Solving Wastewater Management Challenges for Non-Point Source Nitrogen Control in Coastal Watersheds

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US Environmental Protection Agency
Region 1

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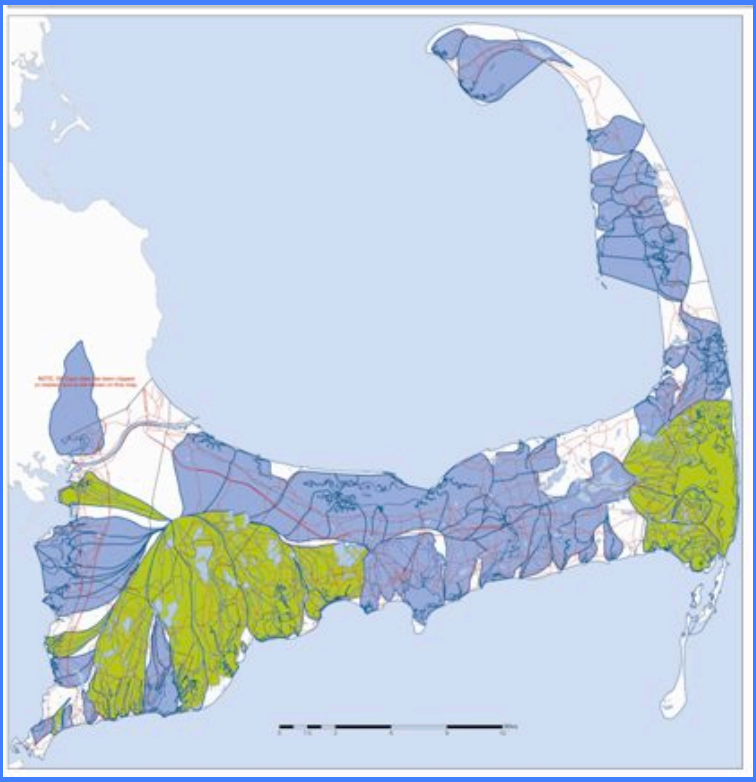

CAPE COD COMMISSION

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Executive Summary

The is the final report of activities undertaken by the Cape Cod Commission relative to a US Environmental Protection Agency (EPA) grant entitled, "Solving Wastewater Management Challenges for Non-Point Source Nitrogen Control in Coastal Watersheds." The goal of this project was to develop technical assistance materials to educate and assist communities to establish and implement new regulatory, planning, and wastewater management strategies for non-point source nitrogen control.

The period of activity on the EPA grant spanned from August 2005 to September 2009. Cape Cod scientists, planners, and officials made some very significant advances in their understanding of coastal eutrophication and its relation to implementing Total Maximum Daily Loads. At the beginning of this grant, towns were just beginning to receive the first set of Massachusetts Estuaries Project (MEP) Technical Reports, the Barnstable County Wastewater Implementation Committee was completing work on over $2.7 million dollars of technical assistance to the communities, and the Cape Cod Water Protection Collaborative was established to assist the region in securing better financial assistance.

Cape Cod Commission staff established a short-term working group that assisted in discussing the use of MEP findings in Comprehensive Wastewater Management Plans (CWMPs), natural attenuation, nutrient trading, and the scope of a regional "Coastal Waters Restoration Conference." Commission staff also worked with local groups and Massachusetts Department of Environmental Protect (MassDEP) staff on their watershed planning and pilot Total Maximum Daily Load (TMDL) implementation grant. A significant task was determining the town and subwatershed allocation of nitrogen load from the MEP Technical Reports. When towns begin to discuss sharing TMDL compliance, they need to know just how much of the daily load is from each town.

Cape Cod Commission staff also incorporated the approved EPA TMDLs into the Cape Cod Regional Policy Plan. The Regional Policy Plan sets the regulatory and planning standards that the Commission uses in its review of Developments of Regional Impact (DRIs), which include local CWMPs. The 2009 revision of the Regional Policy Plan recognizes the approved TMDLs as watershed management goals. Towards this end the Commission has stepped away from the "no net" nitrogen-loading policy and has recognized that a private development is entitled to a "fair share" of the watershed nitrogen load as defined by the TMDL. The fair-share approach offers an equitable allocation of available nitrogen capacity to projects until comprehensive solutions are implemented.

Cape Cod Commission staff have reviewed and commented on CWMPs for the towns of Mashpee, Falmouth, Barnstable, Orleans, and Chatham. Staff also assisted other towns in developing scopes of work, providing graphics, and participating in selection committees that are beginning the CWMP process.

Staff from the Cape Cod Commission and the University of Massachusetts–Dartmouth School for Marine Science and Technology (SMAST) identified a need to educate local officials and consultants on the procedure to obtain water quality modeling scenarios from the MEP Technical Team. The Commission and other partners organized a workshop in Hyannis. Staff also worked with the Town of Mashpee to compile a universal land use database for MEP scenarios proposed by the town's consultants, and reviewed and recommended MEP scenarios of Lewis Bay for the Town of Barnstable.

Commission staff identified a regional need to provide groundwater modeling technical assistance to the towns and undertook an initiative to build this capacity. Commission staff assisted the MEP in the delineations of watersheds in the Monomoy Lens and undertook investigations of contaminant migration and wellhead protection for the Sagamore Lens. In a similar manner, Commission staff provided technical reviews of groundwater modeling scopes of work and assessments of preferred treated-wastewater-effluent disposal sites for the towns of Chatham, Orleans, and Falmouth. The Commission also distributed the final US Geological Survey report on groundwater modeling work that was funded by Barnstable County.

The Commission prepared maps, tables, and other compilations of the status of wastewater planning and MEP reports across Cape Cod. These materials were incorporated into the Cape Cod Water Protection Collaborative web site and numerous technical presentations on Cape Cod and other regions to transfer this technical knowledge to others.

Extending the period of this grant back to 2001 when a major investment in technical assistance by Barnstable County and Cape Cod towns began, the number of towns that are in the CWMP process has increased from four in 2001 to 13 in 2009. Of those, five are in, or have been in regulatory MEPA review. As we begin to see these efforts come to conclusion, public support and understanding of the science, technologies, and management of TMDL implementation will be increasingly important. Participants at the Coastal Restoration Conference indicated, in their evaluations, that the odds of successful TMDL implementation was a good bet; however, they cited cost as the overwhelming constraint, and education as the key to get there.

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1 Watershed TMDL Implementation

1.1 Background

The subject of watershed management in the context of non-point source nutrient management was discussed and debated on Cape Cod for a number of years before this US Environmental Protection Agency (EPA) grant. Barnstable County established a Wastewater Implementation Committee in 2001, which was active to the end of 2006 as part of a Massachusetts Department of Environmental Protect (MassDEP) Watershed Initiative grant. The WIC, a regional forum of the 15 Cape towns to discuss options for wastewater management issues, was Barnstable County's first forum for wastewater planning. The WIC assisted in spending over $2.7 million in regional and local wastewater planning assessments and guidance documents. "Wastewater management districts" were a central issue that the MassDEP grant asked the WIC to evaluate. The WIC secured funding for a consultant to undertake such an evaluation.

Instead of a formal assessment of wastewater districts, what evolved was a broad identification of wastewater management issues and reasonable actions for the state, county, and region to tackle in order to move wastewater planning towards implementation. The so-called "tools report," formally titled"Enhancing Wastewater Management Planning, Administrative and Legal Tools" (Wright-Pierce, 2004), was an important direction at the time because only four of the 15 Cape towns had any active wastewater planning at all. Many of the actions detailed in the report were in the category of interim measures to assist the towns to set up and move through the Comprehensive Wastewater Management Plan (CWMP) process. The tools study not only produced recommendations but also provided a sustained period for key local official to discuss and become familiar with a host of scientific, regulatory, planning, technology, and management issues associated with wastewater planning that is directed towards TMDL compliance.

Between 2001 and 2005 the number of towns undertaking formal wastewater studies increased from four to nine. Beginning in 2006, the WIC transitioned to the newly established Cape Cod Water Protection Collaborative. Barnstable County established the collaborative to focus more political strength on assisting the region with the financing of wastewater infrastructure.

When the grant proposal was submitted to EPA for this project, the term "watershed permitting" was widely used. It was thought that watershed permitting would be required because many of the watersheds to coastal embayments are shared by two or more towns and because a single permit could collectively deal with multiple towns and multiple non-point and point sources of nutrients. The MassDEP simultaneously began a similar project that was also geared toward watershed permitting. However, comprehensive wastewater plans on Cape Cod were nowhere near advanced enough to begin the task of

permitting. The focus of the Cape Cod Commission's EPA grant was to assist the towns of Cape Cod with overcoming challenges to TMDL implementation. The project would focus on developing tools and information that would educate and support officials at all levels with the important task of moving from the scientific TMDL studies into wastewater planning. This report details the activities that were undertaken by staff to help Cape Cod communities "solve TMDL implementation challenges." Staff's work on TMDL implementation was divided into three areas: (1) regional work group items; (2) local-scale watershed group items; (3) regional planning and regulatory review; and (4) specific technical assistance areas as defined under the Phase II project amendment.

1.2 Working Group

The establishment of a working group was the first task of the grant. The Barnstable County Wastewater Implementation Committee members, comprised of representatives of several towns and agencies as listed in Table 1-1 below, volunteered for the project.

Table 1-1 EPA Working Group Members 2006

		EPA GRANT WORKING GROUP		Feb-06
Members	**Name**	**Address**	**Town**	
Barnstable	John Jacobson	DPW Town Hall Main St	Hyannis	MA 02601
Chatham	Bob Duncanson	Town Hall Annex 261 George Ryder R	Chatham	MA 02633
Falmouth	Amy Lowell	59 Town Hall Square	Falmouth	MA 02540
Harwich	Frank Sampson	109 Riverside Dr	West Harwich	MA 02671
Mashpee	Tom Fudala	Town Hall, Planning Dept.	Mashpee	MA 02649
Orleans	Augusta McKusick	PO Box 548	South Orleans	MA 02662
County Health	Sue Rask	BCDHE Superior Court House	Barnstable	MA 02630
CCC	Tom Cambareri	CCCommission 3225 Main St	Barnstable	MA 20630
CCC/MEP	Ed Eichner	CCCommission 3225 Main St	Barnstable	MA 20630
DEP	Brian A. Dudley	DEP-SERO Riverview Dr.	Lakeville	MA 02347
SMAST/MEP	Brian Howes	706 South Rodeny French Blvd	New Bedford	MA 02744-1
Wright-Pierce	Mike Giggey	99 Main Street	Topsham	ME 04086
Others				
Barnstable	Lindsey Counsell	PO Box 215	Osterville	MA 02655
Stearns and Wheler	Nate Weeks	255 Stevens Street	Hyannis	MA 02601
Orleans	George Meservey	Town Hall	Orleans	MA 02662
Barnstable	Mark Ells	DPW Town Hall Main St	Hyannis	MA 02601
CCC	Margo Fenn	CCCommission 3225 Main St	Barnstable	MA 20630
DEP	Claire Barker	One Winter Street	Boston	MA
EPA	Robert Adler	One Congress Street	Boston	MA
DEP	Madelyn Morris	One Winter Street	Boston	MA
Yarmouth	George Allaire	DPW Town Hall Route 28	Yarmouth	MA 02664

The working group included members from several of the larger towns on Cape Cod that were at various stages of wastewater planning, and Cape Cod Commission and MassDEP staff. Many of the representatives on the group were the same members of the earlier "tools report" working group and consultants in wastewater planning were welcome to attend. The Commission also hired a technical meeting facilitator using the EPA grant resources: the firm of Wright-Pierce of Topsham, Maine, the same firm that prepared the

"tools report." The consultant prepared notes and helped the working group focus on the project goals.

During the course of this study, staff and the working group were involved in numerous issues ranging from specific local scientific studies to comprehensive wastewater management planning. Regional discussions on many of these issues transitioned from the project's established working group to the more recently formed Cape Cod Water Protection Collaborative.

There was ample opportunity to leverage grant resources with other on-going and new initiatives including (1) MassDEP's EPA TMDL Pilot Project (DEP, 2008), (2) established regional and local watershed working groups, (3) various regional and state funded grant projects, and (3) revision of the Cape Cod Regional Policy Plan. There were also numerous opportunities for developing and applying new strategies; presenting grant project work items to various local and regional working groups; and incorporating the nutrient threshold findings of MEP Technical Reports into TMDL compliance strategies through Comprehensive Wastewater Management Plans.

1.3 Case Study Selection and Direction of Project

The working group met five times during the initial part of the project. Staff initially discussed the grant project and its goals and recommended that the Popponesset watershed should be the case study for this project. A nutrient TMDL for non-point source nitrogen had been adopted by DEP for Popponesset Bay in 2006, three towns shared the watershed, and the Town of Mashpee was engaged in a Comprehensive Wastewater Management Plan. The working group strongly believed that the grant activities should cover more than one watershed and also include the Pleasant Bay watershed. MassDEP (in its EPA-funded pilot watershed-permitting project) had already formed watershed-scale working groups from existing groups such as the Pleasant Bay Alliance and established new ones for Popponesset and Three Bays (Figure 1-1). Staff evaluated the working group input and proposed working on urgent items of technical assistance to both the Popponesset and Pleasant Bay watersheds. Staff's work in these watersheds supplemented the ongoing work of the MassDEP pilot project that would prepare a detailed characterization of the watersheds and their needs (DEP, 2008). Through this interaction and the already-established local watershed groups, staff was able to focus technical assistance directly on identified needs, as described in later sections.

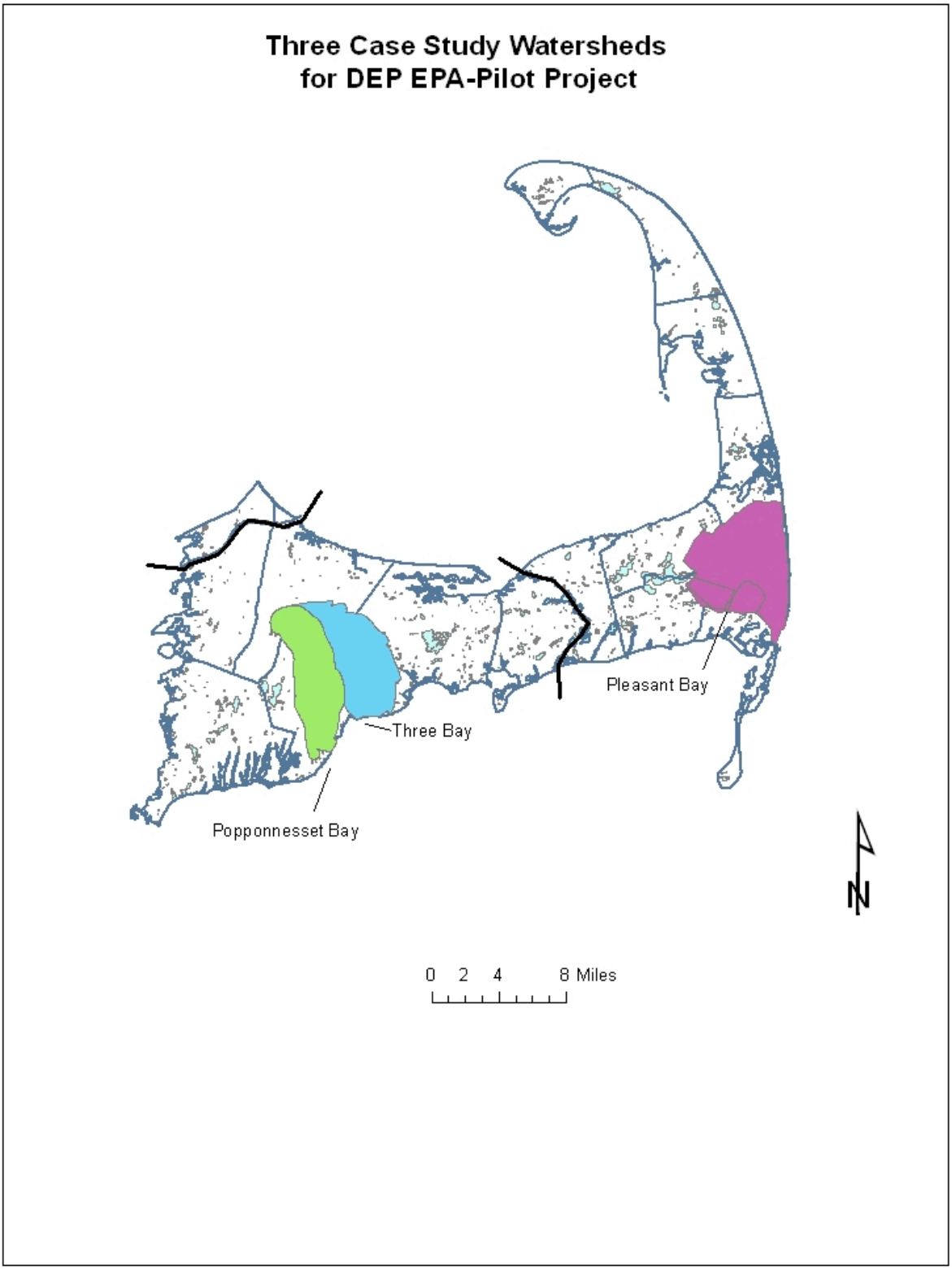


Figure 1-1 DEP pilot study watersheds that received technical services under the Cape Cod Commission EPA grant.

1.4 Enhanced Natural Attenuation

The regional working group was initially interested in how the results of the Massachusetts Estuaries Project (MEP) technical reports would be incorporated into CWMPs. Staff arranged a presentation by the MEP Project Manager at the second meeting. The focus of the presentation was to better understand the MEP technical reports and review potential methods to achieve TMDL compliance. The suggested methods included sewering, tidal exchange modification and enhanced natural attenuation. The working group identified the subject of enhanced natural attenuation as a significant TMDL challenge.

