, nutrient, and sediment loads to potential climate change and urban development in 20 U.S. watersheds." (National Center for Environmental Assessment, Washington D.C.; EPA/600/R-12/058F). The closest watershed to southeastern Massachusetts that was examined in this study is a New England coastal basin located between Southern Maine and Central Coastal Massachusetts. These watersheds do not encompass any of the watersheds in the Massachusetts Estuary Project (MEP) region, and it has vastly different watershed characteristics, including soils, geography, hydrology and land use – key components used in a modeling analysis. The initial "first order" conclusion of this study is that, in many locations, future conditions, including water quality, are likely to be different from past experience. However, most significantly, this study did not demonstrate that changes to TMDLs (the water quality restoration targets) would be necessary for the region. EPA's 2012 Climate Change Strategy also acknowledges that the Northeast, including New England, needs to develop standardized regional assumptions regarding future climate change impacts. EPA's 2013 modeling study does not provide the scientific methods and robust datasets needed to predict specific long-term climate change impacts in the MEP region to inform TMDL development.

MassDEP believes that impacts of climate change should be addressed through TMDL implementation with an adaptive management approach in mind. Adjustments can be made as environmental conditions, pollutant sources, or other factors change over time. Massachusetts Coastal Zone Management (CZM) has developed a StormSmart Coasts Program (2008) to help coastal communities address impacts and effects of erosion, storm surge and flooding which are increasing due to climate change. The program, www.mass.gov/czm/stormsmart offers technical information, planning strategies, legal and regulatory tools to communities to adapt to climate change impacts.

As more information and tools become available, there may be opportunities to make adjustments in TMDLs in the future to address predictable climate change impacts. When the science can support assumptions about the effects of climate change on the nitrogen loadings to Chilmark Pond the TMDL can be reopened, if warranted.

Implementation Guidance

The town of Chilmark is urged to meet the target threshold N concentrations by reducing N loadings from any and all sources, through whatever means are available and practical, including reductions in on-site subsurface wastewater disposal system loadings as well as reductions in stormwater runoff and/or fertilizer use within the watershed through the establishment of local by-laws and/or the implementation of stormwater Best Management Practices (BMPs).

MassDEP's "MEP Embayment Restoration Guidance for Implementation Strategies," available at: http://www.mass.gov/eea/agencies/massdep/water/watersheds/coastal-resources-and-estuaries.html provides N loading reduction strategies that are available to Chilmark that could be incorporated into the implementation plans. The following topics related to N reduction are discussed in the Guidance:

- Wastewater Treatment;
    - On-Site Treatment and Disposal Systems
    - Cluster Systems with Enhanced Treatment
    - Community Treatment Plants
    - Municipal Treatment Plants and Sewers
- Tidal Flushing;
    - Channel Dredging
    - Inlet Alteration
    - Culvert Design and Improvements
- Stormwater Control and Treatment*;
    - Source Control and Pollution Prevention
    - Stormwater Treatment
- Attenuation via Wetlands and Ponds;
- Water Conservation and Water Reuse;
- Management Districts;
- Land Use Planning and Controls;
    - Smart Growth
    - Open Space Acquisition
    - Zoning and Related Tools
- Nutrient Trading.

*The Town of Chilmark is not currently covered by the Phase II storm water program requirements in Massachusetts.

The appropriateness of any of the alternatives will depend on local conditions, and will have to be determined on a case-by-case basis, using an adaptive management approach.

Monitoring Plan

MassDEP is of the opinion that there are two forms of monitoring that are useful to determine progress towards achieving compliance with the TMDL. MassDEP's position is that implementation will be conducted through an iterative process where adjustments may be needed in the future. The two forms of monitoring include: 1) tracking implementation progress as approved in the town CWRMP plan (as appropriate); and 2) monitoring ambient water quality conditions, including but not limited to, the sentinel station identified in the MEP Technical Report.
If necessary to achieve the TMDL, the CWRMP will evaluate various options to achieve the goals set out in the TMDL and Technical Report. It will also make a final recommendation based on existing or additional modeling runs, set out required activities and identify a schedule to achieve the most cost effective solution that will result in compliance with the TMDL. Once approved by MassDEP, tracking progress on the agreed-upon plan will, in effect, also be tracking progress towards water quality improvements in conformance with the TMDL.

Relative to water quality, MassDEP believes that an ambient monitoring program, much reduced from the data collection activities needed to properly assess conditions and to populate the model, will be important to determine actual compliance with water quality standards. Although the TMDL load values are not fixed, the target threshold N concentrations at the sentinel stations are. Through discussions amongst the MEP it is generally agreed that existing monitoring programs which were designed to thoroughly assess conditions and populate water quality models can be substantially reduced for compliance monitoring purposes. Although more specific details need to be developed on a case by case basis, MassDEP's current thinking is that about half the current effort (using the same data collection procedures) would be sufficient to monitor compliance over time and to observe trends in water quality changes. In addition, the benthic habitat and communities would require periodic monitoring on a frequency of about every 3-5 years.

