VIII. CRITICAL NUTRIENT THRESHOLD DETERMINATION AND DEVELOPMENT OF WATER QUALITY TARGETS

VIII.1 ASSESSMENT OF NITROGEN RELATED HABITAT QUALITY

Determination of site-specific nitrogen thresholds for an embayment requires integration of key habitat parameters (infauna and eelgrass), sediment characteristics, and nutrient related water quality information (particularly dissolved oxygen and chlorophyll a). Additional information on temporal changes within each sub-embayment and its watershed further strengthen the analysis. These data were collected to support threshold development for the Three Bays System by the MEP Technical Team and were discussed in Chapter VII. Nitrogen threshold development builds on this data and links habitat quality to summer water column nitrogen levels determined from the baseline Three Bays Water Quality Monitoring Program collected by Three Bays Preservation and the Town of Barnstable. At present, Three Bays, is showing a gradient of significantly impaired (upper basins) to moderately impaired (Cotuit Bay, West Bay) habitat quality. The lower basins show moderate impairment based upon all 3 parameters (eelgrass, infauna, D.O.), in spite of their proximity to the tidal inlet and the high quality waters of Nantucket Sound. All of the habitat indicators show consistent patterns of habitat health in each of the major sub-embayments and that habitat impairments are consistent with nitrogen enrichment (Chapter VII).

Eelgrass: The Three Bays Estuary is relatively deep compared to others along the south shore of Cape Cod from Falmouth to Barnstable (Chapter V). Water depths are well within the range for eelgrass growth in Massachusetts, under suitable conditions of light penetration. However, the need for more transparent waters requires lower nitrogen loads to these deep basins, compared to shallower basins, to support this habitat.

Currently, there are no remaining eelgrass beds within the Three Bays System. However, it appears that all of the major sub-embayments had water quality conditions capable of supporting eelgrass (except in the deeper channels and basin depths) in 1951. However, eelgrass appears to have been restricted to the shallows (North and Cotuit Bays) or to Prince’s Cove and West Bay basins. If the issue in 1951 was nitrogen enrichment, the pattern of the beds would have been very different, with more eelgrass in lower Cotuit Bay and West Bay and much less in Prince’s Cove and North Bay (except in the very shallows). Instead, it is likely that disturbance related to activities in North and Cotuit Bays associated with training during WWII played a role in the North and Cotuit Bay pattern of beds in the 1951 assessment. Whatever the cause, it is clear that in the recent past, the Three Bays system was capable of supporting eelgrass within each of its major sub-embayments. It also appears that the recent losses (post 1951) are associated with nitrogen enrichment, as in virtually every other embayment in southeastern Massachusetts. The absence of eelgrass in each basin and the fact that they supported eelgrass in the recent past classifies each basins eelgrass habitat as “significantly impaired” (Table VIII-1).

The current absence of eelgrass in each of the major sub-embayments of the Three Bays System is consistent with the observed oxygen depletions in each basin and the high chlorophyll levels in the upper regions. The greater depths in the Three Bays Estuary also makes oxygen depletions more likely than in shallow basins with the same nitrogen levels. This results from the fact that deeper systems are more likely to periodically stratify. The central deep basins in North Bay and Prince’s Cove are particularly sensitive to eelgrass loss as it takes less intense phytoplankton blooms to reduce light penetration to the bottom, and thereby prevent eelgrass growth. In addition, the basins are sensitive to periodic oxygen depletion. At this time, it is not clear if these regions have historically (100 years) supported eelgrass. However, eelgrass beds fringing these basins are well documented. As regards the lack of eelgrass within the lowermost portion of Cotuit Bay and the Seapuit River, it is likely associated with the documented highly dynamic coastal processes in this area. The level of natural disturbance in this region is very high (sand transport, overwash, etc). Physical stability is important to the ability of eelgrass beds to form and persist. Nitrogen levels in lower Cotuit Bay would presently support eelgrass habitat (tidally averaged TN 0.32 mg L-1) as they are much lower than those in many other eelgrass beds in nearby systems that are physically stable. In addition, the persistence of eelgrass beds through 1995-2001 in the shallow waters of south Windmill Cove, but in a stable physical setting, were at much higher nitrogen levels (tidally averaged TN 0.40 mg L-1).

