Chapter 4

Massachusetts Estuaries Project and Nitrogen Limit Development

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MASSACHUSETTS ESTUARIES PROJECT AND NITROGEN LIMIT DEVELOPMENT

4.1 INTRODUCTION

The Massachusetts Estuaries Project (MEP) was established to provide water quality, nutrient loading, and nitrogen-limit development information for 89 estuaries in Southeastern Massachusetts. The project has created a "linked watershed/estuary model" that is used to predict the water quality changes in an estuary using nitrogen loading inputs from the estuary's watershed. The model is then used to establish nitrogen loading thresholds that can be used as management goals in the respective watersheds. As part of the MEP, the health of the estuarine habitat is evaluated and compared with the estuary's nitrogen concentrations. This information is used to establish the nitrogen concentration threshold to maintain or improve the habitat. Threshold nitrogen levels are defined by MEP as "the average water column concentration of nitrogen that will support the habitat quality being sought." These thresholds become the basis for generating Total Maximum Daily Loads (TMDLs) that are used for watershed permitting.

As generally defined in the Clean Water Act, TMDLs establish the threshold value for a particular pollutant in a water body, and this threshold is to be consistent with State water quality standards. In the case of the Stage Harbor/Oyster Pond system, Sulphur Springs/Bucks Creek, Taylors Pond/Mill Creek, Muddy Creek, Bassing Harbor system, Pleasant Bay and the Cockle Cove Creek Salt Marsh, the pollutant of interest is nitrogen. Due to the non-point source nature of nitrogen loadings, it is appropriate to base the TMDL on annual average loadings instead of on daily loadings.

The MEP is a collaborative effort by the Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA) (through the MassDEP) and the University of Massachusetts-

Dartmouth School of Marine Science and Technology (SMAST), with contributions from the United States Geological Survey (USGS), Cape Cod Commission (CCC), and Applied Coastal Research and Engineering, Inc (ACRE).

The following reports relating to the Stage Harbor/Oyster Pond system, Sulphur Springs/Bucks Creek, Taylors Pond/Mill Creek, Bassing Harbor system, Muddy Creek, Pleasant Bay System and the Cockle Cove Creek Salt Marsh watersheds were produced:

- "Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for Stage Harbor, Sulphur Springs, Taylors Pond, Bassing Harbor and Muddy Creek, Chatham , Massachusetts" Final Report – December 2003.
- "Stage Harbor, Sulphur Springs, Taylors Pond, Bassing Harbor and Muddy Creek Total Maximum Daily Loads for Total Nitrogen", November 2004.
- "Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for the Pleasant Bay System, Orleans, Chatham, Brewster and Harwich, Massachusetts," Final Report – May 2006.
- "Draft Pleasant Bay System Total Maximum Daily Loads for Total Nitrogen", July 2006.
- "MEP Technical Memorandum – Final; Cockle Cove Salt Marsh Nitrogen Threshold", November 2006.
- "Linked Watershed-Embayment Model to Re-evaluate Critical Nitrogen Loading Thresholds for Stage Harbor/Oyster Pond, Sulphur Springs/Bucks Creek, Taylors Pond/Mill Creek, Chatham, MA" Final Report – February 2007.
- "FINAL Pleasant Bay System Total Maximum Daily Loads for Total Nitrogen (Report # 96-TMDL-12, Control #244.0)", May 2007.
- "DRAFT Stage Harbor/Oyster Pond, Sulphur Springs/Bucks Creek, Taylors Pond/Mill Creek Total Maximum Daily Load Re-Evaluations for Total Nitrogen", January 3, 2008.
- "Stage Harbor/Oyster Pond, Sulphur Springs/Bucks Creek, Taylors Pond/Mill Creek Total Maximum Daily Load Re-Evaluations for Total Nitrogen (Control # CN 206.1)", December 31, 2008.

The reports all found that nitrogen from septic systems is the largest source of nitrogen, comprising 71 to 84 percent of the nitrogen input that may be controlled through management systems. As a result, these reports focus on the management of this source.

The purpose of this Chapter is to summarize the major findings of the MEP reports for Chatham's estuaries and salt marshes, and summarize the nitrogen TMDLs for the watershed to these areas.