The MEP will continue working with the Town of Chilmark to develop and refine monitoring plans that remain consistent with the goals of the TMDL. Through the adaptive management approach ongoing monitoring will be conducted and will indicate if water quality standards are being met. If this does not occur other management activities would have to be identified and considered to reach to goals outlined in this TMDL. It must be recognized however that development and implementation of a monitoring plan will take some time, but it is more important at this point to focus efforts on reducing existing watershed loads to achieve water quality goals.

Reasonable Assurances

MassDEP possesses the statutory and regulatory authority, under the water quality standards and/or the State Clean Water Act (CWA), to implement and enforce the provisions of the TMDL through its many permitting programs, including requirements for N loading reductions from on-site subsurface wastewater disposal systems. However, because most non-point source controls are voluntary, reasonable assurance is based on the commitment of the locality involved. The town of Chilmark expects to use the information in this TMDL to generate support from their citizens to take the necessary steps to remedy existing problems related to N loading from on-site subsurface wastewater disposal systems, stormwater, and runoff (including fertilizers) and to prevent any future degradation of these valuable resources.

Moreover, reasonable assurances that the TMDL will be implemented include enforcement of regulations, availability of financial incentives and local, state and federal programs for pollution control. Stormwater NPDES permit coverage will address discharges from municipally owned stormwater drainage systems. Enforcement of regulations controlling non-point discharges include local implementation of the Commonwealth's Wetlands Protection Act and Rivers Protection Act; Title 5 regulations for on-site subsurface wastewater disposal systems and other local regulations such as the Town of Rehoboth's stable regulations.

Financial incentives include federal funds available under Sections 319, 604 and 104(b) programs of the CWA, which are provided as part of the Performance Partnership Agreement between MassDEP and EPA. Other potential funds and assistance are available through Massachusetts' Department of Agriculture's Enhancement Program and the United States Department of Agriculture's Natural Resources Conservation Services. Additional financial incentives include income tax credits for Title 5 upgrades and low interest loans for Title 5 on-site subsurface wastewater disposal system upgrades available through municipalities participating in this portion of the state revolving fund program.

As the town of Chilmark implements this TMDL, the TMDL values (kg/day of N) will be used by MassDEP as guidelines for permitting activities and should be used by local communities as a management tool.

Public Participation

Public meetings to present the results of and answer questions on this TMDL was held on April 2, 2019 in the Selectmen's Meeting Room, Chilmark Town Hall. Patti Kellogg and Barbara Kickham with MassDEP summarized the Massachusetts Estuaries Project and described the draft total nitrogen TMDL report findings. Brian Dudley, also with MassDEP, assisted with responding to questions. No written comments were received within the 30-day comment period following the public meeting. This final version of the TMDL report includes a summary of the questions/comments received during the public meeting, the Department's response to the comments, as well as answers to Frequently Ask Questions, and scanned images of the attendance sheets from the meetings (Appendix E).

References

Environmental Protection Agency (2001). Nutrient Criteria Technical Guidance Manual: Estuarine and Coastal Waters (EPA-822-B-01-003). The United States Environmental Protection Agency, Washington D.C.. Available at: http://www2.epa.gov/nutrient-policy-data/nutrient-criteria-technical-guidance-manual-estuarine-and-coastal-waters

Howes B., S.W. Kelly, R. I. Samimy, E.M. Eichner, G. Simmons, D.R. Schlezinger and J.S. Ramsey (2015). *Linked Watershed Embayment Model to Determine Critical Nitrogen Loading Thresholds for the Chilmark Pond Embayment System, Chilmark*, *Massachusetts*. SMAST/DEP Massachusetts Estuaries Project. Massachusetts Department of Environmental Protection. Boston, MA. http://www.mass.gov/eea/agencies/massdep/water/watersheds/the-massachusetts-estuaries-project-and-reports.html

MassDEP (2007). *Massachusetts Surface Water Quality Standards (314 CMR 4.00).* Massachusetts Department of Environmental Protection, 1 Winter Street, Boston, MA.

MassDEP (2015). CN 450.1. *Massachusetts Year 2014 Integrated List of Waters: Final Listing of the Condition of Massachusetts' Waters Pursuant to Sections 305(b), 314 and 303(d) of the Clean Water Act*. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

MassDOR (2012). Property Type Classification Codes. Massachusetts Department of Revenue, Division of Local Services, Bureau of Local Assessment.