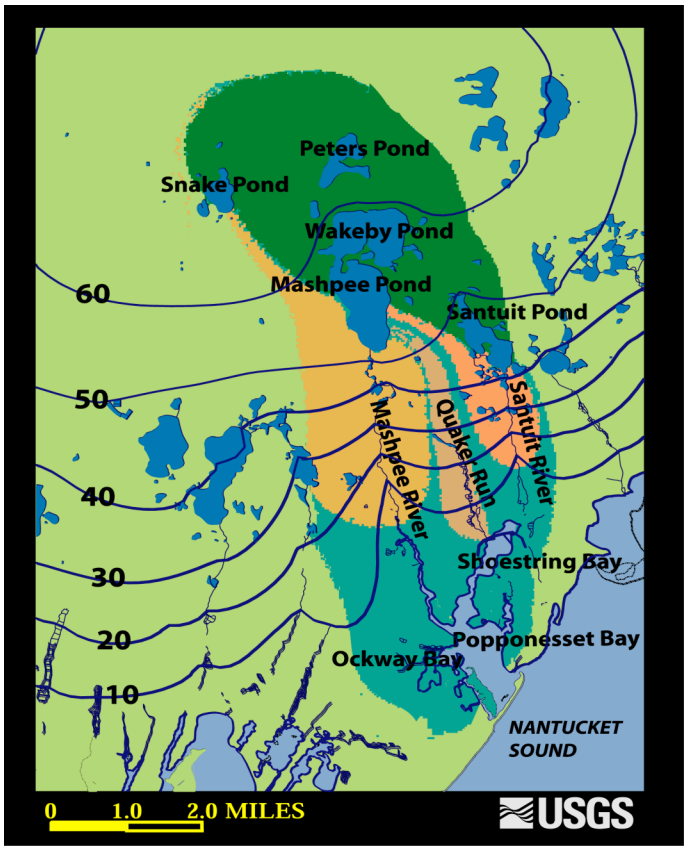


Figure 1-2 Popponesset watershed showing groundwater flow to ponds (green), streams (Yellow), and direct discharge into marine water.

The MEP, through water quality monitoring of marine and fresh water systems, demonstrated that nitrogen is attenuated in the fresh water systems of Cape Cod (Howes et al., 2001). These systems include ponds, creeks, rivers, wetlands, and bogs. Cape Cod is home to over 1,000 fresh water ponds. For example, groundwater modeling by the US Geological Survey estimates that over 46 percent of the water flow in the Popponesset Bay watershed passes through ponds (Figure 1-2). Groundwater flow recharges a kettle-hole pond on the upgradient side, and pond water is discharged back into the aquifer on the downgradient side (Figure 1-3). Nitrogen is taken up

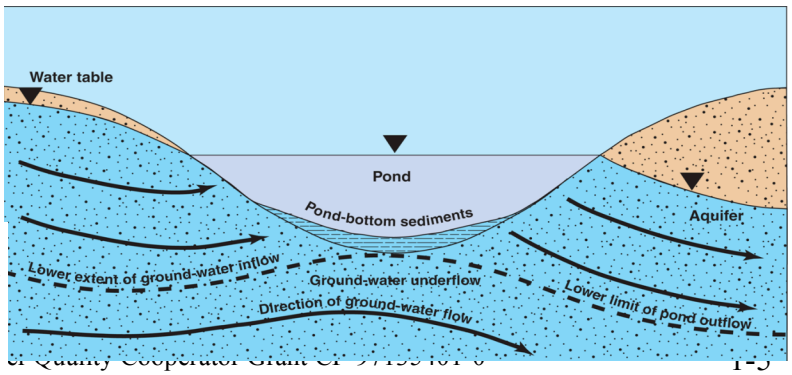


Figure 1-3 Cross-section showing groundwater flow into and out of a freshwater kettle-hole pond.

by freshwater plant and fauna in the water column and at the groundwater/pond sediment interface.

MEP technical reports and subsequent established TMDLs incorporate natural attenuation values of 50 percent for ponds and 30 percent for creek or rivers to decrease watershed nitrogen loads. Enhanced natural attenuation (ENA) is the modification of an existing freshwater system that enhances its ability to attenuate more nitrogen. This could be accommodated in several ways. A pond could be deepened to increase residence time, abandoned cranberry bogs could be dredged to increase volume and residence time, a brackish creek could be diked at an appropriate place to convert the brackish system into a freshwater system, or a tidal inlet could be opened to allow greater flushing.

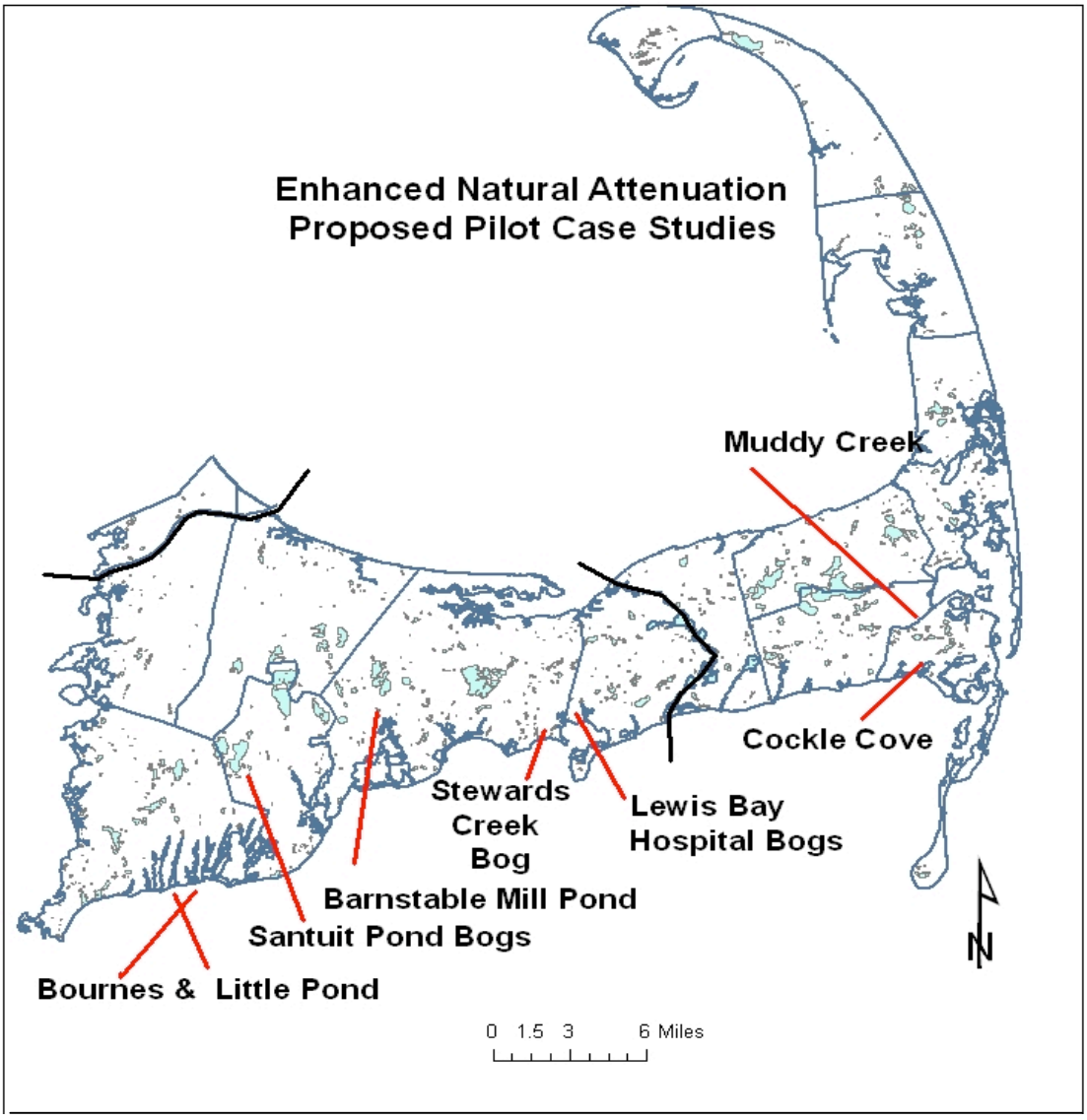


Figure 1-4 Enhanced natural attenuation case studies.

Staff worked with the regional working group to prepare summary documents of seven potential ENA projects on Cape Cod (Figure 1-4). The ENA projects included Bournes and Little ponds, Falmouth; Santuit Bogs, Mashpee; Mill Pond, Barnstable; Stewart's Creek, Barnstable; Hospital Bogs, Barnstable; Cockle Cove, Chatham; and Muddy Creek, Chatham and Harwich. Leldon Langley, a MassDEP wetlands expert, attended a subsequent and third meeting of the working group to discuss some of the regulatory framework for implementing ENA projects. This was an excellent transfer of regulatory knowledge in which MassDEP acknowledged the potential benefits of ENA but noted that (1) there are very few precedents for permitting of activities such as these; (2) MassDEP is actively establishing related policies and guidance to assist towns in evaluating and proposing such projects; (3) a literature review has been commissioned by MassDEP to summarize the technical issues related to the effectiveness of the natural attenuation; (4) MassDEP is able to comment only on certain state programs and can make no comments on related federal programs; and (5) a regulatory pathway for many of these projects may be possible if the benefits can be documented.

Cape Cod Commission staff had an opportunity to use the EPA grant resources to assist in a case study of enhanced natural attenuation and worked with the MassDEP Popponesset pilot group and SMAST to evaluate the potential of the Santuit Bogs for natural attenuation (Figure 1-5). This project is described in the DEP report and also as part of a technical memo from SMAST to the Town of Mashpee (Howes et al., 2007). Work included the characterization of the ponds and bogs and delineation of the recharge areas under both existing and proposed conditions, as if the bogs were to be turned into ponds. The Santuit Bogs proposal found that deepening the ponds had an insignificant effect to increase attenuation over what presently exists. However, SMAST did propose managing the flow through the bogs system to produce better results. MassDEP summarized that the enhanced flow-through system could be equivalent to sewering 90 homes (MassDEP, 2008). The outcome of the Santuit project was to consider the next steps to move the ENA pilot project along to include further field characterizations and permitting issues. At the writing of this report, the town had not pursued that action but continued to work on their CWMP to evaluate sewering alternatives.

In response to growing interest in natural attenuation, DEP used an EPA 104b grant to fund a literature review on the subject by the Woods Hole Group and Teal Partners (2007) entitled, "Final Report, Natural Attenuation of Nitrogen in Wetlands and Water Bodies, April 2007." The review indicated that natural attenuation was a phenomenon demonstrated in a number of studies and provided a flow chart to assist in selecting pilot projects. Cape Cod Commission staff participated in a MassDEP-sponsored workshop to discuss the findings of the natural attenuation report on April 25, 2007, in Harwich, Massachusetts. The Commission's written comments resulted in an addendum to the report that acknowledged natural attenuation that is part of the MEP reports and adopted TMDLs.

Cape Cod Commission staff has supported continued study of a number of the proposed case study systems. Over the course of the EPA project, staff reviewed and provided supporting comments on a tidal opening of Rushy Marsh in Barnstable (Figure 1-5), which is adjacent to the Three Bays watershed. Staff has also encouraged further study and evaluation of the Hospital Bog site shared by Barnstable and Yarmouth (Figure 1-5). Staff participated in the Cape Cod Water Protection Collaborative funding of a characterization of Muddy Creek, which is shared by Harwich and Chatham (Figure 1-5). The potential ENA project for Muddy Creek involved the diking of an upgradient reach of a brackish creek to turn it into a phosphorous-limited freshwater system that would not be nitrogen limited (and therefore not suffer from eutrophication) and would have the benefit of an enhanced ability to attenuate nitrogen (and thereby reduce the output of watershed nitrogen to the downgradient estuary). When presented at a public meeting to citizens living along the creek, the proposal received mixed reactions. The study was competed and is available on the Cape Cod Water Protection Collaborative web site (SMAST and ACRP, 2008). The Pleasant Bay Alliance recently began to evaluate increasing the tidal exchange of the creek with Pleasant Bay as another alternative.

Most recently, the Cape Cod Water Protection Collaborative funded a study to assist in better defining the regulatory hurdles toward implementing ENA projects. The collaborative selected Golledge Associates to work on the project, which began in spring 2009. Summary pilot project documents from this EPA project were forwarded to the consultants.

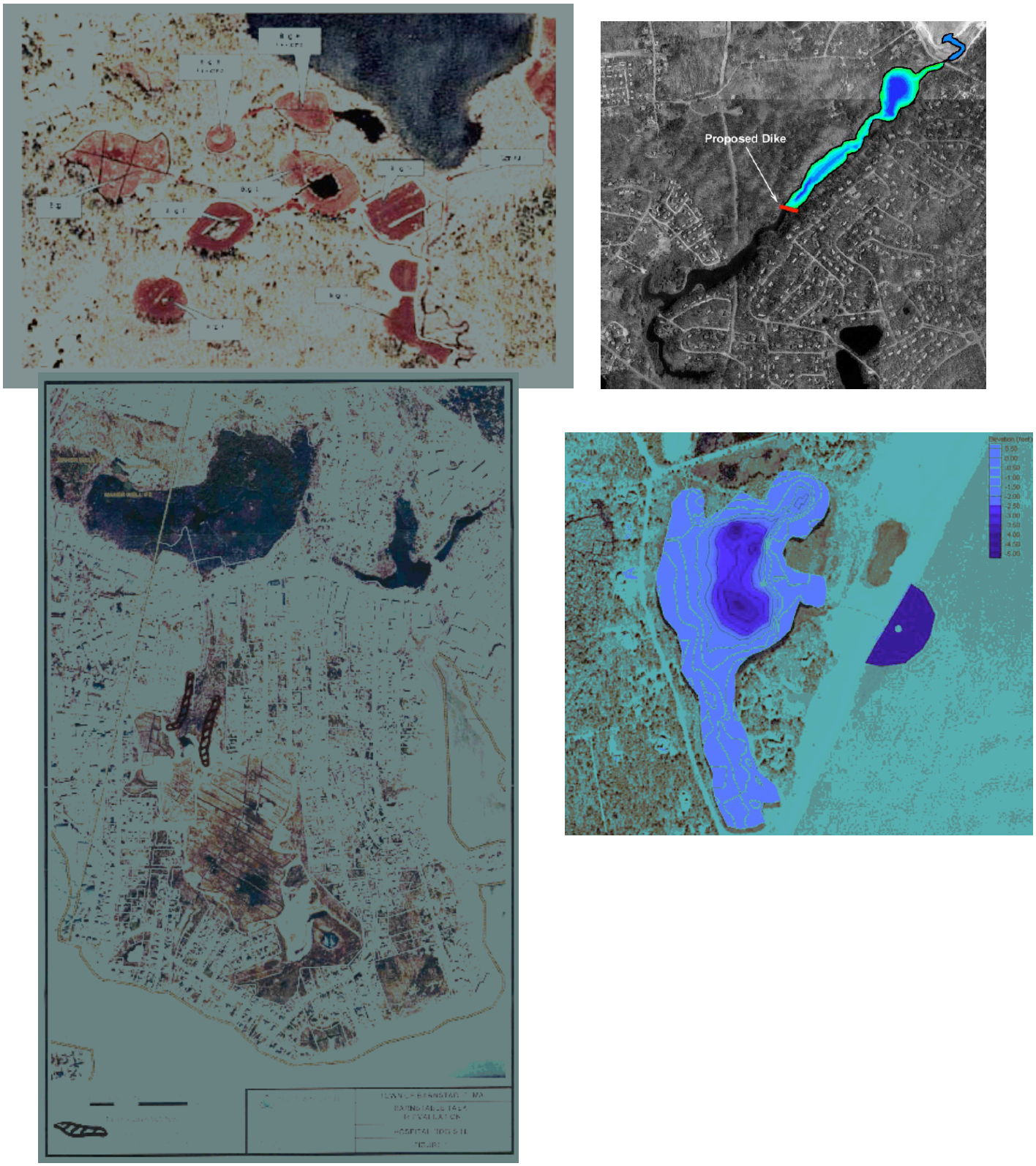


Figure 1-5 Selected ENA pilot photo images of Santuit Bogs, Mashpee; Hospital Bogs, Hyannis/Yarmouth; Rushy Marsh, Barnstable; and Muddy Creek, Chatham/Harwich (counterclockwise from upper left).

1.5 TMDL Allocations

Non-point source nutrient TMDLs are established to restore the water quality of impaired coastal embayment systems. The TMDLs are interpreted as the maximum load of watershed-derived nitrogen that can be assimilated by the coastal water. In many cases the TMDLs are segmented into sub-watersheds of major systems. Although the watershed is the resource-based framework for the TMDLs, the implementation of strategies to reduce daily nitrogen loads is often segmented into two or more towns that share different portions of the same watershed. When towns begin to discuss sharing TMDL compliance, they need to know just how much of the daily load is from each town. Similarly, when one town undertakes a strategy to comply with the TMDL, at present the legal starting point is to address only that load within that town's borders. This information is not readily available for the MEP Technical Report. Several groups asked Cape Cod Commission staff to help by determining the town's allocation of watershed TMDL loads.

Commission staff reviewed the MEP threshold reports and TMDLs and calculated the town's independent allocation of load. Commission staff prepared these allocations for Popponesset, Pleasant Bay, Three Bays, and Rock Harbor watersheds. The allocation results were shared as memos to the watershed groups and involved towns and were presented at a public meeting. In some cases additional detail or information was requested and the memos were revised (see Appendix D). The following is a summary of the response and use of the allocation information to further implement TMDLs on Cape Cod.

1.5.1 Popponesset

Staff worked with the MassDEP Popponesset pilot group that typically met in the Town of Mashpee. Popponesset was one of the first towns to receive a MEP Technical Report, and nutrient TMDLs in 2006. The watershed is shared by three towns: Mashpee, Barnstable, and Sandwich. MassDEP through its pilot project prepared the first allocation of nitrogen load from the MEP Technical Reports. After several discussions, the Popponesset working group asked Commission staff to prepare an allocation of the nitrogen load by subwatershed and town. These combined efforts led the way for several discussions about how the towns could allocate their responsibility to reduce nitrogen. The work of the committee on this topic is described in the pilot project report (MASSDEP, 2008).