4.2 SUMMARY OF MEP FINDINGS FOR STAGE HARBOR AND SOUTH COASTAL EMBAYMENTS

The first MEP technical report, released in December 2003, included the Stage Harbor system, Sulphur Springs/Bucks Creek, and Taylors Pond/Mill Creek, as well as the Chatham Pleasant Bay sub-embayments of Muddy Creek and the Bassing Harbor system. It should be noted that the 2003 Chatham MEP study did not include Chatham Harbor or the Chatham watersheds draining directly to Pleasant Bay. However, at the request of the Town, the findings from the 2003 MEP report were re-evaluated based on updated water use data to be consistent with the Pleasant Bay MEP study. The updated findings were reported in a revised Final Report on the Stage Harbor system, Sulphur Springs/Bucks Creek, and Taylors Pond/Mill Creek released in February 2007. The following is a summary of the 2007 findings.

A. **Stage Harbor and South Coast Embayments MEP Technical Report Results.** Nitrogen loading estimates were developed for each subwatershed within each system (Stage Harbor, Oyster Pond, Oyster Pond River, Mill Pond, Little Mill Pond, Mitchell River, Sulphur Springs, Bucks Creek, Taylors Pond, and Mill Creek). Nitrogen inputs from wastewater, stormwater runoff, fertilizer, and natural sources were estimated. These estimated values are shown as "Present Load" in Table 4-1. The "Build-out Load" is the nitrogen load based on the same inputs, but at the potential future conditions. In order to compare these nitrogen loads to naturally occurring nitrogen levels, estimates were made of what the nitrogen loads would be if there were no human sources. This analysis assumed only atmospheric deposition, with natural forests occupying the watershed area. The "No Anthropogenic Load" column in Table 4-1 summarizes these loads for each subwatershed.

The analyses described above aid in estimating the impact of future growth and human activity on the nitrogen load entering each subwatershed. Based on these analyses, the MEP determined that much of the watershed is already moderately to significantly impaired and needs remediation. In addition, the MEP developed a "target nitrogen concentration," which is the concentration at a point in the system ("sentinel station") that would aid in restoration of the system. The target concentration for the sentinel station in each estuary was determined to be 0.38 milligrams of Total Nitrogen per liter. Table 4-2 presents one nitrogen reduction scenario presented by MEP that focuses on removal of the wastewater nitrogen from septic systems that could achieve the target nitrogen concentration. As stated by MEP, this scenario is one of many possible ways to achieve the target concentration.

The percent change as shown in Table 4-2 represents the percent of the nitrogen contributed to the watershed by wastewater that needs to be removed in order to achieve the stated threshold. For example "-100 percent" indicates that 100 percent (or all) of the nitrogen currently being contributed by septic systems and wastewater treatment effluent needs to be removed from the watershed to achieve the stated threshold. This information is also illustrated on Figure 2-4.

B. **Stage Harbor and South Coast Embayment TMDL Development.** The first round of TMDLs were developed for the Stage Harbor system, Sulphur Springs/Bucks Creek, and Taylors Pond/Mill Creek in 2004 and approved by USEPA in June 2006, as part of the federal Clean Water Act (CWA). This first TMDL also included the Chatham Pleasant Bay sub-embayments of Muddy Creek and the Bassing Harbor system. The re-evaluated TMDLs for the Stage Harbor/Oyster Pond system, Sulphur Springs/Bucks Creek, and Taylors Pond/Mill Creek were issued in 2008. Compliance with section 303(d) of the CWA results in the identification of water bodies that do not meet the water quality standards for the designated uses, therefore requiring a TMDL. All these watersheds were identified as requiring nutrient TMDLs.

The MEP work assessed the water quality and determined the loading capacity of the water body (described above). The loading capacities were developed by setting water quality conditions that would:

- Restore the natural distribution of eelgrass because it provides valuable habitat for shellfish and finfish.
- Prevent algal blooms.

- Protect benthic communities from impairment or loss.
- Maintain dissolved oxygen concentrations that are protective of the estuarine communities.

Although the conditions listed above are the objectives of the TMDLs, these conditions may not be observed in all subembayments by achieving the TMDL. For example, benthic infauna will be the only restored condition in certain subembayments where eelgrass has not been observed in historic records.