Appendix A: Overview of Applicable Water Quality Standards

Water quality standards of particular interest to the issues of cultural eutrophication are dissolved oxygen, nutrients, bottom pollutants or alterations, aesthetics, excess plant biomass, and nuisance vegetation. The Massachusetts water quality standards (314 CMR 4.0) contain numeric criteria for dissolved oxygen, but have only narrative standards that relate to the other variables. This brief summary does not supersede or replace 314 CMR 4.0 Massachusetts Water Quality Standards, the official and legal standards. A complete version of 314 CMR 4.0 Massachusetts Water Quality Standards is available online at https://www.mass.gov/regulations/314-CMR-4-the-massachusetts-surface-water-quality-standards

Applicable Narrative Standards

314 CMR 4.05(5)(a) states "Aesthetics – All surface waters shall be free from pollutants in concentrations that settle to form objectionable deposits; float as debris, scum, or other matter to form nuisances, produce objectionable odor, color, taste, or turbidity, or produce undesirable or nuisance species of aquatic life."

314 CMR 4.05(5)(b) states "Bottom Pollutants or Alterations. All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms."

314 CMR 4.05(5)© states, "Nutrients –Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established by the Department pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control."

Description of Coastal and Marine Classes and Numeric Dissolved Oxygen Standards

Excerpt from 314 CMR 4.05(4) (a):

(4) Class SA. These waters are designated as an excellent habitat for fish, other aquatic life and wildlife, including for their reproduction, migration, growth and other critical functions, and for primary and secondary contact recreation. In certain waters, excellent habitat for fish, other aquatic life and wildlife may include, but is not limited to, seagrass. Where designated in the tables to 314 CMR 4.00 for shellfishing, these waters shall be suitable for shellfish harvesting without depuration (Approved and Conditionally Approved Shellfish Areas). These waters shall have excellent aesthetic value.

1. Dissolved Oxygen. Shall not be less than 6.0 mg/l. Where natural background conditions are lower, DO shall not be less than natural background. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.

Excerpt from 314 CMR 4.05(4) (b):

(b) Class SB. These waters are designated as a habitat for fish, other aquatic life and wildlife, including for their reproduction, migration, growth and other critical functions, and for primary and secondary contact recreation. In certain waters, habitat for fish, other aquatic life and wildlife may include, but is not limited to, seagrass. Where designated in the tables to 314 CMR 4.00 for shellfishing, these waters shall be suitable for shellfish harvesting with depuration (Restricted and Conditionally Restricted Shellfish Areas). These waters shall have consistently good aesthetic value.

- Dissolved Oxygen. Shall not be less than 5.0 mg/l. Seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained. Where natural background conditions are lower, DO shall not be less than natural background.

Excerpt from 314 CMR 4.05(3) (b):

(b) Class B. These waters are designated as a habitat for fish, other aquatic life, and wildlife, including for their reproduction, migration, growth and other critical functions, and for primary and secondary contact recreation. Where designated in 314 CMR 4.06, they shall be suitable as a source of public water supply with appropriate treatment ("Treated Water Supply"). Class B waters shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value.

1. Dissolved Oxygen. Shall not be less than 6.0 mg/l in cold water fisheries and not less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.

Waterbodies Not Specifically Designated in 314 CMR 4.06 or the tables to 314 CMR 4.00

Note many waterbodies do not have a specific water quality designation in 314 CMR 4.06 or the tables to 314 CMR 4.00**.** Coastal and Marine Classes of water are designated as Class SA and presumed High Quality Waters as described in 314 CMR 4.06 (4).

314 CMR 4.06(4):

(4) Other Waters. Unless otherwise designated in 314 CMR 4.06 or unless otherwise listed in the tables to 314 CMR 4.00, other waters are Class B, and presumed High Quality Waters for inland waters and Class SA, and presumed High Quality Waters for coastal and marine waters. Inland fisheries designations and coastal and marine shellfishing designations for unlisted waters shall be made on a case-by-case basis as necessary.

Applicable Antidegradation Provisions

Applicable antidegradation provisions are detailed in 314 CMR 4.04 from which an excerpt is provided:

Excerpt from 314 CMR 4.04:
4.04:Antidegradation Provisions

(4) Protection of Existing Uses. In all cases existing uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.

(2) Protection of High Quality Waters. High Quality waters are waters whose quality exceeds minimum levels necessary to support the national goal uses, low flow waters, and other waters whose character cannot be adequately described or protected by traditional criteria. These waters shall be protected and maintained for their existing level of quality unless limited degradation by a new or increased discharge is authorized by the Department pursuant to 314 CMR 4.04(5). Limited degradation also may be allowed by the Department where it determines that a new or increased discharge is insignificant because it does not have the potential to impair any existing or designated water use and does not have the potential to cause any significant lowering of water quality.