To summarize, the committee used the allocations and a subsequent MEP scenario run to determine that a watershed-wide reduction of unattenuated nitrogen load of 49 percent would have the result of achieving TMDL compliance. This became the preferred allocation thrust of the working group. While viewed as a "fair share" of responsibility, it did not incorporate natural attenuation that occurred within the watershed. Because wastewater planning was being conducted only by the Town of Mashpee, there was little chance that the shared responsibility of nutrient reductions would be acted upon by other towns. However, the Town of Mashpee is presently awaiting scenarios runs on several

sewering alternatives that include areas beyond the town boundaries to achieve TMDL compliance. The allocation and natural attenuation were tied together in an assessment of opportunities for nutrient trading that will be discussed in the next section. Recently both the towns of Barnstable and Sandwich have begun initial steps to evaluate wastewater management for nutrient issues, so these ideas about allocation will be useful in the near future.

1.5.2 Pleasant Bay

Cape Cod Commission staff regularly attended the Pleasant Bay technical working group, a preexisting body of the Pleasant Bay Alliance. The alliance serves as a sub-regional watershed group for all matters on Pleasant Bay, with representatives from the towns of Chatham, Orleans, Harwich, and Brewster. It has a steering committee and its executive director chairs the technical working group meetings. The technical group became very focused on the nutrient management issues surrounding Pleasant Bay and assists the towns in coordinating water quality monitoring and other shared concerns. When Pleasant Bay received its MEP Technical Report and subsequent TMDL, members very quickly wanted to have a better understanding of their respective town allocation of load and responsibility. On May 1, 2007, the executive director submitted a written request for the Commission staff to undertake this work through the EPA grant. The staff calculated the allocation, prepared a memo, and presented the final version to the working group in May 2007.

Orleans and Chatham are the only towns with an active wastewater planning effort. The Town of Chatham has decided to sewer all of the town and, as such, did not need to use the allocation information (Chatham CWMP/FEIR, 2009). Orleans, on the other hand, has prepared a draft plan that incorporates the use of the allocation and has taken on the responsibility to reduce nitrogen within its portions of the Pleasant Bay watershed by 52 percent (Orleans CWMP DEIR, 2009). At this time, Orleans is reevaluating its plan and Harwich and Brewster are awaiting certain data to begin their work. Barnstable County awarded funds to Orleans through the collaborative to conduct a study of cost savings that accrue from regional solutions among the towns. The study found that, for Pleasant Bay, the most cost-effective solution for Brewster and Orleans to achieve TMDL compliance by reducing their allocated nitrogen loads was to undertake a regional effort (Wright-Pierce, 2009).

1.5.3 Three Bays

Cape Cod Commission staff met with the MassDEP pilot group on the Three Bays watershed in Barnstable several times. The Three Bays watershed is shared by the towns of Barnstable, Sandwich, and Mashpee, with the majority being in Barnstable. The group also asked the Commission to prepare an allocation of nitrogen load and responsibility. The allocations were calculated and presented to the working group (see Appendix). At the time of this effort, the Town of Barnstable was not engaged in wastewater planning for the watershed, so the allocation remains to be used. The town has just begun a

Nutrient Management Plan, so it is likely that the issue of allocation will be addressed in the near future.

1.5.4 Rock Harbor

The Cape Cod Commission prepared and submitted a draft allocation for the Rock Harbor system to the EPA. The Rock Harbor system is located in Orleans and drains to the north into Cape Cod Bay. Other systems associated with Rock Harbor include Namskaket and Little Namskaket creeks, which are not nitrogen overloaded. The Commission is awaiting the adoption of the TMDL by MassDEP and EPA before releasing it to the town.

1.6 Nutrient Trading

At the time of the EPA grant submittal, there was a desire by many to evaluate the opportunities for nutrient trading. Nutrient trading as a task item was included on the Commissions' grant application. The Commission prepared a draft scope for the task item that was reviewed by the working group and retained Dr. Mike Miller, a systems economist from Suffolk University, to evaluate nutrient-trading opportunities on Cape Cod. The consultant worked with staff to evaluate the nutrient-trading opportunities for Popponesset Bay. The consultant presented his findings to the working group at their September 2006 meeting. Dr. Miller presented his findings to the MassDEP pilot group in Mashpee and at the 2006 regional watershed conference ("Restoring and Protecting Coastal Waters") under this grant. The following is Dr. Miller's analysis of nutrient trading for Cape Cod:

> *A number of pollutant trading systems have been implemented and have generated significant quantities of trades, The best known of these designs trade greenhouse gasses such as carbon dioxide and sulfur dioxide. Typically, in these systems, an overall limit for greenhouse gases is mandated and then allocated to individual emitters, Credits are created by those greenhouse gas emitters who reduce their emissions to a level below their allowable limit. These credits are in turn purchased by other emitters and they allow the purchaser to avoid reducing their own emissions by the amount of the credit. Purchasers include emitters who have a mandated limit on their greenhouse gasses and can also include environmentally conscious individuals or organizations who, while not mandated to do so, want to offset their greenhouse gas emissions.*
>
> *Nutrient trading, as contrasted to emissions trading, has been explored in many settings and a number of systems have been implemented, but relatively few trades have been completed. Nutrient trading markets operate across a single water system and so tend to have many fewer participants. Fewer participants makes it more difficult for organizations that want to trade to find a counter party*

with which to trade and also makes it more unlikely that the two parties will arrive at a negotiated agreement.

There are a number of conditions required in order to have a functioning emissions or nutrient trading market. First, reductions must be mandated, If reductions are not required there is little incentive to achieve any reductions at all and less incentive to achieve excess reductions that would be translated into credits, There also would be scant incentive to purchase credits in the absence of mandated reductions, Second, reductions need to be measurable, If the reduction cannot be measured, there is no way of insuring compliance with mandated reductions nor is there any way of determining the number of credits created, The question of measurement is especially important if non-point sources are to be included in the trading system. Third, there needs to be varying costs of compliance. Assuming that no organization would sell credits for less than the cost of creating those credits, and that no organization would buy credits for more than it would cost them to reduce on their own, the costs need to be different across organizations for the possibility of a trade to exist. If the costs are different, a clearing price can be found between the costs of the two organizations and a trade can be consummated.

If we consider nutrient trading and specifically limit ourselves to nitrogen loading on Cape Cod, the third of these conditions, that the cost of compliance varies, is the most problematic. The great majority of the nitrogen on Cape Cod is generated by private septic systems. Nitrogen loading reductions would, for the most part, be accomplished by replacing private septic systems with sewer systems. While it may be cheaper to achieve equivalent reductions in one neighborhood or another (mostly due to differences in density) it is hard to imagine that the cost of reducing a kilogram of nitrogen load would vary greatly across towns. The cost of reduction does vary, however, if we consider attenuated load and if we are concerned with the nitrogen load that reaches the bay as opposed to the nitrogen load in the watersheds that feed the bay, This is because a kilogram of nitrogen that enters into a watershed far from the bay will naturally be reduced (or attenuated) before it reaches the bay, while a kilogram that loads directly into the bay will not be attenuated. Even if we assume that the cost of reducing a kilogram of load is constant, the cost of reducing a kilogram of attenuated load will vary; at the bay reduction of a kilogram of attenuated load requires a reduction of a one kilogram of nitrogen, while further from the bay more than a kilogram of load has to be eliminated (with accompanying higher costs) to achieve a one kilogram reduction in load reaching the bay.

Taking Popponesset Bay as an example, Figure 1-6 shows the percentage of nitrogen that reaches the bay (i.e., is not attenuated) from each area that discharges nitrogen into the bay. Reducing a kilogram of load in the dark green portion of the map (where there is no attenuation) results in a reduction of a kilogram of load in the bay. In the yellow portion of the map, however, 16.8

kilograms of load would have to be eliminated to achieve a reduction of 1 kilogram of load at the bay (because of natural attenuation only 5.95% of the 16.8 kilograms, or 1 kilogram out of the 16.8, would ultimately reach the bay from the yellow portion). If our goal is to reduce the load measured at the bay, it will be more cost effective to reduce nitrogen loading from the areas with the least attenuation. This suggests a basis for trades across towns; towns closer to the bay will find it less expensive to reduce nitrogen load to the bay compared to towns further from the bay. Conceivably a town close to the bay would be willing to reduce nitrogen loads more than required thus creating credits and a town further from the bay might find it advantageous to purchase these credits rather than reduce load themselves.

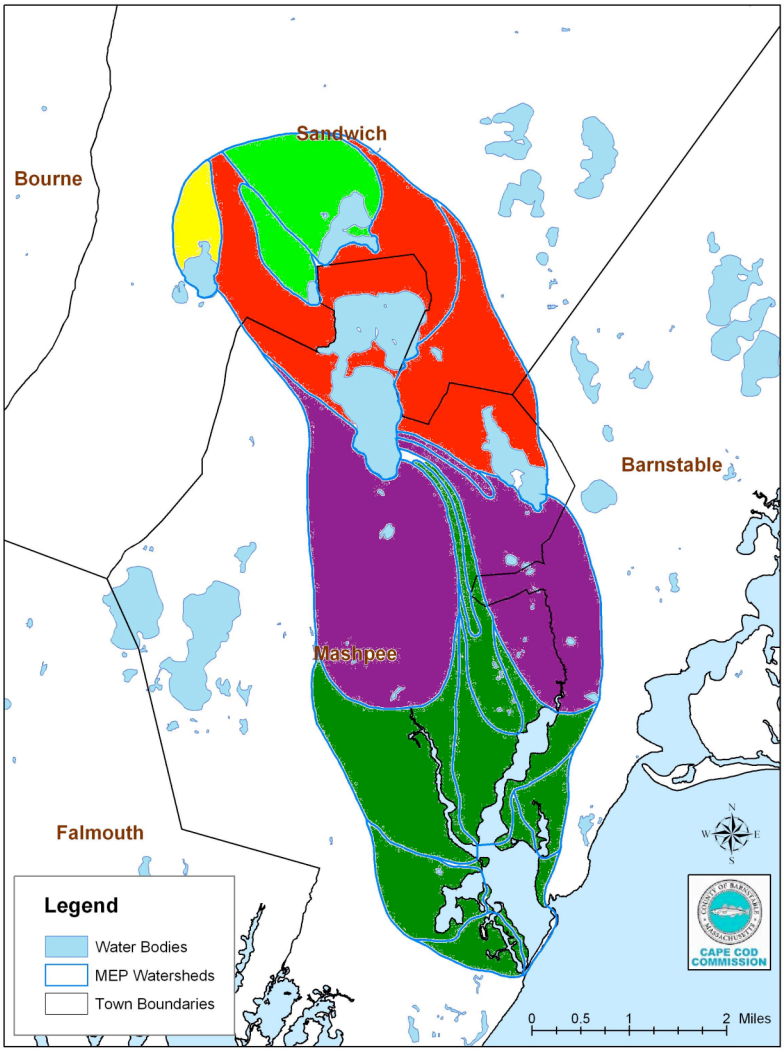
There are questions, though, about how this might work and in fact if it would be feasible in practice. First, recall that we are assuming that a significant portion of the reduction would come from sewering. A town that installs sewers can raise the funds to pay for the sewering by charging betterments to the residents whose homes are put on the sewer system. This is fair to any residents already on a sewer system who would not pay again for sewering. A town that does not sewer and instead purchases credits would not, in all likelihood, be able to charge a betterment and would have to purchase the credits using some other funding source. Besides the obvious questions of the availability of alternative funding and the impact on taxes in the affected town, this also raises potential questions of fairness if any portion of the town already has sewers.

There also may be some benefit to having sewers as opposed to septic systems (there is evidence, for example, that housing prices are greater, all else being equal, for a house on a sewer system as opposed to one with septic) and the town purchasing the credit would not receive this benefit. In fact, the town purchasing the credit would essentially be paying for any benefit received by the town installing the sewers. At the very least, this would suggest that the cost of the credit should be significantly less than the cost of creating the credit. In addition, presumably each town would have to meet a nitrogen target for each year.

A town may very well reduce their load below their required level in one year, creating a credit, but then because of additional development in the town would not have any credits, or have fewer credits, to sell in future years. A town that did not reduce their own load and instead relied on the purchase of credits would want to have a reasonable expectation that credits would be available for their purchase in future years. Since there will be few players in the market, purchasers of credits will not be able to rely on market forces to ensure availability of credits and instead would want to enter into long term contracts.

Putting this all together, it is doubtful that a working nitrogen trading market could exist among so few players, especially in the absence of significant outside intervention to coordinate agreements among the parties. We must keep in mind,

however, that the purpose of a trading system is to allocate effort to lower cost of the infrastructure. There are other mechanisms, such as reverse auctions, that could accomplish the same objective and might have a greater chance of success. These other possibilities should be investigated.



Percent of Load Not Attenuated
Yellow – 5.95%
Light green – 17.5%
Red – 35%
Purple – 70%
Dark green – 100%

Figure 1-6 Popponesset Bay watershed showing percent of nitrogen that contributes to the bay after natural attenuation within the ponds and streams.

1.7 "Restoring and Protecting Coastal Waters" Workshop

A significant task item of the EPA grant was to conduct a workshop to educate and assist communities to consider new regulatory, planning, and wastewater management strategies for non-point source nitrogen control within the context of existing development, regulatory structures, and goals for future growth areas in watersheds to coastal estuaries. Commission staff prepared a conceptual workshop agenda by staff and shared it with the working group. The working group established a conference subcommittee that provided regular feedback to staff. Staff partnered with the Association to Preserve Cape Cod to provide outreach and administrative help in registering guests. Several outreach efforts were used to enlist participants. Staff sent an initial post card to town officials to save the date, developed a flyer and sent it to town officials, carried an article about the conference in the Commission's newsletter *The Reporter*, and posted information about the workshop on the Cape Cod Commission and Association to Preserve Cape Cod web sites. Staff also sought sponsors to provide support, and the Community Foundation of Cape Cod provided lunch to enable a full-day conference.

The conference was divided into several sections including: TMDL Implementations, Science, Technology and Management, Regional Projects Overview, Creative Approaches, and a Panel Discussion of Regional Role and Opportunities. Program Agenda as shown in Figure 1-7.

Figure 1-7 Flyer from EPA-sponsored workshop

PROGRAM AGENDA

RESTORING AND PROTECTING COASTAL WATERS-
Local and Regional Efforts to Implement Total Maximum Daily Loads
and Opportunities for the Future of Cape Cod

Nov 16, 2006 • Harwich Community Center • Harwich, Massachusetts

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8:00 AM **REGISTRATION**

9:00 AM **Introductions**
Tom Cambareri, Cape Cod Commission

Opening Remarks
Linda Murphy, EPA Region 1, Director of Ecosystem Protection

9:30 AM **TMDL Implementation**
Science, Technology, Management

Mass Estuary Project Status
Brian Howes, U Mass Dartmouth, SMAST

Groundwater Modeling
Don Walter, US Geological Survey

Comprehensive Water Management Planning
Mike Giggey, Wright-Pierce

10:30 AM **REFRESHMENT BREAK**

11:00 AM **Regional Projects Overview**

Popponesset Bay Pilot Project
Tom Fudala, Mashpee Town Planner

Pleasant Bay Multi-town Case Study
Carol Ridley, Dir. Pleasant Bay Alliance

Nutrient Trading
Mike Miller, Suffolk University

12:00 PM **LUNCH**

12:40 PM **RECONVENE**

12:45 **Afternoon Remarks,**
Arleen O'Donnell,
DEP Commissioner

1:00 PM **Creative Approaches**

Effluent Recharge, Disposal and Reuse
Nate Weeks, Stearns and Wheler

Fiscal Infrastructure Planning in Chatham
William Hinchey, Chatham Town Administrator

Wastewater Management Planning in Yarmouth
David Young, Camp, Dresser, McKee

2:00 PM **Regional Role and Opportunities**
Panel Discussion

Citizen and Community Role/ Public Participation
Maggie Geist, APCC

Regional Regulatory Growth Mgmt/ Regional Policy Plan
Margo Fenn, Cape Cod Commission

State Regulatory Model/ DEP
Brian Dudley, DEP

Cape Cod Water Protection Collaborative Objectives
Paul Niedzwiecki, Water Protection Collaborative

2:30 PM Moving Forward Moderated Q & A

3:00 PM **CONFERENCE ENDS**

Speaker Biographies

Tom Cambareri, Cape Cod Commission – Water Resources Program Manager. Tom has over 27 years of experience dealing with water resources issues on Cape Cod. He has an MS in Geology from UMASS-Amherst and is a Certified Groundwater Professional and LSP.

Brian Dudley, DEP - Environmental Engineer. Brian has been an environmental engineer for the Department of Environmental Protection for 17 years. Brian was a local consultant after he received his MS in Environmental Engineering from UMASS-Amherst

Margo Fenn, Cape Cod Commission – Executive Director. Margo has been with the Commission since its inception and has been its Executive Director for 7 years. Margo was previously the Town Planner for Chatham and held similar positions across the Country. She has a degree in planning from UCLA.

Tom Fudala, Mashpee Town Planner. Tom has been the Town Planner for Mashpee for over 32 years. He has a BA from University of Pennsylvania and a Masters of Community Planning from Harvard. He is currently an elected member of both the Mashpee Sewer Commission and the Mashpee Water District

Maggie Geist, Association to Preserve Cape Cod - Executive Director. Maggie works to promote policies and programs that foster the preservation of the resources of Cape Cod, pass better laws, stop harmful development, create better communities and inspire residents to be activists and stewards. Prior to coming to APCC in January 2000, Maggie was the Research Translator at the Waquoit Bay National Estuarine Research Reserve. There it was her responsibility to make scientific information understandable to policy makers and the public. While at the Reserve, her work centered on the problem of excessive nitrogen delivery to coastal ecosystems.

Michael Giggey, Wright-Pierce – Vice Principal. Mike is a registered Professional Engineer who has been involved assisting Cape Cod Towns for over 25 years. He is currently the project Manager of the Orleans CWMP and technical consultant to the County EPA Working Group.

William Hinchey, Chatham - Town Manager.