Table VIII-1. Summary of Nutrient Related Habitat Health within the Three Bays Estuary on the south shore of Barnstable , MA., based upon assessment data presented in Chapter VII.

Health Indicator	**Three Bays Estuary**						
	Princes Cove	**Warrens Cove**	**North Bay**		**Cotuit Bay**	**West Bay**	**Eel Pond**
			Upper	**Lower**			
Dissolved Oxygen	SI/SD[1]	SI/SD	SI/SD[1]	MI/SI[2]	MI/SI[2]	SI	H/MI[3]
Chlorophyll	SI	SI	MI/SI	MI/SI	MI	H/MI	--
Macroalgae	MI	SD[4]	--	--	MI[6]	MI	SI
Eelgrass	SI	SI	SI	SI	SI	SI	SI
Infaunal Animals	SD[7]	SD[8]	SD[8]	MI/SI	H/MI	H/MI	MI
Overall:	**SI/SD**	**SD**	**SI/SD**	**MI/SI**	**MI**	**MI**	**MI/SI**

1 – periodic oxygen depletions to <2 mg/L and frequently <4 mg/L.
2 – infrequent oxygen depletions to 3-4 mg/L, periodic 4-5 mg/L., generally >5 mg/L.
3 – generally >5 mg/L., grab sample data only.
4 – macroalgal floating accumulations during summer
5 – moderate macroalgal accumulations on bottom.
6 – low to moderate patches on bottom only.
7 – modest numbers of individuals dominated by stress indicator species.
8 – absence of infaunal community (<15 individuals/grab).
H = healthy habitat conditions; MI = Moderate Impairment; SI = Significant Impairment;
SD = Severe Degradation
-- = not applicable to this estuarine reach

Nitrogen management of this system is likely to restore at least an area equivalent to the 130 acres observed in 1951 (Table VII-3). Even more area is likely, if the “natural” pattern of marginal beds can be restored (not observed in the 1951 mapping). Even a restoration of fringing beds in North and Cotuit Bays and restoration of West Bay would result in several times the 1951 acreage. Note that restoration of this habitat will necessarily result in restoration of other resources throughout the Three Bays System and in the region of Prince’s Cove. While it is unlikely that Warren’s Cove will support eelgrass after restoration, given its salt marsh basin habitat, the present macroalgal problem would cease due to the nitrogen reductions required to restore the eelgrass. Eelgrass recovery following nitrogen management would likely follow the pattern of beds first being re-established in the marginal areas in the lower basins and move to the deeper regions and the margins of the upper sub-embayments.

Water Quality: The dissolved oxygen (DO) records indicate that the major sub-embayments to the Three Bays system (Cotuit Bay, West Bay, North Bay and Prince's Cove) are currently under seasonal oxygen stress, consistent with nitrogen enrichment (Table VII-1). That the cause is nitrogen enrichment is supported by parallel observations of chlorophyll a (Table VII-2). Oxygen conditions and chlorophyll a levels generally improved with decreasing distance to the tidal inlet, although all basins showed oxygen depletions to <4 mg L^{-1}. There was also a clear gradient in chlorophyll a, with highest levels in the uppermost reaches and lowest levels near the tidal inlet to Nantucket Sound. The results of the summer oxygen and chlorophyll a studies are consistent with the absence of eelgrass throughout the Three Bays System and the near absence of animal communities throughout the upper basins where oxygen depletions routinely dropped below 3 mg/L (see below). These observations are consistent with a classification of the upper basins (North Bay and Prince's Cove and Warren's Cove) as generally "Significantly Impaired" and the lower basins (Cotuit Bay, West Bay) as "Moderately Impaired".