(3) Protection of Outstanding Resource Waters. Certain waters are designated for protection under this provision in 314 CMR 4.06. These waters include Class A Public Water Supplies (314 CMR 4.06(1)(d)1.) and their tributaries, certain wetlands as specified in 314 CMR 4.06(2) and other waters as determined by the Department based on their outstanding socio-economic, recreational, ecological and/or aesthetic values. The quality of these waters shall be protected and maintained.

(a) Any person having an existing discharge to these waters shall cease said discharge and connect to a Publicly Owned Treatment Works (POTW) unless it is shown by said person that such a connection is not reasonably available or feasible. Existing discharges not connected to a POTW shall be provided with the highest and best practical method of waste treatment determined by the Department as necessary to protect and maintain the outstanding resource water.

(b) A new or increased discharge to an Outstanding Resource Water is prohibited unless: the discharge is determined by the Department to be for the express purpose and intent of maintaining or enhancing the resource for its designated use and an authorization is granted as provided in 314 CMR 4.04(5). The Department's determination to allow a new or increased discharge shall be made in agreement with the federal, state, local or private entity recognized by the Department as having direct control of the water resource or governing water use; or the discharge is dredged or fill material for qualifying activities in limited circumstances, after an alternatives analysis which considers the Outstanding Resource Water designation and further minimization of any adverse impacts. Specifically, a discharge of dredged or fill material is allowed only to the limited extent specified in 314 CMR 9.00 and 314 CMR 4.06(1)(d). The Department retains the authority to deny discharges which meet the criteria of 314 CMR 9.00 but will result in substantial adverse impacts to the physical, chemical, or biological integrity of surface waters of the Commonwealth

(4) Protection of Special Resource Waters. Certain waters of exceptional significance, such as waters in national or state parks and wildlife refuges, may be designated by the Department in 314 CMR 4.06 as Special Resource Waters (SRWs). The quality of these waters shall be maintained and protected so that no new or increased discharge and no new or increased discharge to a tributary to a SRW that would result in lower water quality in the SRW may be allowed, except where:

(a) the discharge results in temporary and short term changes in the quality of the SRW, provided that the discharge does not permanently lower water quality or result in water quality lower than necessary to protect uses; and
(b) an authorization is granted pursuant to 314 CMR 4.04(5).

(5) Authorizations.
(a) An authorization to discharge to waters designated for protection under 314 CMR 4.04(2) may be issued by the Department where the applicant demonstrates that:
1. The discharge is necessary to accommodate important economic or social development in the area in which the waters are located;
2. No less environmentally damaging alternative site for the activity, receptor for the disposal, or method of elimination of the discharge is reasonably available or feasible;
3. To the maximum extent feasible, the discharge and activity are designed and conducted to minimize adverse impacts on water quality, including implementation of source reduction practices; and
4. The discharge will not impair existing water uses and will not result in a level of water quality less than that specified for the Class.
(b) An authorization to discharge to the narrow extent allowed in 314 CMR 4.04(3) or 314 CMR 4.04(4) may be granted by the Department where the applicant demonstrates compliance with 314 CMR 4.04(5)(a)2. Through 314 CMR 4.04(5)(a)4.
(c) Where an authorization is at issue, the Department shall circulate a public notice in accordance with 314 CMR 2.06. Said notice shall state an authorization is under consideration by the Department, and indicate the Department's tentative determination. The applicant shall have the burden of justifying the authorization. Any authorization granted pursuant to 314 CMR 4.04 shall not extend beyond the expiration date of the permit.
(d) A discharge exempted from the permit requirement by 314 CMR 3.05(4) (discharge necessary to abate an imminent hazard) may be exempted from 314 CMR 4.04(5) by decision of the Department.
(e) A new or increased discharge specifically required as part of an enforcement order issued by the Department in order to improve existing water quality or prevent existing water quality from deteriorating may be exempted from 314 CMR 4.04(5) by decision of the Department.

(6) The Department applies its Antidegradation Implementation Procedures to point source discharges subject to 314 CMR 4.00.

(7) Discharge Criteria. In addition to the other provisions of 314 CMR 4.00, any authorized Discharge shall be provided with a level of treatment equal to or exceeding the requirements of the Massachusetts Surface Water Discharge Permit Program (314 CMR 3.00). Before authorizing a discharge, all appropriate public participation and intergovernmental coordination shall be conducted in accordance with Permit Procedures (314 CMR 2.00).

Appendix B: Summary of the 2004 Nitrogen Concentrations for Chilmark Pond Estuarine System

Table B-1: Summary of the 2004 Nitrogen Concentrations for the Chilmark Pond Estuarine System
(Reprinted from Table VI-1 of the MEP Technical Report, Howes *et. al,* 2015, pg. 83).