The TMDLs, as stated above, for Stage Harbor/Oyster Pond, Sulphur Springs/Bucks Creek, and Taylors Pond/Mill Creek have been re-evaluated and a DRAFT Re-Evaluated TMDL was issued for these south coastal embayments in January 2008, followed by a December 31, 2008 submittal to USEPA for approval. Although the original TMDLs issued for Chatham in 2004 included all of the estuaries (except Pleasant Bay proper), a separate Final TMDL for Pleasant Bay that included Bassing Harbor and Muddy Creek was issued in May 2007. These TMDLs are discussed under the Pleasant Bay System section of this chapter.

Similar to Table 4-2, Table 4-3 shows the percent of nitrogen that needs to be removed from each south-side watershed; however, unlike Table 4-2, the watershed load shown here includes all controllable nitrogen sources, not just nitrogen from wastewater.

Consideration of the natural background nitrogen levels and the nitrogen loading allocated to point and nonpoint loads led to the development of TMDLs. The background levels were developed as discussed in section 4.2.A. Table 4-4 lists the TMDLs for Chatham's south coastal embayment subwatersheds.

The TMDL is the sum of the target threshold watershed load, atmospheric deposition load, and benthic flux load.

4.3 SUMMARY OF FINDINGS FOR PLEASANT BAY SYSTEM

The 2003 MEP Report on Chatham's embayments did not include Chatham Harbor nor did it include Chatham's impact on Pleasant Bay proper. There was also concern about MEP evaluations of Chatham's Pleasant Bay sub-embayments (Muddy Creek and the Bassing Harbor

system) in the absence of the evaluation of the larger Pleasant Bay system as a whole. The Pleasant Bay Alliance (Chatham, Harwich & Orleans) were able to have the Pleasant Bay system, including Chatham Harbor, included in the MEP. The final MEP technical report for the Pleasant Bay System was released in May 2006, and the Final TMDL report was released in May 2007. The results of the evaluation related to the Town of Chatham are summarized in the following sections.

A. **Pleasant Bay System MEP Technical Report Results.** Nitrogen loading estimates were developed for each subwatershed within the Pleasant Bay System. Nitrogen inputs from wastewater, stormwater runoff, fertilizer, and natural sources were estimated. These estimated values are shown as "Present Load" in Table 4-5. The "Build-out Load" is the nitrogen load based on the same inputs, but at the potential future conditions. In order to compare these nitrogen loads to naturally occurring nitrogen levels, estimates were made of what the nitrogen loads would be if there were no human sources. This analysis assumed only atmospheric deposition, with natural forests occupying the watershed area. The "No Anthropogenic Load" column summarizes these loads for each subwatershed.

The analyses described above aid in estimating the impact of future growth and human activity on the nitrogen load entering each subwatershed. Based on these analyses, the MEP determined that much of the watershed was already moderately to significantly impaired, similar to the Stage Harbor and south coastal embayments. The target concentration for the sentinel station was determined to be 0.16 milligrams of bioactive Nitrogen per liter (a change from the 0.38 mg/L of total nitrogen used in other MEP evaluations).

In general, MEP found that the total nitrogen levels within Pleasant Bay were highly variable. As a result, MEP chose to use the bioactive portion of nitrogen (which data showed was less variable) as the parameter to identify the nitrogen levels that are supportive of healthy eelgrass habitat. A detailed explanation is provided in the MEP "Linked Watershed – Embayment Model to Determine Critical Nitrogen Loading Thresholds for the Pleasant Bay System, Orleans, Chatham, Brewster and Harwich, Massachusetts" Executive Summary.

Table 4-6 presents one nitrogen reduction scenario presented by MEP that focuses on removal of the wastewater nitrogen from septic systems that could achieve the target nitrogen concentration. Again, stated by MEP, this scenario is only one of many possible ways to achieve the target

concentration. The percent change in this table represents the percent of the nitrogen contributed to the watershed by wastewater that needs to be removed in order to achieve the stated threshold. For example "-100 percent" indicates that 100 percent (or all) of the nitrogen currently being contributed by septic systems and wastewater treatment facilities needs to be removed from the watershed to achieve the stated threshold.

B. **Pleasant Bay System TMDL Development.** Final TMDLs were developed for the Pleasant Bay System as part of the federal Clean Water Act (CWA), similar to the methods described for Stage Harbor and south coastal embayments.

Similar to Table 4-6, Table 4-7 shows the percent of nitrogen that needs to be removed from each watershed; however, unlike table 4-6, the watershed load shown here includes all nitrogen sources, not just nitrogen from wastewater.