Dr. Brian Howes, Coastal Systems Program, School of Marine Science and Technology UMASS-Dartmouth – Manager/Professor. Brian has been working on wetland and estuarine ecology and processes particularly the response of estuarine systems and habitat quality to nutrient enrichment since his postdoc work at WHOI. He has a PhD in from Boston University Marine Program and has published numerous research papers and major applied technical reports.

Dr. Michael Miller, Sawyer Business School of Suffolk University - Professor. Mike has his Ph.D. in Operations Research from MIT and has over 20 years of experience consulting to business, non-profit and governmental agencies.

Linda Murphy, EPA Region 1, Director of Ecosystem Protection. The Office of Ecosystem Protection is a multi-media office responsible for the air, surface and drinking water, hazardous waste, pesticides and toxics programs. The office also is responsible for the Indian and urban programs. Linda has worked for EPA since 1974 and has also worked in the air and Superfund programs. Prior to that she worked for USDA and for a local municipality. She holds civil engineering degrees from Tufts and U. Mass.

Paul Niedzwiecki, Town of Barnstable - Assistant Town Manger. Paul works with all Departments in the Town of Barnstable. Paul formerly worked at the MWRA and is Chairman of the newly established Cape Cod Water Protection Collaborative.

Arleen O'Donnell, DEP - Acting Commissioner. Prior to becoming Acting Commissioner, Ms. O'Donnell was Deputy Commissioner for Policy and Planning where she oversaw all policy and regulatory issues, strategic planning, information management and the office of research and standards. From 1989 to 2000, she was Assistant Commissioner in charge of the Bureau of Resource Protection (BRP), where she oversaw all water resources regulatory

programs as well as the water and wastewater State Revolving Fund program. Arleen has a BA in Zoology and Environmental Science from UMASS-Amherst and a MS from Tufts in Civil Engineering and Urban/Environmental Policy.

Carol Ridley, Ridley & Associates – Principle. Carol works with local governments and private businesses on environmental management, land use, transportation, and related public policy issues. She is currently serving as coordinator for the Pleasant Bay Resource Management Alliance, and for a growth management program of the Cape Cod Business Roundtable, in addition to her work with other public and private sector clients. Ms. Ridley has a BA in economics with honors from Trinity College, and a Master in Public Policy from the John F. Kennedy School of Government at Harvard University.

Don Walter, US Geological Survey – Hydrologist. Don has been a hydrologist for the USGS for nearly 18 years he has developed groundwater flow models for Cape Cod, Long Island and the Mass Military Reservation. He has a MS in Geology from the University of Missouri

Nate Weeks, Stearns and Wheler –Senior Project. Nate specializes in watershed management and has worked with the Towns of Falmouth and Provincetown to complete their recent CWMPs; and is currently working with Barnstable, Chatham, Harwich, and Mashpee on their on-going wastewater planning projects. Nate is also an adjunct professor at Cape Cod Community College where he teaches in the Environmental Technology and Management Program. He holds Bachelor and Master of Engineering degrees from Cornell's Agricultural and Biological Engineering Department.

David Young, Camp, Dresser, McKee – Vice President. Mr. Young has over 27 years of experience in wastewater planning, design and implementation services with many of those years spent on projects for Cape Cod communities. He has a BS in Civil Engineering from Tufts University and a MBA from Babson College. He is a registered professional engineer in five New England states including Massachusetts. Mr. Young is a Board Certified Environmental Engineer (BCEE) with the American Academy of Environmental Engineers (AAEE)

The conference sections were populated with principal speakers on their respective topics. Many of the presentations were summaries of projects that were partially funded through Barnstable County from 2003 to 2006 from wastewater management reserve funds. Linda Murphy from EPA and Arleen O'Donnell from MassDEP were keynote agency speakers. About 150 people, including town officials, watershed groups and citizens, attended the conference. Many new members from the recently established Cape Cod Water Protection Collaborative attended, as did as State Senator Robert O'Leary.

A videographer recorded the proceedings, which aired on public access TV. The Cape Cod Community College aired the conference multiple times. The Commission's staff created a CD with PowerPoint files of the presentations.

The staff prepared and distributed a questionnaire for feedback. The evaluations were extremely supportive of the conference and many respondents indicated that they had come away with important facts. Participants handed in approximately 45 evaluations at the end of the conference. Most of the feedback about the structure and format of the conference was supportive. Three questions at the end of the evaluation asked: (1) what are the odds of TMDL implementation?, (2) what are the impediments?, and (3) what needs to be done to insure successful TMDL implementation on Cape Cod? After ranking the answers 1 ("no good") to 3 ("good"), the average rating was 2.3, indicating that conference participants thought that TMDL implementation was a safe bet. "Cost of

infrastructure" was the overwhelming response to the question on the impediments to implementing CWMPs. "Education" was the overwhelming response to the question of what needs to be done. Other responses indicated the need for better regulations and a regional approach.

2 Regional TMDL Implementation

2.1 Cape Cod Regional Policy Plan

The Cape Cod Regional Policy Plan is the planning and regulatory document for Barnstable County that is implemented by the Cape Cod Commission through regional planning and economic development work, technical assistance to towns, and the review of Developments of Regional Impact (as defined by the Cape Cod Commission Act). The Regional Policy Plan addresses a number of issue areas (such as water resources, traffic, historical protection, and land use) and incorporates minimum performance standards for the regulatory review of development projects and for local planning consistency. Commission water resources staff worked to incorporate EPA nutrient-TMDLs into the Regional Policy Plan that was effective as a county ordinance in January 2009.

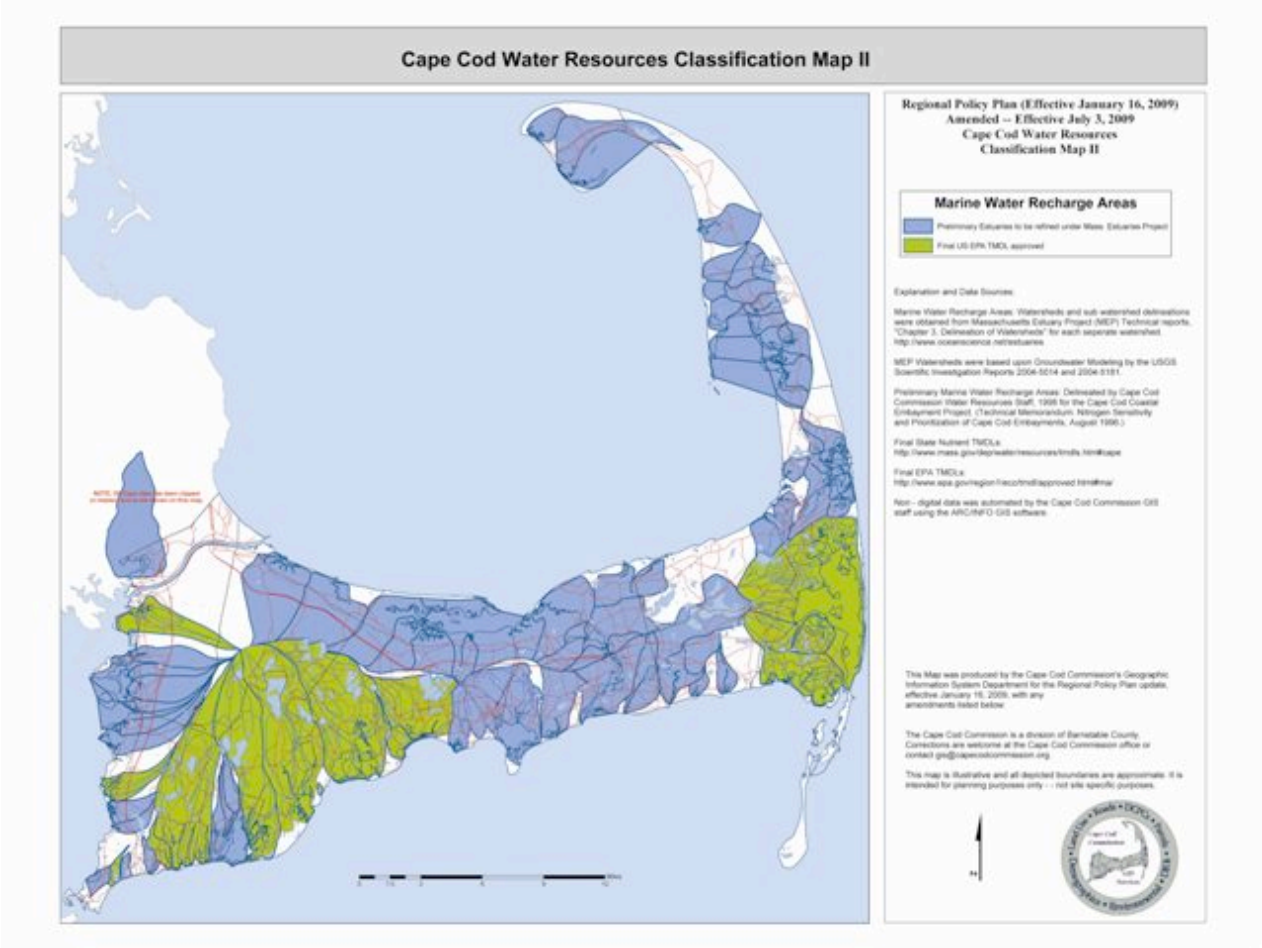


Figure 2-1 Regional Policy Plan "Water Resources Classification Map" showing EPA-approved TMDLs

The revised 2009 plan refers to EPA-approved coastal nutrient TMDLs in the "Water Resources" section and references them on a regulatory map referred to as Water Resources Classification Map II, as shown in Figure 2-1. Minimum performance standards referring to TMDLs are found in the section of the plan with the goal of restoring the ecological integrity of marine water ecosystems.

2.2 Implementing TMDLs through Regulatory Review

The previous versions of the Regional Policy Plan recognized that many of the Cape's embayments were suffering from water quality impacts associated with nitrogen from septic systems. The plan's minimum performance standards to maintain or improve coastal water quality were interpreted as the "no net" nitrogen load policy. This means that development in a watershed to a nutrient-overloaded system could not add any more nitrogen to the watershed.

The "no net" policy may be achieved by (1) providing wastewater treatment for the development or redevelopment and additional treatment capacity for nearby land uses, (2) installation of alternative denitrifying technologies for existing septic systems in the same Marine Water Recharge Area, and/or (3) an equivalent contribution of $1,550 per kg/yr of nitrogen towards a municipal or watershed effort that achieves the intent of the "no net" load policy. The implementation of the policy was fairly successful and was accepted by the towns and the regulated community. It resulted in increased levels of wastewater treatment from proposed package plants; the construction of package plants with excess capacity to hook in neighboring areas; and hundreds of thousands of dollars in mitigation funds for towns to pursue mitigation and/or Comprehensive Wastewater Management Plans. Most importantly, it resulted in an acceptance that coastal eutrophication was an important matter for Cape Cod and that better treatment of wastewater was required.

The 2009 Regional Policy Plan changed the "no net" policy to reflect the newly adopted TMDLs by MassDEP and EPA. The new performance standard is now an adopted TMDL reflected as a "fairshare." The fairshare is the TMDL equivalent load on a per-acre rate using the watershed and sub-watershed area. The Commission has been applying a no-net increase for over a decade and the establishment of the TMDLs allows the use of the fairshare method. Previous work under this grant (for Popponesset Bay, Pleasant Bay, Centerville River, Three Bays, and Orleans Northside embayments) to determine town-wide and sub-watershed allocations of the TMDLs are being used as a basis for determining fairshare. The following is the excerpted portion of the Regional Policy Plan in the "Marine Water Quality" section:

2.3 Regional Policy Plan Water Resources Goal – WR3:

Marine Water Embayments and Estuaries (Marine Water Recharge Areas)

To preserve and restore the ecological integrity of marine water embayments and estuaries.

The following Minimum Performance Standards shall apply to development and redevelopment in Marine Water Recharge Areas as shown on Water Resources Classification Map II.

Minimum Performance Standards
WR3.1Critical Nitrogen Load Standard for Development
In watersheds to estuaries/embayments where a critical nitrogen load has been determined, through either a Total Maximum Daily Load (TMDL), or a Massachusetts Estuaries Project-accepted technical report, development and redevelopment shall not exceed the identified critical nitrogen loading standard for impact on marine ecosystems, except as provided in WR3.3. The Commission shall maintain a list and map of estuary/embayment critical nitrogen loading standards that shall be the basis for applying this MPS; the list and map will be updated on a regular basis as TMDLs are approved by the Massachusetts Department of Environmental Protection and the US Environmental Protection Agency.

WR3.2 Maintenance or Improvement of Nitrogen Loading
In watersheds to estuaries/embayments where there are documented marine water quality problems and a critical nitrogen load has not been developed, including but not limited to those embayments shown on the Cape Cod Water Resources Classification Map, development and redevelopment shall maintain or improve existing levels of nitrogen loading, except as provided in WR3.3 and WR3.1.

WR3.3 Local Management Plans
In lieu of the requirements set forth in MPS 3.1 and 3.2, in watersheds with Commission-approved watershed nutrient management plans, or Commission-approved comprehensive wastewater management plans, nitrogen loading from development and redevelopment shall attain the nitrogen loading limit specified by the plan.

WR3.4 Nitrogen Offset Contribution
In watersheds to estuaries/embayments where development and redevelopment must meet either WR3.1 or WR3.2, development and redevelopment may meet these standards by providing an equivalent nitrogen offset contribution to be used toward meeting the intent of WR3.1 or WR3.2 as provided in the following paragraph.

The load requirements of WR3.1 and WR3.2 above may be achieved by providing wastewater treatment for the development or redevelopment and additional treatment capacity for nearby land uses, installation of alternative denitrifying technologies for existing septic systems in the same Marine Water Recharge Area,

and/or an equivalent contribution of $1,550 per kg/yr of nitrogen towards a municipal or watershed effort that achieves the intent of WR3.1 and WR3.2.

WR3.5 Monetary Contribution
In watersheds where the critical nitrogen load has not been determined, development and redevelopment may be required to make a monetary contribution toward the development or implementation of appropriate nitrogen management strategies not to exceed $20 per gallon of design flow of wastewater per day.

WR3.6 Public and Private Wastewater Treatment Facilities
Public and private wastewater treatment facilities may be used within Marine Water Recharge Areas subject to MPS WR5.2 and MPS WR6.1 through MPS WR6.9 below.

2.4 Regional Policy Plan Fairshare

The 2009 Regional Policy Plan recognizes the approved TMDLs as watershed management goals. Towards this end the Cape Cod Commission stepped away from the "no net" nitrogen loading policy and recognized that a private development is entitled to a "fairshare" of the watershed nitrogen load, as defined by the TMDL. Fairshare nitrogen limits serve as *critical nitrogen loads* referenced by MPS WR3.1 of the Regional Policy Plan, which effectively limit project nitrogen loads by acre. Fairshare limits may be used by local agencies that seek to compare project nitrogen loads with standardized thresholds.

Fairshare nitrogen limits are unit-area allocations of *target threshold watershed loads* of TMDLs that are published in state-issued TMDL reports and apportioned across watershed areas after natural nitrogen loads are subtracted and attenuation afforded by down-gradient ponds, streams, or wetlands is credited. The fairshare approach offers an equitable allocation of available nitrogen capacity to projects until comprehensive solutions are implemented. The fairshare is implemented in a similar fashion to the "no net" nitrogen-loading policy that allows reduction of loads through shared systems, expanded service areas, or monetary off-set. Because most of the Cape's embayment systems are overloaded, their apportioned share of nitrogen load per acre tends to be extremely low. For very sensitive embayments, the area required to meet the TMDL fairshare would be one residential house per eight acres.

Draft fairshare calculations have been developed for the following systems:

- Oyster Pond (Falmouth)
- West Falmouth Harbor (Falmouth)
- Phinneys Harbor (Bourne)
- Centerville River* (Barnstable)
- Three Bays* (Barnstable/Mashpee)

- Pleasant Bay* (Orleans/Brewster/Harwich/Chatham)

** Nearly complete: Finalization of fairshare calculations pending clarification of information from the MEP or release of MEP results for adjacent watersheds that share split-pond watersheds.*

Remaining systems for which fairshare calculations will be calculated include south-side watersheds in Chatham and Falmouth, Popponesset Bay, Waquoit Bay, and Lewis Bay, and systems for which results have not yet been released by the MEP.

The following is an excerpt of a Cape Cod Commission regulatory review project that involved the application of fairshare. This project was located in the watershed to Little Pond, which received a TMDL:

> *Nitrogen Thresholds*
> *The project is located in the Little Pond watershed. Little Pond is a nitrogen-sensitive marine embayment that is experiencing impact from development in its watershed. A critical nitrogen limit, or Total Maximum Daily Load (TMDL), has been established for Little Pond by the Massachusetts Estuaries Project (MEP). Based on the published TMDL, Commission staff has calculated a fair-share nitrogen limit of 2.20 kilograms-N per year per acre (kg-N/yr/a). Projects that are reviewed by the Cape Cod Commission as Developments of Regional Impact (DRIs) are required to meet critical (fair-share) nitrogen limits protective of nitrogen-sensitive coastal waters in accordance with Regional Policy Plan standards and the Cape Cod Commission's nitrogen-loading Technical Bulletin 91-001.*

Fair Share Nitrogen Limit	2.20 kg-N/yr/a

> *The proponent seeks to establish a one-year performance record of wastewater treatment before completing subsequent development phases. The Falmouth Conservation Commission (FCC) Special Condition #37 requires the treatment of wastewater effluent to a nitrogen concentration of 5 mg-N/L. Special Condition #40 further requires the project to meet a 3-mg-N/L nitrogen-loading concentration using TB 91-001. Parameters prescribed by TB 91-001 result in calculated nitrogen loads that generally exceed those used by the MEP.*

The project nitrogen-loading calculations were subsequently reviewed by staff to evaluate how the proponent could best meet the intent of the fairshare. The Commission has developed a "Turbo-Loader," which assists staff and project proponents to calculate nitrogen loading and to compare their respective mitigation amount under the fairshare.