Measured nitrogen concentrations for Chilmark Pond. TN data represented in this table were collected from 2004 in Chilmark Pond. The offshore Atlantic Ocean data (offshore Pleasant Bay Inlet) are from the summer of 2005.				
Sampling Station Location	Total Nitrogen			
	Date	Concentration (mg/L)	s.d. all data (mg/L)	N (Number of samples)
Wades Cove Upper (CHP1)	July 12	0.45	0.119	4
	July 27	0.61		
	Aug 10	0.63		
	Sept 8	0.74		
Mean		0.608		
Atlantic Ocean	0.232		0.044	17

Appendix C: Stormwater Loading Information

Table C1: The Chilmark Pond Estuarine System estimated waste load allocation (WLA) from runoff of all impervious areas within 200 feet of its waterbodies.

System Name	Impervious Area in 200 ft buffer (acres)[1]	Total Impervious Area in Watershed (acres)	Total Watershed Area (acres)	% Impervious of Total Watershed Area	Impervious Area in 200ft buffer as Percentage of Total Watershed Impervious Area	MEP Total Unattenuated Subwatershed Impervious Load (kg/day)[2]	MEP Total Unattenuated Watershed Load (kg/day)	Impervious buffer (200ft) WLA (kg/d)[3]	Buffer area WLA as percentage of MEP Total Unattenuated Subwatershed Load[4]
Lower Chilmark Pond	3.0	77.6	1,467	5.3%	3.9%	0.29	5.49	0.01	0.21%
Upper Chilmark Pond	3.0	108.4	1,944	5.6%	2.8%	0.44	15.22	0.01	0.08%
Total	6.0	186.0	3,411	5.5%	3.2%	73.2%	20.70	0.02	<0.01%

1- The entire impervious area within a 200 foot buffer zone around all waterbodies as calculated from GIS. Due to the soils and geology of Cape Cod and Islands it is unlikely that runoff would be channeled as a point source directly to a waterbody from areas more than 200 feet away. Some impervious areas within approximately 200 feet of the shoreline may discharge stormwater via pipes directly to the waterbody. For the purposes of the wasteload allocation (WLA) it was assumed that all impervious surfaces within 200 feet of the shoreline discharge directly to the waterbody.
2- This includes the unattenuated nitrogen loads from wastewater from septic systems, fertilizers, agriculture, runoff from both natural and impervious surfaces and atmospheric deposition to freshwater waterbodies.
3- The impervious subwatershed buffer area (acres) divided by total subwatershed impervious area (acres) then multiplied by total impervious subwatershed load (kg/year).
4- The impervious subwatershed buffer area WLA (kg/yr) divided by the total subwatershed load (kg/yr) then multiplied by 100.

Appendix D: Chilmark Pond Total Nitrogen TMDL

Table D-1: Chilmark Pond Estuarine System Total Nitrogen TMDL

Embayment	Segment ID	Impairment[1] [TMDLType]	TMDL (kg N/day)
Lower Chilmark Pond			7.515
Upper Chilmark Pond			11.195
Chilmark Pond (System Total)	**MA97-05**	Estuarine Bioassessments, Nutrient/Eutrophication Biological Indicators, Nitrogen (Total) [Restoration].	**18.71**

1. Massachusetts Year 2014 Integrated List of Waters (MassDEP 2015).

Appendix E: Response to Comments

Massachusetts Estuaries Project (MEP)
Response to Comments For

DRAFT TOTAL MAXIMUM DAILY LOAD (TMDL) REPORT FOR
CHILMARK POND ESTUARY SYSTEM (CONTROL #451.0)
(REPORT DATED MARCH 2019)

THE FOLLOWING INCLUDES PUBLIC COMMENTS MADE AT THE PUBLIC MEETING ON APRIL 2, 2019. NO WRITTEN RESPONSES WERE RECEIVED BY THE CLOSE OF THE PUBLIC COMMENT PERIOD ON MAY 3, 2019.

1. **The scenario presented in the TMDL and the technical report is a very difficult one for us to achieve. We are not planning to construct sewers in town.**

   MassDEP Response: The scenario presented in the Technical Report and the TMDL is just one possible scenario to meet Water Quality Standards and see recovery in the eelgrass and benthic habitats within the estuary. The standard runs completed for the Technical Reports are Present, Future Build-out, and an additional run to illustrate a scenario to reduce the nitrogen load to meet the target concentrations at the sentinel stations. The Town of Chilmark has the option to do additional model runs which consider other possible scenarios such as small, localized, wastewater treatment systems or bylaws requiring innovative/alternative Title 5 wastewater treatment systems.

2. **How did you get a target concentration in Upper Chilmark Pond without sampling?**

   MassDEP Response: The entire embayment system was modeled which included the bathymetry, hydrodynamics, groundwater contribution, landuse loading and benthic community sampling collected within the upper pond. This data was used as input and calibration for the model, which was then used to predict the target concentration of total nitrogen in the water column at the sentinel stations.