Dissolved oxygen levels near atmospheric equilibration are important for maintaining healthy animal and plant communities. Short-duration oxygen depletions can significantly affect communities even if they are relatively rare on an annual basis. For example, for the Chesapeake Bay it was determined that restoration of nutrient degraded habitat requires that instantaneous oxygen levels not drop below 3.8 mg L^{-1}. Massachusetts State Water Quality Classification indicates that SA (high quality) waters maintain oxygen levels above 6 mg L^{-1}. The tidal waters of the Three Bays System are currently listed as SA under the State Classification.

The level of oxygen depletion and the magnitude of daily oxygen excursion and chlorophyll a levels indicate highly nutrient enriched waters and impaired habitat quality at all MEP DO mooring sites within the estuary (Figures VII-3 through VII-12). The oxygen data throughout the estuary is consistent with elevated organic matter loads from phytoplankton production (chlorophyll a levels) indicative of nitrogen enrichment and eutrophication of these estuarine systems. The oxygen records further indicate that the upper tidal reaches of each estuary have the largest daily oxygen excursion, with daily excursions in excess of 6 mg L-1 common. This further supports the assessment of a high degree of nutrient enrichment.

The use of only the duration of oxygen below, for example 4 mg L^{-1}, can underestimate the level of habitat impairment in these locations. The effect of nitrogen enrichment is to cause oxygen depletion; however, with increased phytoplankton (or epibenthic algae) production, oxygen levels will rise in daylight to above atmospheric equilibration levels in shallow systems (generally ~7-8 mg L^{-1} at the mooring sites). This was periodically observed within the upper basins, further supporting the contention that the upper basins are currently eutrophic. The oxygen and chlorophyll data also shows a gradient of impairment with high levels of impairment in the upper sub-embayments (Prince's Cove, Warren's Cove, North Bay) and better conditions in the lower basins (Cotuit Bay and West Bay). However, there was clear oxygen depletion at all mooring sites, which indicates that additional nitrogen loading will cause further habitat decline at all sites

Infaunal Communities: The Infauna Study indicated that most of the upper areas of the Three Bays system are presently significantly impaired to severely degraded by nitrogen enrichment

(Prince's Cove, Warren's Cove and portions of North Bay), while the lower basins of Cotuit Bay and West Bay are moderately impaired (Table VII-4).

Prince's Cove, Warren's Cove and 2 of 3 sites in North Bay are virtually devoid of infaunal animal communities. They support populations of <50 individuals per 0.0625 m^2, which is more than an order of magnitude less than in a healthy environment. Three of five locations had 11 or less individuals. The central region of North Bay currently supports a transitional community dominated by amphipods, indicative of organic matter enrichment. In contrast, Cotuit and West Bays generally have ~500-2000 individuals per grab and 16-26 species. While there are stress indicator species (generally *Capitella* or *Streblospio*) in numbers at these locations there are also other species indicative of a healthy environment and overall high diversity. Overall, the pattern of infaunal community quality is consistent with the pattern of oxygen depletion and chlorophyll a during summer and the absence of eelgrass. All sites showed some level of degradation, either in number of individuals, diversity or the presence of stress indicator species. Lowering nitrogen inputs to this system should allow a relatively rapid recovery of communities in the Cotuit and West Bays, with higher levels of nitrogen management required to restore benthic habitat to North Bay and Prince's Cove and Warren's Cove. These upper basins currently support little to no viable benthic habitat. The infaunal community based classification for each sub-embayment is fully supported by the water quality and eelgrass data discussed in the text above.

VIII.2 THRESHOLD NITROGEN CONCENTRATIONS

The approach for determining nitrogen loading rates, which will maintain acceptable habitat quality throughout an embayment system, is to first identify a sentinel location within the embayment. Secondly, it is necessary to determine the nitrogen concentration within the water column which will restore that location to the desired habitat quality. The sentinel location is selected such that the restoration of that one site will necessarily bring the other regions of the system to acceptable habitat quality levels. Once the sentinel site and its target nitrogen level are determined, the Linked Watershed-Embayment Model is used to sequentially adjust nitrogen loads until the targeted nitrogen concentration is achieved.