2.5 Comprehensive Wastewater Management Plans

Comprehensive Wastewater Management Plans prepared by the towns are reviewed by the Cape Cod Commission as Developments of Regional Impact under the Regional Policy Plan. Commission staff plays a duel role in providing technical assistance to the towns on technical, planning, and management of wastewater issues, but is also a regulatory reviewer that recommends that the Commission either deny or approve a CWMP with conditions. Commission staff was involved in the review of several Comprehensive Wastewater Management Plans during the course of the EPA project. Although the regulatory review work conducted by the Commission is part of its everyday mission, a general common thread of each project review was TMDL implementation. In this respect Commission staff found it appropriate to keep our EPA contract administrator abreast of these activities. A summary of projects reviewed by Commission staff is included below:

2.5.1 Mashpee Needs Assessment and Notice of Project Change

The Cape Cod Commission reviewed a Notice of Project Change (NOPC) for the Watershed Nitrogen Management Plan for the Town of Mashpee. The NOPC was accompanied with a report entitled, "Town of Mashpee, Popponesset Bay and Waquoit Bay-East Watersheds, Needs Assessment Report." The Needs Assessment Report documents the significant level of effort that has gone into determining the Total Maximum Daily Load (TMDL) of nitrogen for the two subject embayments over the course of the last six years. The town took advantage of a number of opportunities including the MassDEP Pilot Project and the Cape Cod Commission TMDL Implementation Project, which were both funded through EPA. Through these projects, Mashpee, together with representatives of Barnstable and Sandwich, has been able to participate in the drafting of a TMDL nitrogen-loading allocation for each town and have discussions on potential nutrient-trading opportunities. Mashpee was also able to run a number of MEP alternative nitrogen-loading scenarios and to have an assessment of cranberry bogs and streams for potential additional natural attenuation. The town also received wastewater grant funds from Barnstable County to model sewer collection systems in the Popponesset watershed and technical assistance from the US Geological Survey and Commission water staff, to use a groundwater model to evaluate potential wastewater disposal sites. The identification of priority areas uses the Mashpee Planning areas as its fundamental building block. The Needs Assessment identifies Santuit Pond as being listed on the Clean Water Act 303d list of "impaired waters" and that the Cape Cod Pond Atlas identifies another 18 additional fresh water ponds that are impaired. The Needs Assessment contains a good characterization of the Private Sewage Treatment Facilities, including treatment efficiency and excess capacity. The section on existing infrastructure also includes a brief discussion on innovative and slternative septic systems. Staff participated in Mashpee's Sewer Commission meetings on the town's CWMP on November 5 and December 18, 2007. Their consultants have developed wastewater collection and treatment scenarios for achieving the TMDLs for Popponesset Bay and Waquoit Bay. This has included four sewer collection and treatment scenario and

one on-site plan scenario to be run by SMAST, as described in the section on MEP scenarios.

2.5.2 Falmouth South Coastal Embayment – CWMP

The Cape Cod Commission reviewed an Environmental Notification Form (ENF) for Town of Falmouth Comprehensive Wastewater Management Planning Project for the South Coast Watersheds including the Needs Assessment Report and Alternatives Screening Report for Little Pond, Great Pond, Green Pond, Bournes Pond, Eel Pond and Waquoit Bay. The Needs Assessment Report identifies wastewater needs within a study area that includes the estuary watersheds, while the Alternatives Screen Report reviews the potential technologies to address the identified needs. The Needs Assessment Report and Alternatives Screening Report provide the basis for the development of a draft comprehensive wastewater plan Environmental Impact Report. Staff conducted a technical review of the project and presented a report to the Cape Cod Commission, which forwarded comments to the Massachusetts Environmental Policy Act office. The town also received wastewater grant funds from Barnstable County (1) to receive technical assistance from the US Geological Survey and Commission water staff, to use a groundwater model to evaluate potential wastewater disposal sites, and (2) to conduct detailed hydrogeologic modeling of the most likely discharge site, the Falmouth Country Club. Through its review, the Commission supported the evaluation of the MMR as a potential shared regional facility for the Upper Cape as one alternative.

2.5.3 Chatham – CWMP

The Chatham CWMP is truly the first town-wide plan to be completed that incorporates the state and federal TMDLs to restore coastal water quality for several large coastal embayments. The CWMP/FEIR provides a strategy for wastewater management and reductions of nitrogen loading to restore and protect Chatham's marine embayments, addresses other Areas of Concern (areas experiencing high groundwater, failing systems, and industrial/commercial areas) and includes a topical Adaptive Management Plan for its implementation. The CWMP/FEIR proposes a 20-year implementation schedule for Phase 1 to construct wastewater facilities for the immediate wastewater and nitrogen management needs of the town. The CWMP/FEIR details a two-phased implementation program to meet nitrogen Total Maximum Daily Loads (TMDLs) in Stage Harbor, Pleasant Bay, Sulphur Springs, and Taylors Pond. Phase 1 actual wastewater flows are projected to be an average annual of 0.94 mgd. The actual Phase 2 wastewater flows will be 38 percent more than Phase 1, for an annual average flow of 1.3 mgd over thirty years. The extension of sewers to the remaining part of the town will take another 10 years with an estimated completion date of 2040. The estimated Phase 1 costs are $210 million dollars (in 2007 dollars) over the initial 20 years. The town has adopted a number of innovative approaches for funding the project. The town has established a Capital Facilities Plan with the goal of not having to raise the tax rate. However, it is acknowledged that modest tax increases will be necessary to meet the costs of the proposed plan. Expected homeowner charges are estimated at $3,000 to $10,000 for hook-up and $400 for annual operation and maintenance. The state and the Cape Cod

Commission reviewed this 11-year long project as a Draft Environmental Impact Report (DEIR) in 2008 and as a Final EIR (FEIR) in 2009. The Chatham CWMP/FEIR outlines an Adaptive Management Plan to help guide the 30-year implementation of the plan and to monitor its success. A discussion of the Adaptive Management Plan approach is found in Section 1.11.

2.5.4 Orleans CWMP

The CWMP provides a strategy for wastewater management to achieve reductions of nitrogen loading to restore and protect Orleans's marine embayments. The CWMP also addresses fresh water ponds; areas with septic system problems associated with frequent pumping, intensity of use, and mounded systems; provides modest capacity for expanded residential housing in the commercial district; opportunities for regional management; and an adaptive management approach for its implementation.

The CWMP proposes a core wastewater facility and sewer-collection system to serve 53 percent of the town to meet the nitrogen management and water-quality needs of the town. The project would be implemented in six phases over a 15- to 20-year period of implementation.

The phased sewer plan also accommodates septage and sludge handling and proposes five small package-treatment systems that will hasten nutrient removal as the plan is phased in. The phased plan also targets nutrient reduction through certain non-structural elements, including fertilizer control program, stormwater management, water conservation program coupled with a wastewater flow and load-reduction initiative, enhancement of embayment flushing rates, and land use controls.

The 2008 estimated cost of the CWMP is $150 million dollars over the 15- to 20-year implementation period. The average cost to a home owner is estimated at $2,600 per year. The town has adopted a cost-recovery policy that incorporates property tax assessment to pay for 80 percent of the costs and rely on betterments for the remaining 20 percent of the costs.

Commission staff have reviewed the needs assessment, alternatives assessment, and preferred alternative reports. Staff prepared and presented reports to the Cape Cod Commission, which forwarded comments to the MEPA office. The town received its MEPA certificate to proceed to Final EIR.

2.5.5 Sandwich

Commission staff has assisted the Town of Sandwich in developing a scope of work for a wastewater management plan that includes one component: a regional alternatives analysis that involves the four Upper Cape towns and the Massachusetts Military Reservation (MMR). Falmouth initially spearheaded the regional alternative with the MMR. The Town of Sandwich is looking to rapidly come up to speed to better engage in the regional discussions. The town is pursuing the use of Natural Resource Damages

Assessment Funds from the MMR as a funding source for its water/wastewater plan and received a $400,000 grant in September 2009.

2.6 Adaptive Management Plans and Compliance Reporting

The Commission is presently working on the Chatham CWMP, which is the first CWMP to deal with nutrient TMDLs for its coastal waters in a comprehensive manner. CWMPs are large public infrastructure projects costing hundreds of millions of dollars. The CWMPs, however, outline long implementation periods—two or more decades—to complete the project that will achieve compliance with the coastal TMDLs. The Commission, together with the town, has developed a draft Adaptive Management Plan approach for managing the regulatory review of such an extended project.

Commission staff identified an extremely useful web site on adaptive management that was developed by Foundations of Success (www.fosonline.org). Although the foundation's work was developed for conservation and habitat protection, it is generic enough to apply to long-term wastewater implementation projects that have ecosystem restoration as a goal. The following excerpt from the web site describes monitoring and associated evaluations:

> *Monitoring and evaluation involves the periodic collection and assessment of data about a specific project, program, or organization. People undertake evaluations for a number of reasons, including to expand the knowledge base (basic research), to determine compliance with a set of laws or standards (accounting and certification), to assess where a conservation entity is at a particular point in time (status assessment), and to determine whether a project or intervention is having the intended impact (effectiveness measurement). This last purpose – effectiveness measurement – is the goal behind most project or program evaluations. Within effectiveness measurement, there are two primary, but not necessarily exclusive, purposes for undertaking an evaluation:*
>
> ***Adaptive Management*** *to help people obtain the information they need to manage their projects, programs, or organizations more effectively and efficiently. This process involves determining which actions worked, which didn't, and why. The ultimate goal of adaptive management is to adapt and learn in order to improve an ongoing project or intervention.*

The following is draft language that the Commission and the Town of Chatham are negotiating:

> *The primary purpose of the AMP is to insure the cost-effective achievement of the Town's CWMP goal to restore impaired marine water quality and habitat. The CWMP will achieve this goal by sewering in the Phase 1 Area over the course of*

the next 20 years. There are several types of monitoring and evaluation components of the AMP:

- *Implementation Progress Monitoring,*
- *Groundwater Discharge Permit Monitoring of the facility, and*
- *TMDL Compliance Monitoring of marine water quality, plants and fauna.*

2.6.1 Implementation Progress Reports – Measuring Progress

Monitoring and reporting on the progress of the plan is one component of the type of review that the Commission and MassDEP will require to ensure that the CWMP is implemented. Major milestones for the project as described in the plan and this DRI decision are:

- Initial Sewer Area to be completed in 2012
- Phase I sewer areas shall be connected by year 2030
- Phase II sewer areas will be connected by year 2040

The following items shall be included for measuring progress on the plan's implementation including milestones where appropriate. Implementation Progress Reports shall be filed every two to four years, at the time of filing Project Evaluation Forms to the State Revolving Loan Fund (SRF) program, and include the following:

1) Capital Expenditures to date
2) Amount sewered
3) Percent removed from Phase I watersheds
4) Comparison to TMDL target amounts
5) Planned Capital Expenditures
6) Projected Expansion areas to be serviced in the next two years

2.6.2 Groundwater Discharge Permit

Monitoring according to the GWDP is another component of review that will ensure the treatment facility is complying with its treatment goals and compliance with the Regional Policy Plan and TMDLs of the receiving waters. Monitoring in the receiving waters downgradient of the facility will ensure that the reconfiguration of nitrogen loads in those watersheds (sewering to remove loads in the watersheds vs. additional loads from outside of the watersheds) will be protective of those resources.

- Convene Technical Review Committee to review Draft Permit
  Evaluate past monitoring
  Identify wells, parameters and frequency of monitoring
  Identify stream monitoring locations for flow and quality
  Identify marine water monitoring locations and frequency

- Provide for baseline measurements and phased in monitoring in adjacent receiving watersheds based upon phased in increases of discharge from the facility.
- Reporting to the Commission Annually
  - WWTP –Flow Rate – measured daily & monthly with averages
  - WWTF - Quality-influent/effluent monthly
  - Monitoring Wells - Annually
    - Groundwater quality -parameters such as ammonia, alkalinity should be added
    - TOC and PCPPs should be monitored every five years
    - Water Table Elevations to evaluate mounding
    - Stream flow – continuous stage recorder
    - Marine Water quality at Sentinel Stations - seasonally

2.6.3 Marine Water Quality and Habitat

Monitoring of marine waters in the targeted Phase 1 watersheds which presently exceed nitrogen-TMDLs will provide confirmation that the project's goals are ultimately met.

- Surface Water Quality– Seasonally with Report every 2 years
  - Marine –
    - Sentinel Stations
    - Others to be determined by the TRC (Streams, tributaries…)
    - Eelgrass – to be conducted by Mass DEP
    - Benthic – to be decided by the TRC but no less than every 5 years

2.7 District of Critical Planning Concern

The Cape Cod Commission Act enables the designation of specific resource-sensitive areas for special planning and regulatory efforts. The designation of a District of Critical Planning Concern, or DCPC, can augment existing local bylaws and regulations, allowing the creation and adoption of special rules at the local level to govern development within the district. So-called "grandfathering" protections normally afforded by Massachusetts zoning laws no longer apply once a DCPC is in place. The DCPC designation allows communities to protect resources that have been identified in the Regional Policy Plan or in a town's Local Comprehensive Plan as critical to the ecology, economy, character, or viability of the region.

The DCPC process begins with a nomination of an area, usually initiated by an individual town. Towns may also collaborate on a DCPC nomination to address shared problems or regional concerns. The Cape Cod Commission then considers the nomination and makes a recommendation for designation of the DCPC to the Barnstable County Assembly of Delegates. If the Assembly designates the District of Critical Planning Concern, the town

develops and adopts special "implementing regulations" for it. The town then regulates projects within the district's boundaries under those new rules.

Barnstable County recently designated a DCPC called the Brewster Water Protection District. The Brewster Water Protection District was established to protect drinking water resources and marine water resources of Pleasant Bay. The Town of Brewster adopted a Water Quality Protection Bylaw and a Sand and Gravel Mining Bylaw as implementing regulations for the district. The town also began comprehensive wastewater management planning by appropriating funds and establishing a water quality review board. The outline of the DCPC includes the wellhead protection areas of Brewster's wells and that of their neighbors, as well the Brewster portion of the marine embayment recharge area for Pleasant Bay (Figure 2-2).

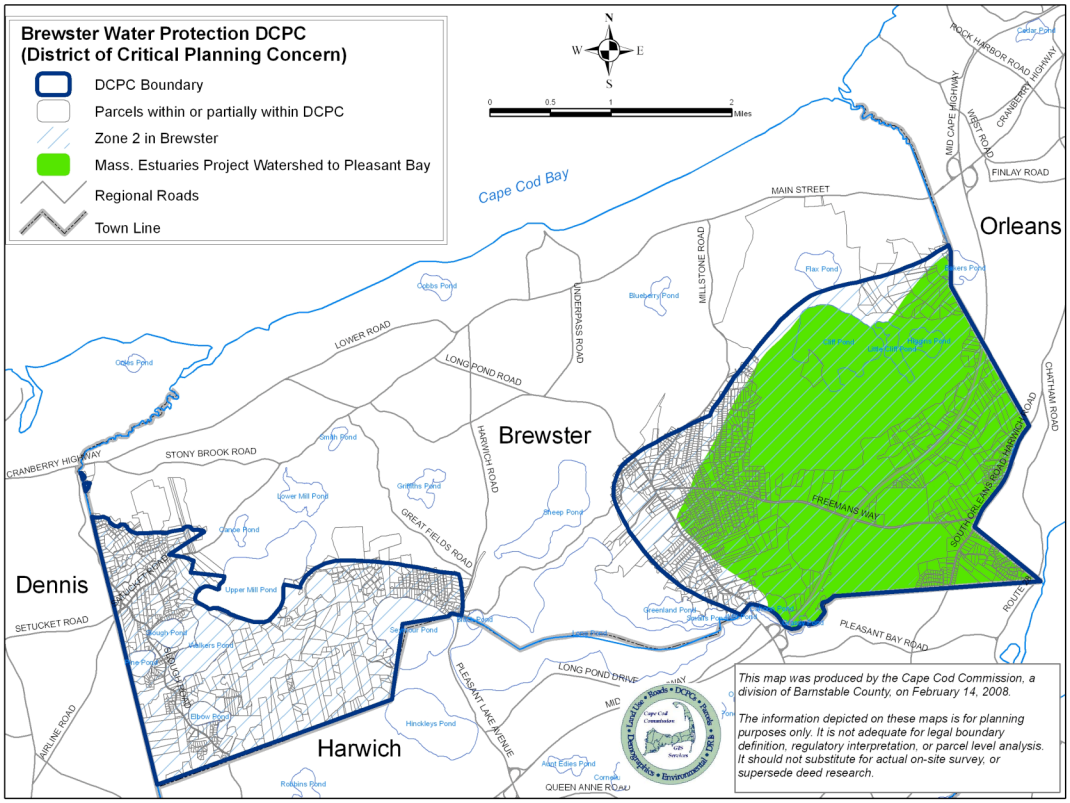


Figure 2-2 Brewster Water Protection District of Critical Planning Concern.

2.8 Cape Cod Water Protection Collaborative and the Environmental Bond Bill

The mission statement of the Cape Cod Water Protection Collaborative is the following: "To offer a coordinated approach to enhance the wastewater management efforts of Towns, the Regional Government and the Community, and to provide cost-effective and environmentally sound wastewater infrastructure, thereby protecting Cape Cod's shared water resources."