3. **Did you include geese in the animal load?**

   MassDEP Response: No, the land use loading model did not include contributions from geese or other wild animals due to the vagaries of their numbers and locations which change from day to day. The land use loading did include farm animals.

4. **We have known that Chilmark Pond is difficult to manage for nitrogen due to the large watershed and the number of homes in the watershed. Requiring newly constructed systems to have denitrification capabilities will not address the large number of existing**

homes with older septic systems. Some areas of the estuary are closed due to water quality problems so shellfishing farms will not be an option. I have no question, just frustrated.

MassDEP Response: We understand your frustration as this is a complicated and potentially expensive process to implement the changes needed for significant nitrogen reductions in the watershed. However, there are a number of options available to you and the sooner you begin to address the excess nitrogen problem the sooner you will see results. We understand that the town is considering other available options, for example, tax incentives for construction of FAST https://www.barnstablecountyhealth.org/resources/publications/compendium-of-information-on-alternative-onsite-septic-system-technology/fast *and other nitrogen reducing Title 5 systems, target developed areas where cluster wastewater systems could be constructed, Permeable Reactive Barriers, and banning use of lawn fertilizers.*

5. **Would increasing the number of pond openings help?**

MassDEP Response: The town currently opens the barrier beach three times per year. An additional opening will likely help, however, it is sometimes difficult to get the right conditions to adequately flush the pond. The length of time each breach stays open to allow circulation with the open ocean varies widely, due to wind and currents. Additional nitrogen removal strategies are needed in addition to pond openings, to provide a long-term solution to the nitrogen problem.

6. **Do we need the Army Corps of Engineers approval for pond openings?**

MassDEP Response: Pond openings require permits from the Army Corps of Engineers, Division of Marine Fisheries, Natural Heritage and Endangered Species Program, MassDEP and the local Conservation Commission.

General Frequently Asked Questions:

1. **Can a Comprehensive Water Resources Management Plan (CWRMP) include the acquisition of open space, and if so, can State Revolving Funds (SRF) be used for this?**

MassDEP Response: State Revolving funds can be used for open space preservation if a specific watershed property has been identified as a critical implementation measure for meeting the TMDL. The SRF solicitation should identify the land acquisition as a high priority project for this purpose which would then make it eligible for the SRF funding list. However, it should be noted that preservation of open space will only address potential future nitrogen sources (as predicted in the build-out scenario in the MEP Technical report) and not the current situation. The town will still have to reduce existing nitrogen sources to meet the TMDL.

2. **Do we expect eelgrass to return if the nitrogen goal is higher than the concentration that can support eelgrass?**

MassDEP Response: There are a number of factors that can control the ability of eelgrass to re-establish in any area. Some are of a physical nature (such as boat traffic, water depth, or even sunlight penetration) and others are of a chemical nature like nitrogen. Eelgrass decline in general has been directly related to the impacts of eutrophication caused by elevated nitrogen concentrations. Therefore, if the nitrogen concentration is elevated enough to cause symptoms of eutrophication to occur, eelgrass growth will not be possible even if all other factors are controlled.The eelgrass will not return until the water quality conditions improve. Where there is no historical evidence of eelgrass, the target concentration has been set at a higher concentrations than generally tolerated by eelgrass, with the goal of restoring the benthic habitat.

3. **Who is required to develop the CWRMP? Can it be written in-house if there is enough expertise?**

MassDEP Response: The CWRMP can be prepared by the town. There are no requirements that it must be written by an outside consultant; however, the community should be very confident that its in-house expertise is sufficient to address the myriad issues involved in the CWRMP process. MassDEP would strongly recommend that any community wishing to undertake this endeavor on its own should meet with MassDEP to develop an appropriate scope of work that will result in a robust and acceptable plan.

4. **Have others written regional CWRMPs (i.e. included several neighboring towns)?**

MassDEP Response: The Cape Cod Commission prepared a Regional Wastewater Management Plan or RWMP which formed a framework and set of tools for identifying several solutions for restoring water quality for each watershed on the Cape. The Section 208 Plan Update (or 208 Plan) is an area-wide *water quality management plan and in general each town then prepared or is preparing its own CWRMP. An example of neighboring towns working on a regional plan is the Pleasant Bay Alliance which consists of Orleans, Brewster, Harwich, and Chatham. Harwich, Dennis and Yarmouth are in discussions regarding a shared wastewater treatment plant.*

Joint Comprehensive Wastewater Management Plans (CWMPs) have been developed by multiple Towns particularly where Districts are formed for purposes of wastewater treatment. Some examples include the Upper Blackstone Water Pollution Abatement District that serve all or portions of the towns Holden, Millbury, Rutland West Boylston and the City of Worcester and the Greater Lawrence Sanitary District that serves the greater Lawrence area including portions of Andover, N. Andover, Methuen and Salem NH. There have also been recent cases where Towns have teamed up to develop a joint CWMP where districts have not been formed. The most recent example is the Towns which discharge to the Assabet River. They include the Towns of Westboro and Shrewsbury, Marlboro and Northborough, Hudson, and Maynard. The reason these towns joined forces was because as a group, they received more priority points in the State Revolving Fund application process than they otherwise would have as individual towns.