For the Three Bays System, the restoration target should reflect both recent pre-degradation habitat quality and be reasonably achievable. Based upon the assessment data (Chapter VII), eelgrass bed restoration within Cotuit Bay and West Bay, with restoration of marginal beds in North Bay and Prince's Cove is supportable. In addition, in the central basins of North Bay and Prince's Cove, where eelgrass habitat has not been documented, as well as in Warren's Cove, restoration of infaunal habitat is necessary. Achieving these habitat quality targets will also result in mitigation of the present macroalgal accumulation problem in Warren's Cove.

To achieve these habitat restoration targets, for the Three Bays Estuary a single sentinel location was selected with secondary criteria that must be achieved at other locations. The secondary criteria serve only as checks to make sure that the targets are achieved when the nitrogen threshold at the sentinel station has been reached. The appropriate sentinel location within Three Bays was determined to be in the upper region of the narrows between North Bay and Cotuit Bay (at the entrance to the Narrows). This location was selected because (1) it is relatively deep (reflecting the larger Three Bays basins) and it supported a major eelgrass bed in the 1951 survey; (2) achieving the threshold nitrogen level at this location will result in high quality habitat conditions throughout Cotuit and West Bays; (3) restoration of nitrogen concentrations at this location should result in conditions similar to 1951 within Prince's and Warren's Coves and North Bay; (4) nitrogen levels restorative of eelgrass beds at the deeper sentinel location should provide for marginal beds in the shallows of Prince's Cove and North Bay and (5) achieving the threshold nitrogen level at the sentinel location will require removal of sufficient nitrogen related stress as to restore infaunal animal habitat in the adjacent deeper waters of Prince's Cove and North Bay.

The target nitrogen concentration for restoration of eelgrass in this system was determined to be 0.38 mg TN L^{-1} at the sentinel location and 0.40 mg TN L^{-1} within the marginal regions (shallows) of North Bay. This secondary level to check restoration of marginal beds in North Bay (O.40 mg TN L^{-1}) is consistent with the analysis of restoration of fringing eelgrass beds in nearby Great Pond, and analysis where eelgrass beds in deep waters could not be supported at a tidally averaged TN of 0.412 mg TN L^{-1} at depths of 2 m. Similarly prior MEP analysis in Bournes Pond indicated that tidally averaged TN levels of 0.42 mg TN L^{-1} excluded beds from all but the shallowest water. The MEP Technical Team cannot specify the exact extent of marginal beds to be restored in the upper deep basins. At tidally averaged TN levels of 0.42 mg TN L^{-1} the eelgrass habitat would be restricted to very shallow waters, while at 0.40 mg TN L^{-1} the eelgrass habitat should reach to 1-2 meters depth, based upon the data from nearby systems. In addition, the persistence of eelgrass beds through 1995-2001 in the shallow waters of south Windmill Cove, but in a stable physical setting, were at nitrogen levels (tidally averaged TN ~0.40 mg L-1).

The target nitrogen concentration for restoration of eelgrass at the sentinel location system was determined to be 0.38 mg TN L^{-1}. It was not possible to make this determination based upon an analysis of the relationship of measured nitrogen levels to existing eelgrass beds in Three Bays, as all beds have been lost. Instead, the value stems from (1) the analysis of Stage Harbor, Chatham which also exchanges tidal water with Nantucket Sound and for which a MEP target has already been set), (2) analysis of nitrogen levels within the eelgrass bed in adjacent Waquoit Bay, near the inlet (measured TN of 0.395 mg N L^{-1}, tidally corrected <0.38 mg N L^{-1}), and (3) a similar analysis in West Falmouth Harbor. The sentinel station under present loading conditions supports a measured nitrogen level at mid-ebb tide of 0.438-0.498 mg TN L^{-1} and a tidally corrected average concentration of 0.485 mg TN L^{-1},

Since infaunal animal habitat is also a critical resource to the Three Bays System, the secondary metric for a successful restoration (after eelgrass) will be to restore the significantly impaired/severely degraded habitats in the Prince's Cove/Warren's Cove and North Bay basins. In the upper more muddy basins of other nearby systems, healthy infaunal habitat is associated with nitrogen levels of TN <0.5 mg TN L^{-1}. This was found for Popponesset Bay where based upon the infaunal analysis coupled with the nitrogen data (measured and modeled), nitrogen levels on the order of 0.4 to 0.5 mg TN L-1 were found supportive of high infaunal habitat quality in this system.