The goals of the collaborative are: (1) attract state, federal, and public-private revenue sources for financing assistance to the Towns for wastewater projects; (2) maximize regional cooperation and action in managing wastewater; (3) coordinate the development of infrastructure that is cost-effective, technologically efficient, and environmentally appropriate; and (4) educate the public concerning the contribution wastewater management makes to sustaining Cape Cod's economic and environmental health. (Barnstable County Ordinance 05-22; www.ccwpc.org)

A fundamental goal when the Cape Cod Water Protection Collaborative was established in 2005 was to identify and develop financing methods to support large wastewater infrastructure projects on Cape Cod. The passage of the Environmental Bond Bill was a significant development for the collaborative, which was included the identification Section 6 of Chapter 29C of the General Laws, as appearing in the 2006 official edition. The bond bill essentially recognizes nutrient issues as a fundamental concern of wastewater infrastructure plans and makes no-interest loans available for a period of 10 years. Since the bill was passed just last year, only one town, Chatham is far enough along to take advantage of it. The Commission staff is presently working with the state to develop specific regulations to guide compliance with the conditions of the loan program as outlined in the legislation below:

> *... permanent loans and other forms of finical assistance made by the trust to finance the costs of certain water pollution abatement projects on the department's intended use plan for calendar year 2009 to calendar year 2019, inclusive, that meet the criteria listed below shall provide for a subsidy or other assistance in the payment of debt service such that the loans and other forms of financial assistance shall be the financial equivalent of a loan made at a zero rate of interest, and the costs of water pollution abatement projects on the intended use plan that are eligible for a permanent loan made at a zero rate of interest shall not exceed 35 percent of the total costs of all water pollution abatement projects on the intended use plan. Projects that meet the following criteria, as verified by the department of environmental protection, are eligible for the zero rate of interest loans:*
>
> 1) *the project is primarily intended to remediate or prevent nutrient enrichment of a surface water body or a source of water supply;*

2) *the applicant is not currently subject, due a violation of a nutrient-related total maximum daily load standard or other nutrient based standard to a department of environmental protection enforcement order or unilateral administrative order, enforcement action by the United States Environmental Protection Agency, or subject to a state or federal court order relative to the proposed project;*

3) *the applicant has a Comprehensive Wastewater Management Plan approved pursuant to regulations adopted by the Department of Environmental Protection;*

4) *the project has been deemed consistent with the regional water resources plans if one exists;*

5) *the applicant has adopted land use controls, subject to the review and approval of the department of environmental protection in consultation with the department of housing and economic development and, where applicable, any regional land use regulatory entity, intended to limit wastewater flow to the amount authorized under zoning and wastewater regulations as of the date of the approval of the CWMP.*

2.9 Regional Wastewater Management Plan

The preparation of a Regional Wastewater Management Plan has been discussed by Barnstable County advisory groups since the Wastewater Implementation Committee of 2001–2006. The Cape Cod Water Protection Collaborative identifies the preparation of such a plan as one of its goals. In spring 2009 the collaborative entered into a contract with the Cape Cod Commission to compile regional and local information and begin the preparation of the Regional Wastewater Management Plan. Many of the project deliverable and tasks that Commission staff worked on under the EPA grant will be used within the plan.

The goal of the Regional Wastewater Management Plan is to articulate regional wastewater needs and identify major policy issues and resource needs to develop recommendations to capitalize on regional solutions. The plan is envisioned as a policy and guidance document, not a regulatory tool; however, work that identifies requirements that might be useful in the regulatory review of comprehensive wastewater management plans for regulatory approval would be formatted in a technical bulletin for Cape Cod Commission staff review. The most recent outline off the Regional Wastewater Management Plan with conceptual policy focus for each section is contained in the Appendix of this document.

3 Wastewater Planning Technical Assistance

3.1 Cape Cod Water Protection Collaborative

Cape Cod Commission staff worked with the Cape Cod Water Protection Collaborative to compile regional information on the present status of scientific work and wastewater planning on Cape Cod into a series of maps and tables. The Commission presented this work to the collaborative at its April 2008 meeting and then updated the collaborative's web site. The material has been particularly useful on a number of occasions for technical transfer of information.

Cape Cod Commission staff compiled information from a number of regional efforts including: (1) the status of the MEP project (Figure 3-1); (2) the status of established TMDLs (Figure 3-2); (3) regional watershed portrayal of percent wastewater reduction necessary to achieve TMDL compliance (Figure 3-3); (4) table of watersheds showing MEP and TMDL adoption periods; (5) table of town wastewater planning activities (or CWMP status); and (6) table of local wastewater contacts.

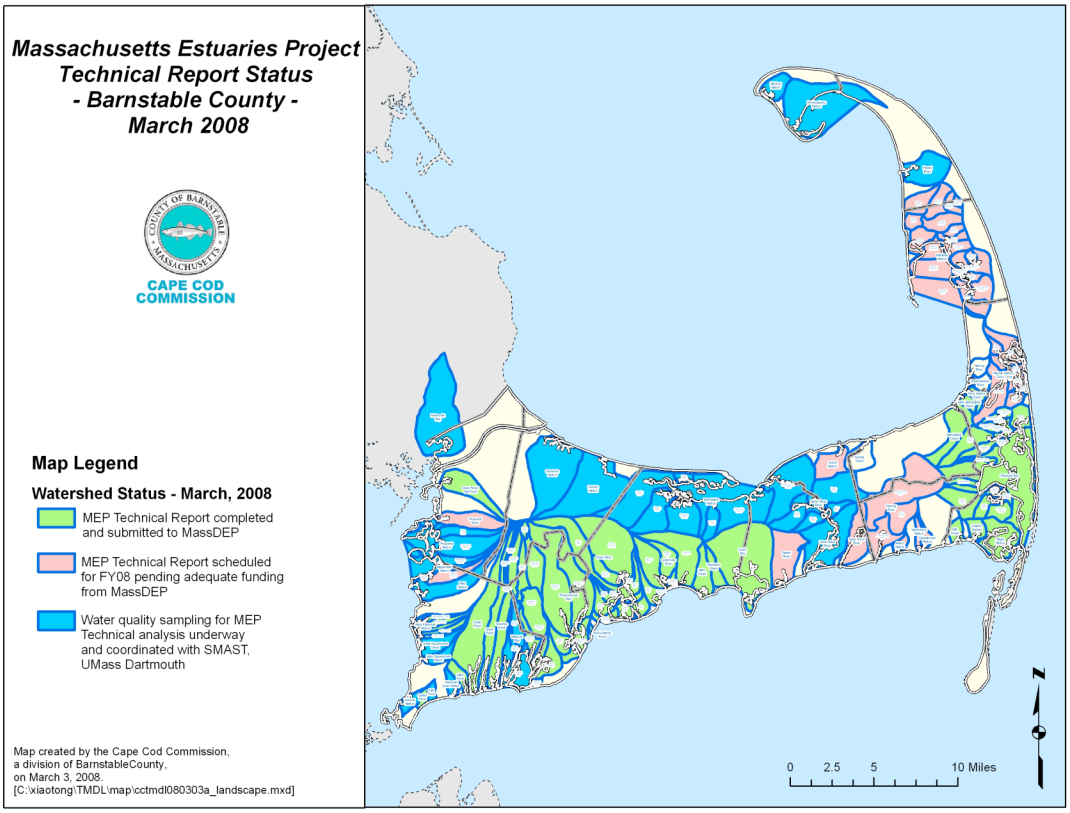


Figure 3-1 MEP Technical Report Status, March 2008.

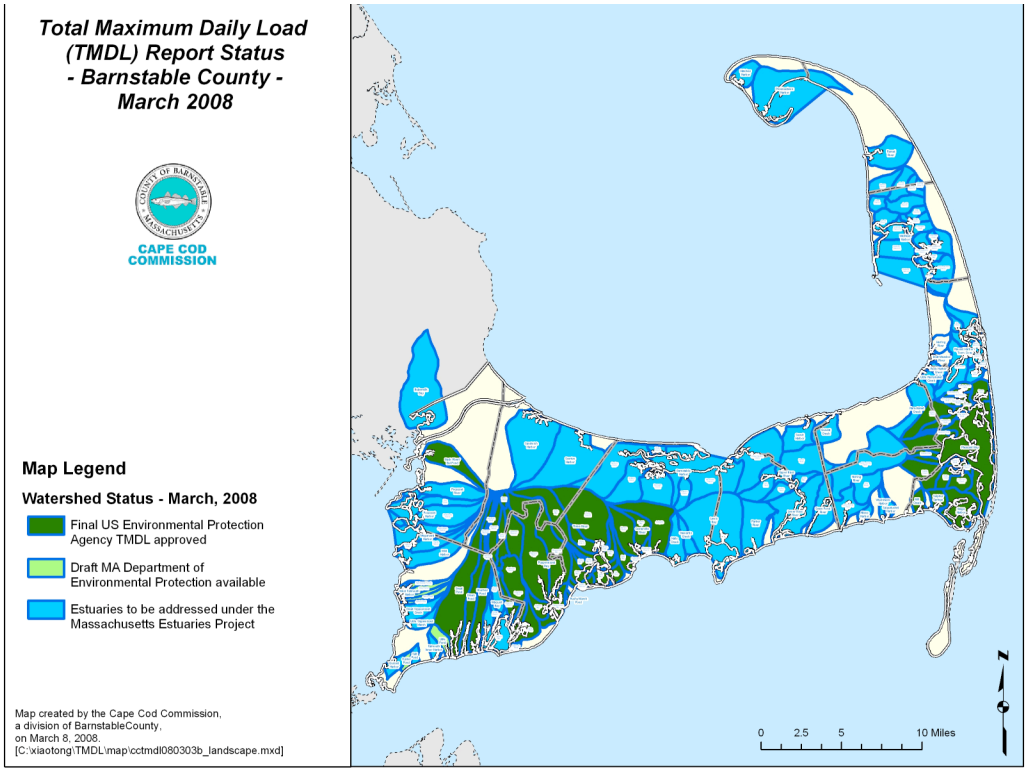


Figure 3-2 Watersheds to coastal embayments showing those with EPA-approved TMDLs.

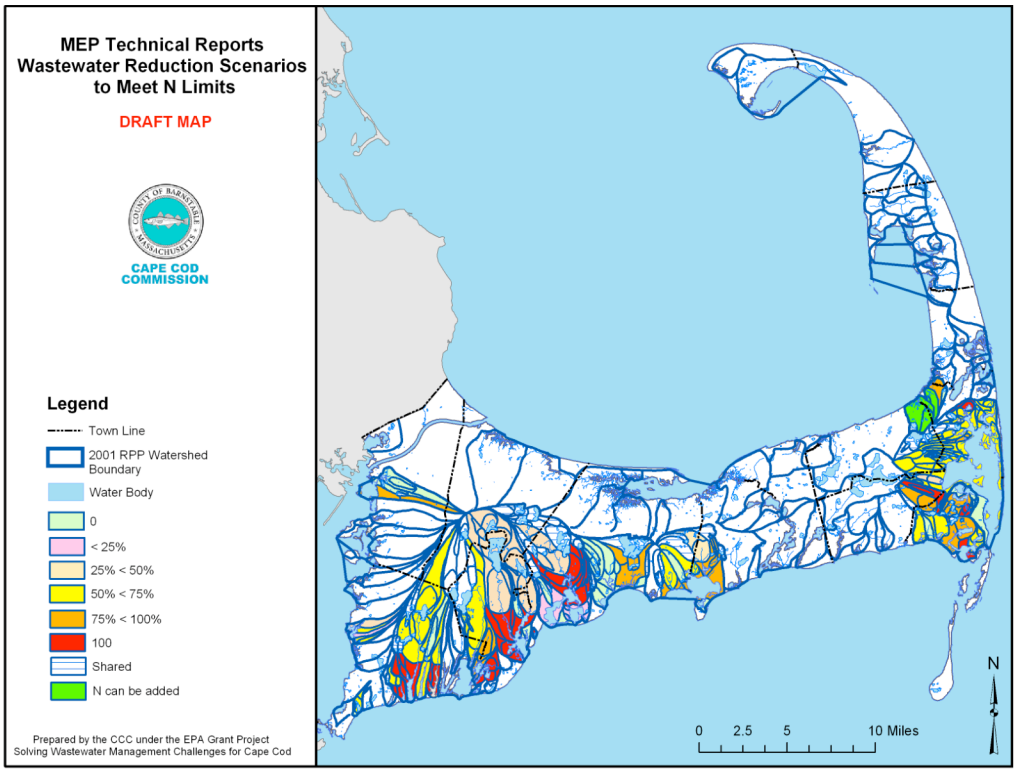
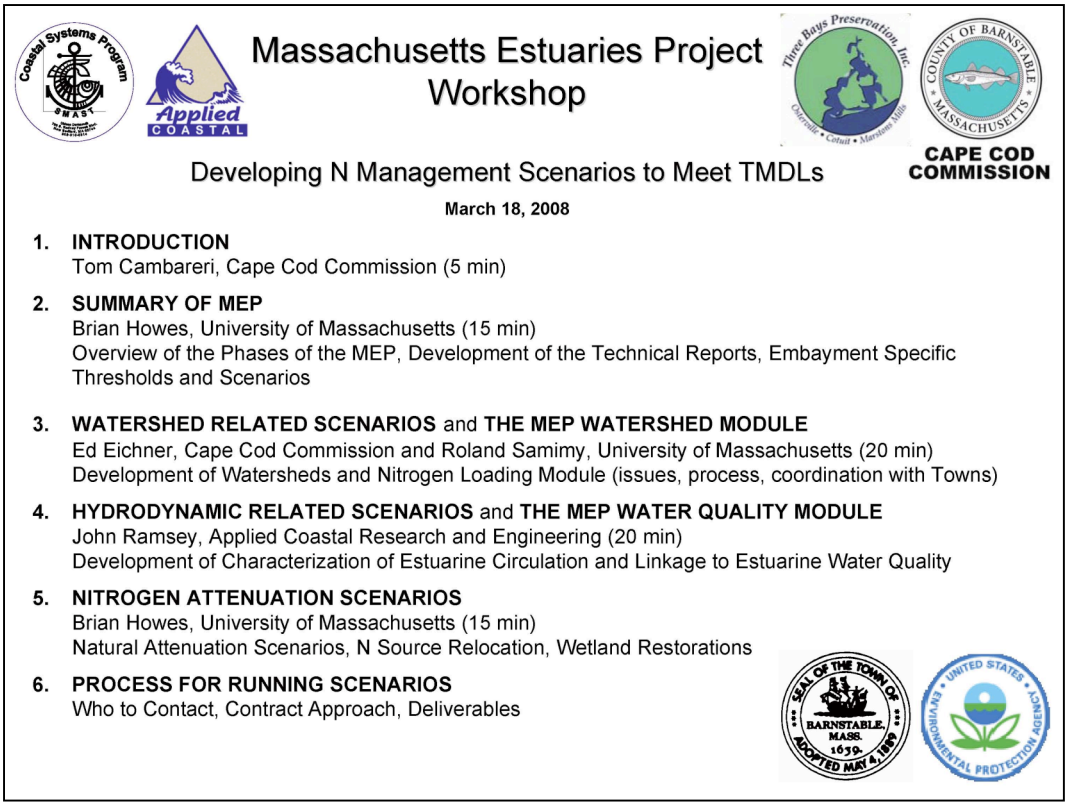


Figure 3-3 Watersheds to coastal embayments on Cape showing the amount of septic system wastewater that needs to be reduced to achieve restoration goals of the TMDL.

3.2 Understanding the Massachusetts Estuaries Project

3.2.1 MEP Workshop

The Massachusetts Estuaries Project (MEP) provides the scientific determination of nitrogen thresholds for each of the studied coastal systems of Cape Cod. These thresholds subsequently become the basis of the adopted TMDL by DEP and EPA. The inclusion of a "restoration scenario" within the technical report has become the fundamental information upon which all of the recent Comprehensive Wastewater Management Plans (CWMPs) on Cape Cod are based. While many are aware of this particular focus, many are not aware that the MEP method can also be used to test if other alternative sewering scenarios can achieve TMDL compliance. It has often been the case that the request from the town or its consultants is not formatted correctly or developed with sufficient detail with which the MEP Technical Team can work. To address this situation, Cape Cod Commission staff, through the EPA grant and partnering with SMAST and Three Bays Preservation of Barnstable, coordinated an MEP workshop for citizens and consultants. The focus of the workshop was to inform the public about the ability and process of working with the MEP Technical Team on scenarios.


Massachusetts Estuaries Project Workshop

Developing N Management Scenarios to Meet TMDLs

March 18, 2008

1. **INTRODUCTION**
   Tom Cambareri, Cape Cod Commission (5 min)
2. **SUMMARY OF MEP**
   Brian Howes, University of Massachusetts (15 min)
   Overview of the Phases of the MEP, Development of the Technical Reports, Embayment Specific Thresholds and Scenarios
3. **WATERSHED RELATED SCENARIOS** and **THE MEP WATERSHED MODULE**
   Ed Eichner, Cape Cod Commission and Roland Samimy, University of Massachusetts (20 min)
   Development of Watersheds and Nitrogen Loading Module (issues, process, coordination with Towns)
4. **HYDRODYNAMIC RELATED SCENARIOS** and **THE MEP WATER QUALITY MODULE**
   John Ramsey, Applied Coastal Research and Engineering (20 min)
   Development of Characterization of Estuarine Circulation and Linkage to Estuarine Water Quality
5. **NITROGEN ATTENUATION SCENARIOS**
   Brian Howes, University of Massachusetts (15 min)
   Natural Attenuation Scenarios, N Source Relocation, Wetland Restorations
6. **PROCESS FOR RUNNING SCENARIOS**
   Who to Contact, Contract Approach, Deliverables

Figure 3-4 MEP workshop agenda.

On March 18, 2008 at Barnstable Town Hall, nearly 30 people, including local officials, consultants, and representatives from regulatory agencies, attended the workshop. The project was video taped and subsequently shown on cable public access. The flyer from the workshop is shown in Figure 3-4.

Items covered under the workshop were:

1. When to contact the MEP team
    a. Pre-MEP report opportunity for scenarios
    b. Post-MEP report opportunity for scenarios

2. Meeting to discuss scenario and information the town/consultant should be prepared to bring and what the MEP will develop in response to document the exact conditions of the scenario.

3. How to contract with the MEP through the UMASS system and the expected costs ($2,000/scenario).

4. Delivery of a technical memo that will contain the results of the scenario as compared to the TMDL and initial restoration scenario.

Several towns (Mashpee, Barnstable, and Yarmouth) and consultants have followed through using this system to engage the MEP in scenario development and testing.