5. **Does nitrogen entering the system close to shore impair water quality more? If we have to sewer, wouldn't it make sense to sewer homes closer to the shore?**

MassDEP Response: Homes closer to the waterbody allow nitrogen to get to that waterbody faster (shorter travel times). Those further away may take longer but still get there over time and are dependent upon the underlying geology. However, what is more important is the density of homes. Larger home density means more nitrogen being discharged thus the density typically determines where to sewer to maximize reductions. Also there are many factors that influence water quality such as flushing and morphology of the water body.

6. **Do you take into account how long it takes groundwater to travel?**

MassDEP Response: Yes, the MEP Technical report has identified long term (greater than 10 years) and short term time of travel boundaries in the ground-watershed.

7. **What if a town can't meet its TMDL?**

MassDEP Response: A TMDL is simply a nutrient budget that determines how much nitrogen reduction is necessary to meet water quality goals as defined by state Water Quality Standards. It is unlikely that the TMDL cannot be achieved however in rare occasions it can happen. In those rare cases the Federal Clean Water Act provides an alternative mechanism which is called a Use Attainability Analysis (UAA). The requirements of that analysis are specified in the Clean Water Act but to generalize the process, it requires a demonstration would have to be made that the designated use cannot be achieved. Another *way of saying this is that a demonstration would have to be made that the body of water cannot support its designated uses such as fishing, swimming or protection of aquatic biota. This demonstration is very difficult and must be approved by the U.S. Environmental Protection Agency. As long as a plan is developed and actions are being taken at a reasonable pace to achieve the goals of the TMDL, MassDEP will use discretion in taking enforcement steps. However, in the event that reasonable progress is not being made, MassDEP can take additional regulatory action through the broad authority granted by the Massachusetts Clean Waters Act, the Massachusetts Water Quality Standards, and through point source discharge permits.*

8. What is the relationship between the linked model and the CWRMP?

MassDEP Response: The model is a tool that was developed to assist the Town to evaluate potential nitrogen reduction options and determine if they meet the goals of the TMDL at the established sentinel station in each estuary. The CWRMP is the process used by the Town to evaluate your short and long-term needs, define options, and ultimately choose a recommended option and schedule for implementation that meets the goals of the TMDL. The models can be used to assist the Towns during the CWRMP process.

9. Is there a federal mandate to reduce fertilizer use?

MassDEP Response: No, it is up to the states and/or towns to address this issue. However, the Massachusetts Department of Agricultural Resources (MassDAR) passed plant nutrient regulations (330 CMR 31.00) in June 2015, which requires specific restrictions for agricultural and residential fertilizer use, including seasonal restrictions, on nutrient applications and set-backs from sensitive areas (public water supplies and surface water) and Nutrient Management Plans. Compliance with the MassDAR regulations will result in reductions in future N loading from agricultural sources.

10. Will monitoring continue at all stations or just the sentinel stations?

MassDEP Response: At a minimum, MassDEP would like to see monitoring continued at the sentinel stations bi-monthly, May-September in order to determine compliance with the TMDL. However, ideally, it would be good to continue monitoring all of the stations, if possible. The benthic stations can be sampled every 3-5 years since changes are not rapid. The towns may want to sample additional locations if warranted. MassDEP intends to continue its program of eelgrass monitoring.

11. What is the state's expectation with CWRMPs?

MassDEP Response: The CWRMP is intended to provide the Towns with potential short and long-term options to achieve water quality goals and therefore provides a recommended plan and schedule for sewering/infrastructure improvements and other nitrogen reduction options necessary to achieve the

TMDL. The state also provides a low interest loan program called the state revolving fund or SRF to help develop these plans. Towns can combine forces to save money when they develop their CWRMPs.

12. Can we submit parts of the plan as they are completed?

MassDEP Response: Submitting part of a plan is not recommended because absent a comprehensive plan, a demonstration cannot be made that the actions will meet the requirements of the TMDL. With that said however the plan can contain phases using an adaptive approach if determined to be reasonable and consistent with the TMDL.

13. How do we know the source of the bacteria (septic vs. cormorants, etc.)?

MassDEP Response: This was not addressed because this is a nitrogen TMDL and not a bacteria TMDL.