In the Three Bays System, present healthy infaunal areas are found at nitrogen levels of TN <0.42 mg TN L^{-1} (Cotuit Bay and West Bay) However, the impaired areas are at nitrogen levels of TN >0.5 mg TN L^{-1} (North Bay) and are severely degraded at nitrogen levels of TN >0.6 mg TN L^{-1}. This is consistent with the findings discussed above from other systems and fully supports a secondary nitrogen criteria for the upper muddy basins of 0.5 mg TN L^{-1}.

It must be stressed that the nitrogen threshold for the Three Bays System is at the sentinel location. The secondary criteria should be met when the threshold is met at the sentinel station and also serve as a "check". The nitrogen loads associated with the threshold concentration at the sentinel location are discussed in Section VIII.3, below.

VIII.3 DEVELOPMENT OF TARGET NITROGEN LOADS

The nitrogen thresholds developed in the previous section were used to determine the amount of total nitrogen mass loading reduction required for restoration of eelgrass and infaunal habitats in the Three Bays system. The load reductions associated with the nitrogen thresholds developed in the previous section only represent one of many different ways to reduce load from the watershed in order to meet the threshold. It is important to note that load reductions can be produced by reduction of any or all sources or by increasing the natural attenuation of nitrogen within the freshwater systems to the embayment. The load reductions presented below represent one example from a suite of potential reduction approaches that need to be evaluated by the communities in the Three Bays system watershed. The purpose of the scenario presented is to establish the general degree and spatial pattern of reduction that will be required for restoration of this nitrogen impaired embayment.

To develop the scenario, tidally averaged total nitrogen thresholds derived in Section VIII.1 were used to adjust the calibrated constituent transport model developed in Section VI. Watershed nitrogen loads were sequentially lowered, using reductions in septic effluent discharges only, until the nitrogen levels reached the threshold level at the sentinel stations chosen for Three Bays.

As shown in Table VIII-2 for the specific load reduction scenario (reductions in septic effluent discharges only), the nitrogen load reductions within the system necessary to achieve the threshold nitrogen concentrations required 100% removal of septic load (associated with direct groundwater discharge to the embayment) for five of the eight total lower sub-watersheds of the system. In addition, a portion of the septic load entering the headwaters of the system from the Marstons Mills River also must be removed to meet the threshold nitrogen concentrations. For the load reduction scenario evaluated, the Marstons Mills River watershed required removal of approximately 25% of the septic load. The distribution of tidally-averaged nitrogen concentrations associated with the above thresholds analysis is shown in Figures VIII-1 and VIII-2.

Tables VIII-3 and VIII-4 provide additional loading information associated with this thresholds scenario. Table VIII-3 shows the change to the total watershed loads, based upon the removal of septic loads depicted in Table VIII-2. For Example, removal of 100% of the septic load from the Warren's Cove sub-watershed results in an 58% reduction in total nitrogen load. For the Marstons Mills River, septic load reduction of 25% resulted in total attenuated watershed load reduction of 17%. Table VIII-4 shows the breakdown of threshold sub-embayment and surface water loads used for total nitrogen modeling. In Table VIII-4, loading rates are shown in kilograms per day, since benthic loading varies throughout the year and the values shown represent 'worst-case' summertime conditions. The benthic flux for this modeling effort is reduced from existing conditions based on the load reduction and the observed particulate organic nitrogen (PON) concentrations within each sub-embayment relative to background concentrations in Nantucket Sound.

Comparison of model results between existing loading conditions and the selected loading scenario to achieve the target TN concentrations at the sentinel station is shown in Table VIII-5. To achieve the threshold nitrogen concentrations at the sentinel station, a reduction in TN concentration of typically greater than 20% is required for the upper portions of the system, in North Bay and Prince's Cove.