3.2.2 Mashpee Scenarios

Mashpee Sewer Commission identified five different management scenarios that would be pursued for evaluation and analysis. The five scenarios are as described by Stearns and Wheler in their report:

- Scenario 1 – No expansion of existing wastewater treatment facilities and construction of new plants
- Scenario 2 – Upgrade and expansion of existing facilities to a practical extent
- Scenario 3 – Decentralized approach
- Scenario 4 – Fair Share
- Scenario 5 – Centralized approach

In general, each scenario was prepared under a set of constraints as described below. Each scenario relied on the use of "sewersheds" (common to each scenario) from which wastewater would be collected. Each scenario also relied on a portion or all of the wastewater generated within the Falmouth portions of the Project Planning Area to be addressed outside of the Project Planning Area. Falmouth is currently developing a comprehensive wastewater management plan that will address this same area. Each

scenario also had the same sites available to it for wastewater treatment facilities (WWTFs) and treated water recharge.

Scenario 1 involves the continued operation of existing private WWTFs and construction of additional treatment facilities as needed to achieve the nitrogen TMDLs. The areas identified for wastewater management through innovative/alternative (I/A) systems and wastewater treatment plants are shown on Figure 3-5. Under this scenario 62 sewersheds were identified for sewering. New WWTFs are identified at Sites 2, 4, 6, and 11 with new treated water recharge at sites 1, 2, 4, 7, and 11. The scenario also includes approximately 380 properties on new I/A systems.

Scenario 2 is similar to Scenario 1: Existing WWTFs address those properties originally identified as being connected (now or in the future) to that WWTF. This scenario varies from the first one in that the existing WWTFs are expanded to the extent feasible to address neighboring sewersheds, and the treatment process is improved to achieve an effluent nitrogen concentration of 3 mg/L under the future condition. Under this scenario 61 sewersheds were identified for sewering. New WWTFs are identified at Sites 2, 4, 6, and 11 with new treated water recharge at sites 2, 4, 7, and 11. The scenario also includes approximately 50 properties on new I/A systems.

Scenario 3 is the decentralized approach. This includes the use of 15 cluster systems that will have their own collection areas with clustered facility and disposal sites. The proposed treatment level of the cluster systems is 3 ppm nitrogen.

Scenario 4 is based on evaluations initially considered as part of the MassDEP-funded Mashpee Pilot Project. The pilot project team determined that a 49.2 percent reduction of all existing (2001) watershed nitrogen sources (not including benthic flux or atmospheric deposition directly onto the embayment) throughout the entire Popponesset Bay watershed would achieve the nitrogen reduction necessary to restore estuary health (see discussion under Mashpee CWMP). Once this homogeneous reduction rate was decided upon, the scenario was evaluated by the MEP, and it was concluded that this reduction would achieve the MEP goals. A similar analysis that attempted to mimic the Popponesset Bay “fairshare reduction” scenario was applied to the Waquoit Bay East watershed as well. The calculations for that watershed (under existing conditions) resulted in a fairshare reduction of approximately 63 percent.

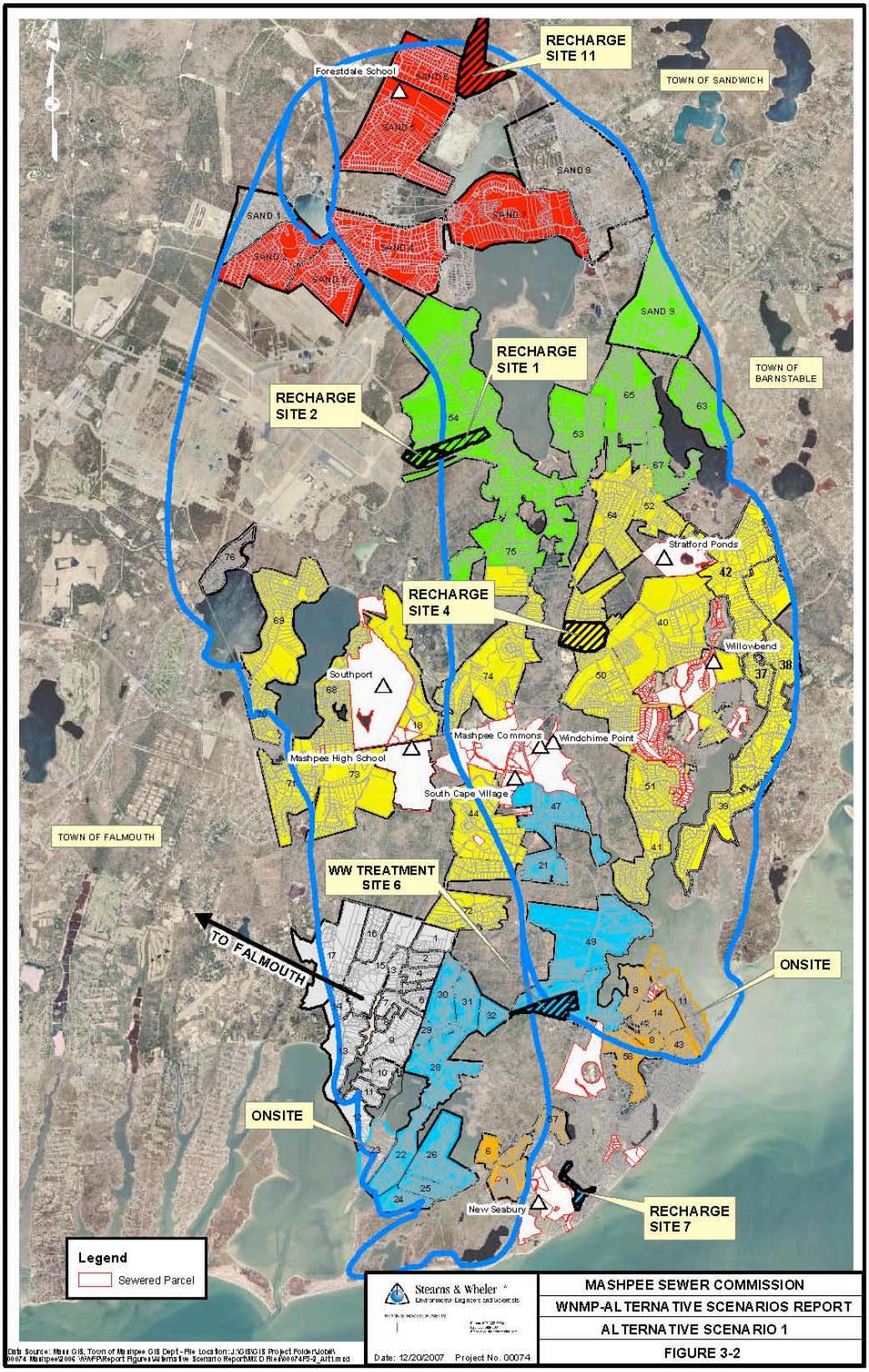


Figure 3-5 Mashpee CWMP/MEP scenario for Alternative 1. Colors represent sewer collection areas.

Under this scenario 58 sewersheds were identified for sewering. New WWTFs are identified at Sites 4, 6, and 11 with new treated water recharge at sites 4, 7, and 11. The scenario also includes approximately 130 properties on new I/A systems.

Scenario 5 involves wastewater treatment by means of centralized (municipal) wastewater treatment facilities. Although this scenario proposes that the flow from both watersheds be treated at a WWTF located on Site 4 (in the Popponesset Bay watershed), treated water recharge occurs at multiple sites within the two watersheds, with the intention of reducing the impact of significant changes to the volume of groundwater flow in either watershed.

This scenario includes the conversion of each of the existing private WWTFs (with the exception of New Seabury) within the Popponesset Bay and Waquoit Bay East to a pumping station. Wastewater treatment activities would cease at these facilities. New Seabury has significant capacity, is outside of the watersheds, and has the potential to service sewersheds that are at significant distances from proposed centralized facilities; therefore the continued use of this facility is recommended. The Forestdale School would serve as a pumping station to pump flow to a new WWTF located in Sandwich (Site 11). Under this scenario 61 sewersheds were identified for sewering. New WWTFs are identified at Sites 4 and 11 with new treated water recharge at sites 1, 4, 5, 7, and 11. The scenario also includes approximately 120 properties on new I/A systems.

The town requested additional GIS assistance from the Commission in order to create a unified land use database as a basis for the MEP scenarios. The Commission completed the work and the scenarios are presently under preparation.

3.2.3 Lewis Bay Scenarios

The towns of Barnstable and Yarmouth cooperated on developing MEP scenarios to evaluate potential shared infrastructure solutions for the Lewis Bay watershed, which they share. The towns requested that Cape Cod Commission staff review the results of MEP scenarios and suggest conditions for developing new scenarios. The MEP Technical report provides the background conditions and process for establishing nitrogen thresholds that will become the approved TMDLs for nutrient management. The MEP technical report provides a single restoration scenario and, in the case of the Lewis Bay report, three initial sewering scenarios and three additional requested sewering scenarios. The sewering scenarios include the present sewering condition for a portion of the Hyannis area and two different proposed Yarmouth scenarios described in the table and as shown on the maps below. The scenarios were run for existing and build-out conditions.

Table 3-1 Lewis Bay Scenarios

A	Initial Yarmouth district and removal from Watershed
B	Initial Yarmouth District with treatment and disposal at WPCF
C	Initial Yarmouth District with treatment and disposal at WPCF and Hospital Bogs
D	Larger Yarmouth District with treatment and disposal outside the Watershed
E	Larger Yarmouth District with treatment and disposal at WPCF
F	Larger Yarmouth District with treatment and disposal at Hospital Bogs

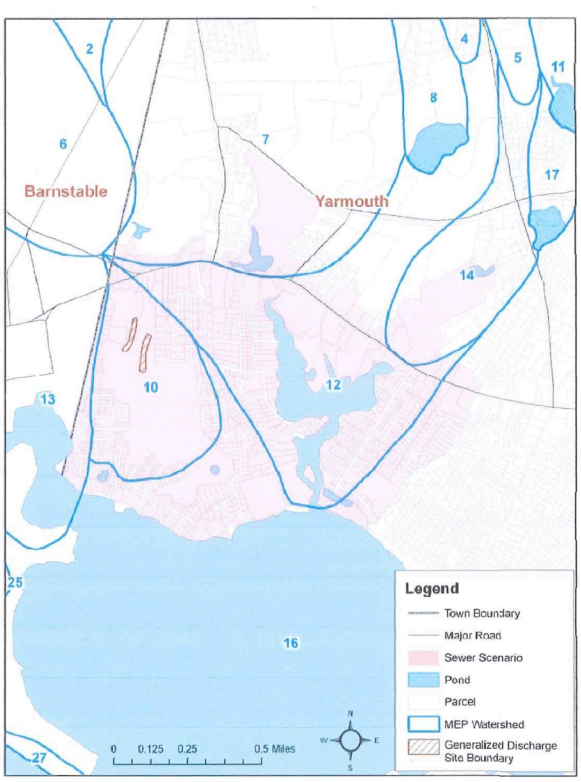


Figure 3-7 Initial Yarmouth Sewer District

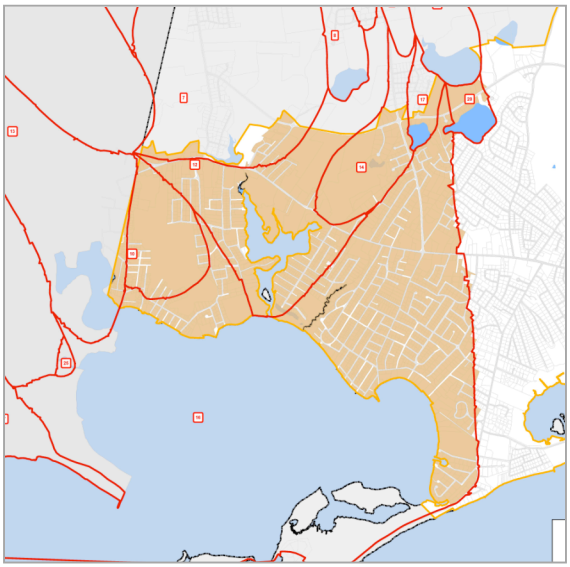


Figure 3-6 Larger Yarmouth Sewer District

It is evident from the MEP results that the loading in initial scenarios A, B, and C are above the Lewis Bay subwatershed restoration load contributing to the TMDL water column nitrogen concentration at the sentinel station being exceeded at BHY-3. When the sewering in Yarmouth is greatly expanded to the Lewis Bay subwatershed boundaries in the scenarios D, E and F, the load to overall Lewis Bay is significantly reduced resulting in the TMDL to be met under existing conditions. It is also the case that the loads to Snow's and Stewart's Creek at existing conditions are under their respective restoration

loads when half the flow is discharged in the Hospital Bogs. The Hospital Bog creek is over the restoration load for that same case, as expected. It appears that water quality conditions in Hyannis Harbor and its subwatersheds have little contribution to the condition of Lewis Bay exceeding the TMDL concentration.

Under build-out conditions, although the loads are less than the restoration load for the Lewis Bay subwatershed, there is enough additional load from Snow's Creek, Hyannis-Inner Harbor, and Mill Pond subwatersheds resulting in the TMDL concentration at the sentinel station of 0.38 mg/l to be exceeded. At build-out conditions, nitrogen loads to Mill Pond are significantly above its restoration threshold and Mill Creek is slightly above its restoration load. Hospital Creek is slightly above its restoration load except for scenario F when effluent is discharged in proximity to the Hospital Bog. Both Stewart's and Snow's creeks are over the restoration load at build-out, even when the effluent discharge is out of the watershed.

Staff suggested a number of issues to take into consideration in the development of subsequent scenarios:

- Future sewer scenario for Hyannis Area that has all the relevant AOCs hooked up to the Water Pollution Control Facility (WPCF).
- Evaluate large build-out parcels in Yarmouth in Mill Pond Watershed.
- Consider sewer extension to Yarmouth side of Willow Street and perhaps Mill Pond.
- Evaluate total wastewater flows at WPCF under the above conditions and determine if additional modeling is required to estimate nitrogen loading to receptors.
- Review Adaptive Management Plan requirements for AOC sewer design and monitoring effluent and water supply interactions in the face of new groundwater discharge permit regulations.
- Determine outcome of load reduction and increase in Halls Creek from sewering and discharge in the watershed under future sewer scenario.
- Review total flow allocation to the WPCF to determine how the addition of 0.5 MGD of Yarmouth flow could be phased or prioritized within the existing allocation.
- Use lower, more recent nitrogen concentrations at the WPCF that are consistent with MEPA/DRI approval requirements.
- Provide additional scenarios to determine an allowable amount of discharge near Hospital Bogs to increase effluent relocation flexibility.

3.3 Groundwater Modeling

Cape Cod Commission staff coordinated a Barnstable County-funded USGS project that evaluated hydrogeologic and watershed issues associated with potential new discharges on a sole source aquifer. Barnstable County contributed $200,000 from the Wastewater Management Reserve Fund towards this $270,000 project. Over the period of the USGS project, from 2003 to 2006, 140 hypothetical modeling scenarios were run to evaluate 51 potential sites, 12 existing sites, and 2 public well fields to assist towns in identifying and screening suitable sites for future wastewater discharges. The project was instrumental in resolving a number of outstanding issues advancing wastewater planning for those participating towns. The USGS recently issued their final report on the project entitled, "Use of Numerical Models to Simulate the Transport of Sewage-derived Nitrate in a Coastal Aquifer, Central and Western Cape Cod, Massachusetts," which is now on the Cape Cod Water Protection Collaborative web site.

Since the project came to an end, however, the absence of these modeling services created a void and although the USGS project provided reliable and significant technical assistance to the towns, there is a general lack of understanding among decision makers about how these models work. The goal of this task was to improve the understanding of the use of groundwater modeling to screen and provide specific information of existing and new treated wastewater effluent recharge sites.

3.3.1 Commission Initiative

Commission staff has had continuing discussion with the Cape Cod Water Protection Collaborative and others on the need for and the use of groundwater models relative to watershed boundaries and evaluating wastewater disposal sites. Barnstable County awarded a $35,000 grant to the town of Mashpee to undertake more detailed analysis of a particular disposal site in the Waquoit Bay watershed that is shared with Mashpee.

The Cape Cod Commission began an initiative to learn and apply the US Geological Survey's groundwater models of the Sagamore and Monomoy lenses. The focus of the initiative was to use the models to assist the towns in evaluating water resource interactions between wastewater discharges and water supply wells, ponds, and coastal embayments. The Commission obtained a license to proprietary software called "Groundwater Vistas" for another modeling use as the first step of the initiative. Staff downloaded input codes from the USGS web site and obtained some limited instruction. Staff conducted several modeling projects for the towns as described below.

3.3.2 MEP Watersheds

The USGS initially delineated the Harwich watershed boundaries for the MEP project. Review of the work found that several freshwater ponds and streams that drain into

Wychmere Harbor were not specified by SMAST to be included in the model. The review indicated that the watershed for Wychmere Harbor would be influenced by the addition of those characteristics and that the model needed to be revised. Commission staff obtained stream-flow data for the streams from SMAST, modified the boundaries by including the drain and ponds into the model, and ran the simulations with particle tracking. The watershed was re-delineated and incorporated into the MEP land use model component of the MEP model, which will lead to an accurate watershed nitrogen loads.