14. Is there a push to look at alternative new technologies?

MassDEP Response: MassDEP recommends communities consider all feasible alternatives to develop the most effective and efficient plans to meet water quality goals. The 208 Plan Update includes an analysis of a wide range of traditional and alternative approaches to nutrient reduction, remediation, and restoration. If a CWRMP relies on such alternative technologies and approaches, the plan must include demonstration protocols, including monitoring, that will confirm that the proposed reduction credits and, when appropriate, removal efficiencies are met. The implementation schedule is in the demonstration protocol for each alternative technology or approach, at which time a determination must be made as to whether the alternative technology/approach meets the intended efficacy goal. MassDEP is also developing a Watershed Permit Pilot program, which includes but is not limited to Under Ground Injection Control (UIC) and groundwater discharge permits and provides a permitting mechanism to approve nontraditional methods of wastewater management and/or impact mitigation that could not otherwise be approved by MassDEP under a typical wastewater management and discharge permit. Watershed permits would include implementation timetables, standards to be achieved, and long-term monitoring to evaluate water quality improvements.

The Massachusetts Septic System Test Center, located on Cape Cod and operated by the Barnstable County Department of Health and Environment, tests and tracks advanced innovative and alternative septic system treatment technologies. In addition MassDEP evaluates pilot studies for other alternative technologies; however, absent a CWRMP and Watershed Permit, MassDEP will not approve a system for general use unless it has been thoroughly studied and documented to be successful.

15. How about using shellfish to remediate and reduce nitrogen concentrations?

MassDEP Response: The use of shellfish to remediate and reduce nitrogen concentrations is an alternative approach that has been utilized and is being evaluated in some areas of Long Island Sound (LIS), Wellfleet, and Chesapeake Bays. More recently, some Cape communities have been evaluating this method, including Falmouth, Mashpee and Orleans. While this approach has demonstrated promise for reducing nitrogen concentrations, there remain questions regarding the effectiveness and circumstances where it can be successfully utilized. MassDEP recommends communities considering this option discuss such plans with the Department, and evaluate the results from ongoing efforts on the Cape and on other states.

16. The TMDL is a maximum number, but we can still go lower.

MassDEP Response: The state's goal is to achieve designated uses and water quality criteria. There is nothing however that prevents a Town from implementing measures that go beyond that goal. It should also be noted that the TMDL is developed conservatively with a factor of safety included.

17. Isn't it going to take several years to reach the TMDL?

MassDEP Response: It is likely that several years will be necessary to achieve reductions and to see a corresponding response in the estuary. However, the longer it takes to implement solutions, the longer it is going to take to achieve the goals.

18. The TMDL is based on current land use but what about future development?

MassDEP Response: The TMDL is based on a habitat restoration target(s)for conditions during the period of data collection. Buildout was considered in the MEP model as part of scenario runs to evaluate implementation strategies. Evaluation of buildout conditions must be considered as part of the CWMP.

SIGN IN SHEET 4/2/2019

Chilmark Pond Estuarine System TMDL Public Meeting

	Print Name	Affiliation
1.	JAMES MALKIN	BOS - CHAIR
2.	Catherine Thompson	resident / Planning Board
3.	JEREMY SCOTT WOOD	RESIDENT
4.	Nan Doty	resident
5.	TERRY DONAHUE	INTERESTED
6.	Warren Doty	Selectman
7.	JENNIFER CHRISTY	TOWN CLERK / CHILMARK
8.	Tim Carroll	TOC TA
9.	Bill Rossi	BOS
10.	Julie JAFFE	citizen
11.	Joan MALKIN	citizen / MVC
12.	Clarissa M. Allen	"

SIGN IN SHEET 4/2/2019
Chilmark Pond Estuarine System TMDL Public Meeting

	Print Name	Affiliation
13.	Kris O'Brien	citizen
14.	Richie Smith	MVTS
15.	Marina Lent Marina Lent	Chilmark Health Dept.
16.	Candy Shweder	
17.	Landry Harlan	Vineyard Gazette
18.	Suellen Lazarus	CTAC
19	Ryan Rossi	Menemsha Harbor dept.
20.	Howard Grimm	
21.	Jim Buhrman	Chilmark Board of Health
22.	Wendy Weldon	ZBA & Squibnocket Pond Committee
23.	Rebekah Thomson	
24.	Janet Weidner	Planning Board

SIGN IN SHEET 4/2/2019
Chilmark Pond Estuarine System TMDL Public Meeting

	Print Name	Affiliation
25.	Matt D'Andrea	MVPS
26.	[illegible]	Chilmark [illegible]
27.		
28.		
29.		
30.		
31		
32.		
33.		
34.		
35.		