Consideration of the natural background nitrogen levels and the nitrogen loading allocated to point and nonpoint loads led to the development of TMDLs. The background levels were developed as discussed in section 4.3.A. Table 4-8 lists the TMDLs for the Pleasant Bay System subwatersheds as related to Chatham (although they may include loadings from Towns with shared watersheds, for example in Muddy Creek shared with Harwich, and Pleasant Bay proper shared with Harwich, Brewster, and Orleans.).

The TMDL is the sum of the target threshold watershed load, atmospheric deposition load, and benthic flux load. For some subwatersheds, the TMDL is less than the target threshold watershed load. This is due to the negative load contributed by the benthic flux.

4.4 SUMMARY OF FINDINGS FOR COCKLE COVE CREEK SALT MARSH

In November 2006, MEP issued a technical memorandum on the Cockle Cove Creek salt marsh related to its nitrogen threshold (Appendix J). In previous studies and reports issued by MEP in 2003 and 2004 as part of the "Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for Stage Harbor, Sulphur Springs, Taylors Pond, Bassing Harbor and Muddy Creek" a limit on the assimilative capacity of the marsh related to nitrogen had not been established. The previous MEP studies identified the need for further study to identify such a threshold. The study focused on three areas:

- Quantify the present habitat health in Cockle Cove Creek salt marsh.
- Determine the degree of nitrogen attenuation within the system.
- Provide marsh ecological data needed to provide a correlation between Cockle Cove Creek salt marsh and other salt marshes related to nitrogen loading.

In general, the primary finding critical to the CWMP process is that the proposed increase in nitrogen associated with sewering and improvements to the existing WWTF will not adversely impact the marsh from a nitrogen perspective. Several of the key findings of this report are summarized below:

- "The high levels of nitrogen and phosphorus, yet the absence of macro-algae, suggests that physical factors may be playing a key role in habitat quality in this tidal creek system."
- "…high nitrogen levels alone do not result in macro-algae accumulation."
- "…as long as the concentration of bioactive nitrogen (nitrate+ammonium+particulate organic nitrogen) in the tidal creek remains unchanged, the habitats should remain high quality."

The report identifies a limit of 3.0 mg/L of bioactive nitrogen (mean concentration of 2.5 mg/L total nitrogen of fresh inflow and mid-marsh concentration) would be protective to the system. Therefore, as long as the average annual discharge concentration within this watershed remained at 3.0 mg bioactive nitrogen/L or less, there would be no nitrogen impact on the Cockle Cove Creek Salt Marsh. The importance of "physical factors" (i.e. flushing) in determining the water quality of Cockle Cove Creek and Bucks Creek was reinforced in a 2007 coastal study (Appendix K) the examined near-shore conditions and inlet configuration.

As a follow up to the salt marsh study findings, MEP modeled the impacts of increased treated water recharge in the watershed up-gradient of Cockle Cove Creek and Bucks Creek (included in Appendix L). Findings of this effort indicated that the threshold nitrogen level at the sentinel station in Bucks Creek is achieved and TN levels in Cockle Cove Creek are acceptable.

4.5 SUMMARY OF TMDL REQUIREMENTS FOR WASTEWATER NITROGEN REMOVAL

Table 4-9 summarizes the percent of wastewater (septic) load reductions that will be necessary to achieve the target nitrogen concentration requirements based on the one scenario that was used as the focus of these reports.

Based on these TMDLs and the findings identified in Chapter 2 from the Needs Assessment Report, the watershed areas to the following waterbodies have been identified as AOCs.

Stage Harbor
- Oyster Pond
- Oyster River
- Stage Harbor
- Mitchell River
- Mill Pond
- Little Mill Pond

Sulphur Springs
- Sulphur Springs
- Bucks Creek
- Cockle Cove Creek

Taylors Pond
- Taylors Pond
- Mill Creek

Pleasant Bay
- Crows Pond
- Ryder's Cove
- Frost Fish Creek
- Bassing Harbor
- Lower Muddy Creek
- Upper Muddy Creek

It is noted that the other AOC's (not related to nitrogen TMDLs) are located within the AOCs identified below:

- Eliphamets Lane
- Enterprise Drive Industrial Area
- Commerce Park Industrial Area