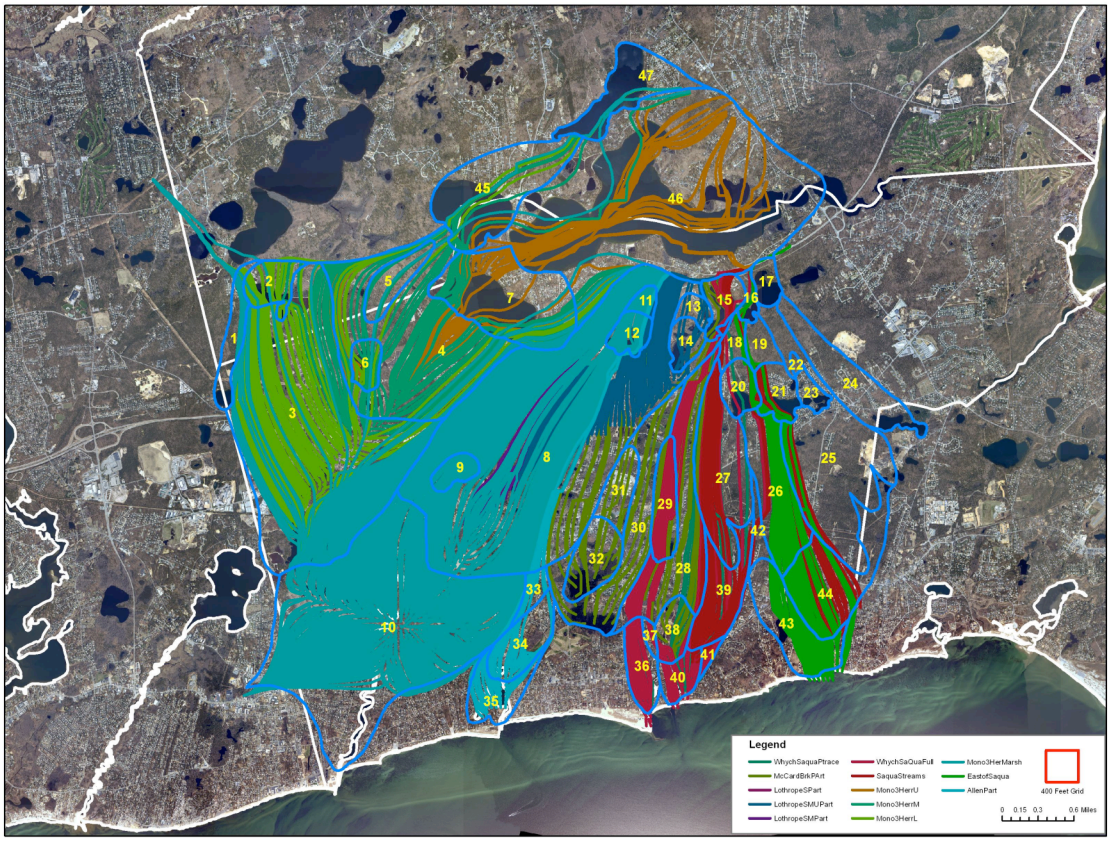


Figure 3-8 Particle tracking to delineate watersheds to coastal embayments

3.3.3 Contamination Threat to Public Drinking Wellfields

The Town of Barnstable was concerned about the path of contaminants from a contaminated site located in the wellhead protection area to two downgradient wellfields. The town approached the Cape Cod Commission to provide an evaluation of the relationship of the contaminated site to the public supply wells. The Commission obtained recent well-pumping data for the downgradient wells and ran the scenario under average and Zone II conditions. The analysis found the contamination would only migrate to the wells under the most extreme pumping scenario.

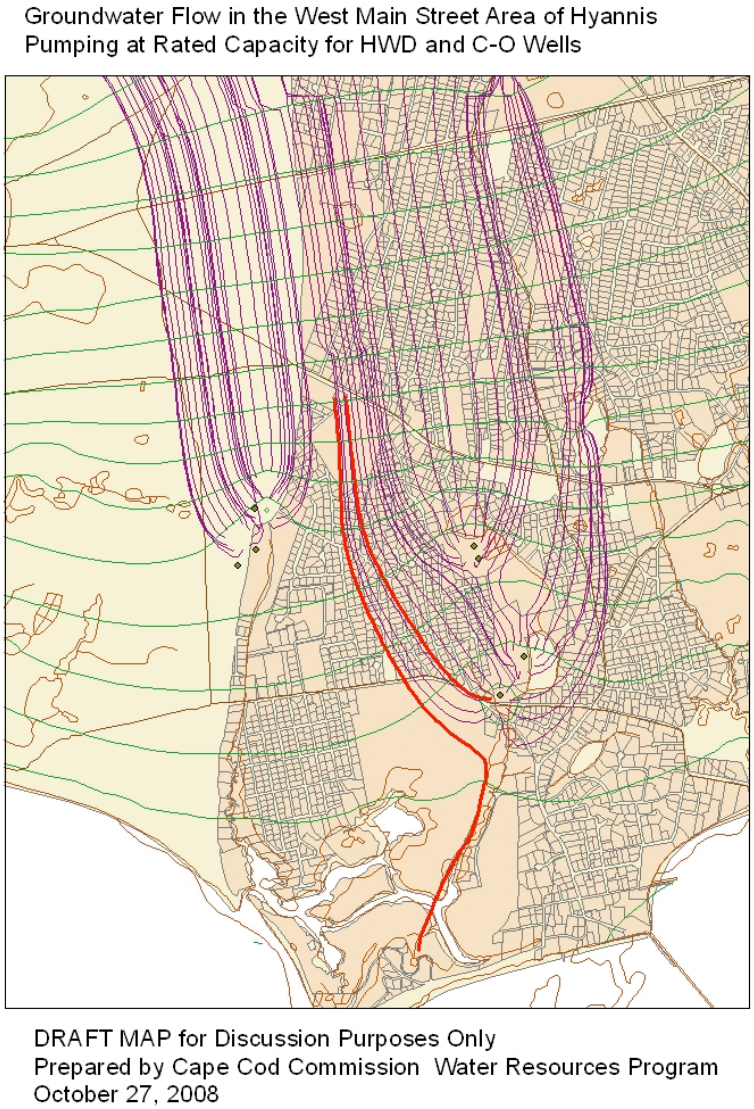
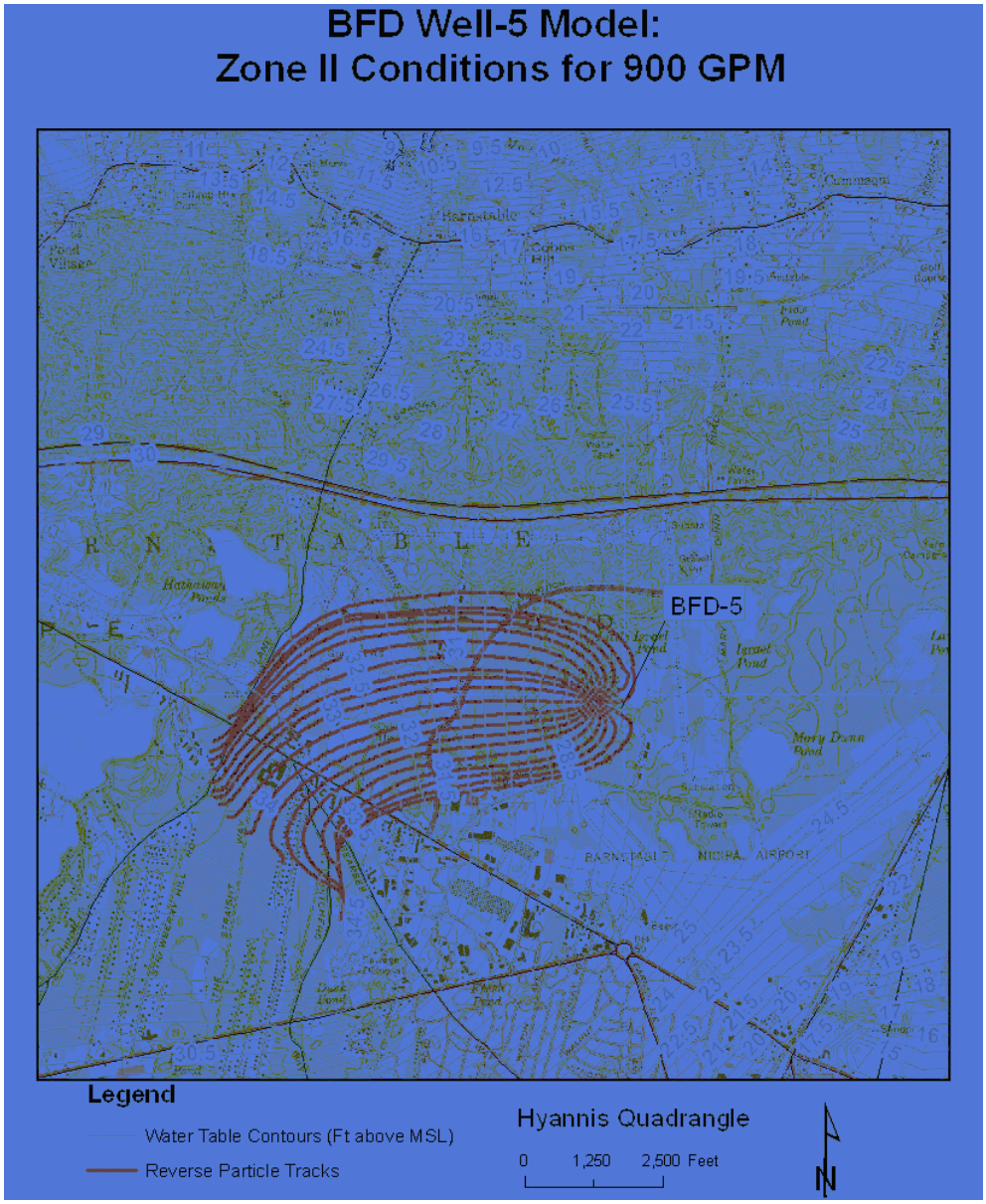


Figure 3-9 Particle tracking to evaluate contaminant migration.

3.3.4 Wellhead Protection Area Delineation

The Barnstable Fire District was in the process of permitting a new well in the village of Hyannis. The district approached the Cape Cod Commission to assist them in delineating the wellhead protection area for the new well. Commission staff analyzed the pumping test data and undertook related field activities to develop appropriate input data for the



computer model. The model was prepared and used to define the area of the aquifer from which the well will withdraw water under the MassDEP Zone II conditions. The modeling work was approved by the MassDEP. Staff also used the model to evaluate the effect of increasing discharge at a major wastewater treatment plant with a groundwater discharge on the configuration of the Wellhead Protection Area.

Figure 3-10 Groundwater modeling to evaluate Wellhead Protection Areas and interaction with wastewater discharges.

3.3.5 Review of Town Consultant Modeling Projects

The identification of suitable sites for wastewater effluent disposal is a challenging component of a CWMP. Once a suitable site is identified, a field and groundwater modeling analysis must be undertaken to evaluate the capacity of the site to accept wastewater flow and to examine the potential impacts from the proposed discharge on potential receptors. As discussed above, Commission staff assisted nine towns in their

initial screening of suitable sites. That work was conducted from 2003 to 2006 under a Barnstable County grant. The towns of Chatham, Orleans, and Falmouth subsequently undertook site-specific assessments. Commission staff were involved in the initial project meetings and provided a review with written comments of the draft reports for local officials. These comments were often made part of the official regulatory review of the CWMPs as they proceeded through the MEPA process.

3.3.5.1 Chatham

Commission staff reviewed the technical groundwater modeling report for the Town of Chatham. The objective of the report was to evaluate mounding beneath the proposed effluent disposal site for future sewering conditions at average flows of 1.3 and 2.1 million and 1.9 and 3.1 mgd for maximum month flow at three different application rates of 15, 30 and 45 gallons/day/ft2. A secondary objective was to evaluate the fate of treated effluent in relation to downgradient water resources.

The technical approach incorporated many aspects of our discussions on the scope. Cross-sections illustrated the subsurface extent of the clay unit and a sensitivity analysis was performed on the clay unit. The final value of 5 ft/day with a 1 to 100 vertical anisotropy appears to be reasonable. Incorporation of the clay unit into the model resulted in a more conservative evaluation of mounding beneath the site. Incorporation of flow rates measured within Cockle Cove provides more accurate results than the initial regional model. The hydraulic conductivity of the receiving aquifer beneath the site was calibrated to be 240 ft/d. While the model is a good tool to arrive at this parameter, a small-scale pump test would provide useful data to better document hydraulic conductivity. A cross section of the model domain to show vertical discretization and assignment of the clay unit would provide additional useful information to evaluate the model.

The maximum high groundwater was modeled by increasing recharge from 27.2 to 48 inches per year across the model to match observed summer maximum high groundwater conditions. Effluent discharge rates were applied to this hypothetical simulation to evaluate maximum mounding. The maximum groundwater elevation beneath the site's land surface of 62 feet was 38 feet, giving a separation of approximately 24 feet.

The fate of treated effluent was modeled using average effluent disposal rates at the three different application rates. The model provides an allocation of where the treated effluent will ultimately discharge. At the average discharge rate of 1.3 MGD using the desired application rate of 30 gpd/ft2, the allocation is 31 percent to Cockle Cove, 13 percent to Taylor's Pond, 21 percent to Bogs, and 35 percent underflows to Nantucket Sound.

The modeling results appear to answer the questions about water table mounding and the fate of treated effluent. We suspect these results will be used in MEP water quality modeling to evaluate water quality improvements from various sewering scenarios.

An adaptive management and monitoring program was recommended to be developed to evaluate the aquifer response to additional hydraulic loading and to track changes in water quality as part of the permitting for this site.

3.3.5.2 Orleans

The Town of Orleans is engaged in a CWMP and has identified a primary site for effluent disposal. Staff reviewed a scope of work for site characterization and a subsequent groundwater modeling report. The following is an excerpt from the review letter to the town:

> *Overall an excellent approach and well thought out. It would be advisable to prepare a water map of the site and its immediate surrounding for use in evaluating the interaction of the mounding on groundwater flow. This could be a snapshot of the wells you are proposing to use and several additional wells upgradient and cross gradient. There actually may be several of these that have already been prepared by the USGS. This would be extremely useful for later model calibration. I suggest making use of the real-time water level recording in USGS well BMW-22. It is located on 6A near Nickerson State Park. The data are online and will give you a good sense of how the loading test compares to regional fluctuations. I just looked at it and it shows the effect of the recent storm that passed through this week end.*
>
> *I was confused by the definition of a failure to obtain a constant head. In one case a failure is overspill of the loading bed, in which case the load is stepped down as described in your table. The second case is that a constant head cannot be obtained due to the permeability of the sediments. In that case the maximum flow rate is maintained at 200 gpd/ft2. The scope should distinguish them. Any thought to increasing loading rate beyond 200 gpd/ft2?*
>
> *The use of a Modflow to make a box model of the area to calibrate against the data that will be generated is a good approach. (In the general scope, I suggest a similar use of a box model for preliminary mounding analysis instead of the Hantush analysis since it is rather straight forward to use, the team will have experience using it and offers more flexibility. For instance, it can be inserted into Phase III activities to evaluate parameters prior to engaging in use of the USGS model.*
>
> *Another item to evaluate for Site 241 is the potential for breakout given the steep slopes around the facility.*
>
> *The use of monitoring wells and borings to document subsurface materials is important. I suspect the existing well at sites 241 will satisfy that need, but it is necessary for the other sites lacking this data. I would advise a deep boring to penetrate into the aquifer rather than just a shallow well.*

Staff response to the subsequent modeling report was in the form of a list of questions that could be addressed in the final report. The following questions were forwarded to the town and their consultant:

1) *What is the sensitivity of mounding elevation to the changes in K?*
2) *Calibration points are all upgradient of the discharge facility. Are there any to use near the marshes or Rock Harbor?*
3) *I believe there is some stream flow information on Namskaket Creek in the USGS open file report 96-111 which indicates flows ranging from 0.14 to 0.53 cfs. Was there an attempt to evaluate the models' ability to correlate observed flow in the marsh?*
4) *The report indicates that drain stages were modified. If there were stages changed, what effect did it have on results?*
5) *The report does not show how discharge at the site was discretized relative to the other boundary conditions. How well does the discretization match the expected flows for various rates? Given the establishment of a groundwater divide along the area of discharge how sensitive are flow trajectories to the location of simulated discharge?*
6) *Nine particles per node were used to simulate the discharge. How was flow allocation calculated?*
7) *Is it possible to run the model to arrive at an upper discharge amount with the given constraints (Rock Harbor) so we would know the excess capacity for expansion? Scenario 5 graphic should be included.*
8) *The report uses the actual cross-sections and USGS well numbers from existing reports. The well labeling in the loading test report should be reviewed.*

3.3.5.3 Falmouth

Cape Cod Commission staff met with the Town of Falmouth and its consultants to discuss the overall approach to the Falmouth groundwater modeling project for the town's CWMP. The modeling project's focus was to evaluate the Falmouth Country Club as a potential shared site to discharge treated effluent. The project, as mentioned above, was funded by the Barnstable County through the Cape Cod Water Protection Collaborative. In the spring of this year the final project was presented to Barnstable County. The report indicated that the site could accommodate initial phases of flow from the intended sewer collection area, However under future conditions the site would be constrained to accept all of the intended flow. Under these conditions flow from Mashpee could not be accommodated either. These conclusions have lead the town to further evaluate a regional proposal to site a regional treatment facility at the Massachusetts Military Reservation. Although regional disposal options have not been evaluated, the Town of Falmouth proposes exceptionally high treated water to be injected directly into the aquifer via injection wells (Stearns and Wheler, 2009).

4 Technical Transfer

Technical transfer was another important aspect of the grant project. Cape Cod Commission staff worked with the EPA Project Manager to develop a response to needs for participating in several conferences and workshops. These technical transfer opportunities, not including those discussed previously in this report, are listed below:

Implementing TMDLs to Restore and Protect Coastal Water Quality for Cape Cod
New England Interstate Water Pollution Commission, 3rd On-Site Wastewater Course, Groton, Connecticut, March 13, 2008.

Restoration and Protection of Coastal Waters through TMDLs and Stormwater LID
New England Water Environment Association Spring Conference, Cape Codder Inn, Hyannis, Massachusetts, June 3, 2008.

TMDL Update, Cape Cod Water Protection
Cape Cod Water Protection Collaborative, April 9, 2008, Orleans Town Hall, Orleans, Massachusetts.

EPA Technical Transfer: TMDLs to Restore and Protect Coastal Water Quality for Cape Cod
US Environmental Protection Agency Narragansett Laboratory, 27 Tarzwell Drive, Narragansett, Rhode Island, June 5, 2008.

Regional Resources Management for Cape Cod
6th Annual Water Resources Research Conference, University of Massachusetts, Amherst, Massachusetts, April, 7, 2009.

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6 Appendix

A) Working Group Plan of Work
B) Wastewater Thematic Maps and Charts
C) Natural Attenuation Project Summaries
D) TMDL Allocation Memos
E) Regional Policy Plan
F) TurboLoader
G) Regional Wastewater Management Plan Draft - Scope