The basis for the watershed nitrogen removal strategy utilized to achieve the embayment thresholds may have merit, since this example nitrogen remediation effort is focused on watersheds where groundwater is flowing directly into the estuary. For nutrient loads entering the systems through surface flow, natural attenuation in freshwater bodies (i.e., streams and ponds) can help by significantly reduce the load that finally reaches the estuary. Presently, this attenuation is occurring due to natural ecosystem processes and the extent of attenuation being determined by the mass of nitrogen which discharges to these systems. The nitrogen reaching these systems is currently “unplanned”, resulting primarily from the widely distributed non-point nitrogen sources (e.g. septic systems, lawns, etc.). Future nitrogen management should take advantage of natural nitrogen attenuation, where possible, to ensure the most cost-effective nitrogen reduction strategies. However, “planned” use of natural systems has to be done carefully and with the full analysis to ensure that degradation of these systems will not occur. One clear finding of the MEP has been the need for analysis of the potential associated with restored wetlands or ecologically engineered ponds/wetlands to enhance nitrogen attenuation. Attenuation by ponds in agricultural systems has also been found to work in some cranberry bog systems, as well. Cranberry bogs, other freshwater wetland resources, and freshwater ponds provide opportunities for enhancing natural attenuation of their nitrogen loads. Restoration or enhancement of wetlands and ponds associated with the lower ends of rivers and/or streams discharging to estuaries are seen as providing a dual service of lowering infrastructure costs associated with wastewater management and increasing aquatic resources associated within the watershed and upper estuarine reaches.

Although the above modeling results provide one manner of achieving the selected threshold level for the sentinel site within the estuarine system, the specific example does not represent the only method for achieving this goal. However, the thresholds analysis provides general guidelines needed for the nitrogen management of this embayment.

Table VIII-2. Comparison of sub-embayment watershed ***septic loads*** (attenuated) used for modeling of present and threshold loading in one possible load reduction scenario for the Three Bays system. These loads do not include direct atmospheric deposition (onto the sub-embayment surface), benthic flux, runoff, or fertilizer loading terms.

sub-embayment	present septic load (kg/day)	threshold septic load (kg/day)	threshold septic load % change
Cotuit Bay	17.022	13.618	-20.0%
West Bay	15.490	12.392	-20.0%
Seaptuit River	2.921	2.921	0.0%
North Bay	24.978	0.000	-100.0%
Prince’s Cove	11.192	0.000	-100.0%
Warren’s Cove	6.975	0.000	-100.0%
Prince’s Cove Channel	4.767	0.000	-100.0%
Marstons Mills Crescent	3.573	0.000	-100.0%
Surface Water Sources			
Marstons Mills River	10.071	7.553	-25.0%
Little River	3.203	3.203	0.0%

Table VIII-3. Comparison of sub-embayment ***total watershed loads*** (including septic, runoff, and fertilizer) used for modeling of present and threshold loading in one possible load reduction scenario for the Three Bays system. These loads do not include direct atmospheric deposition (onto the sub-embayment surface) or benthic flux loading terms.			
sub-embayment	present load (kg/day)	threshold load (kg/day)	threshold % change
Cotuit Bay	21.778	18.374	-15.6%
West Bay	19.068	15.970	-16.2%
Seaptuit River	3.767	3.767	0.0%
North Bay	29.447	4.468	-84.8%
Prince's Cove	13.362	2.170	-83.8%
Warren's Cove	12.027	5.052	-58.0%
Prince's Cove Channel	5.537	0.770	-86.1%
Marstons Mills Crescent	7.293	3.721	-49.0%
Surface Water Sources			
Marstons Mills River	14.518	12.000	-17.3%
Little River	3.962	3.962	0.0%

Table VIII-4. Threshold sub-embayment and surface water loads used for total nitrogen modeling of the Three Bays system under one possible scenario, with sub-watershed N loads, atmospheric N loads, and benthic flux			
sub-embayment	watershed load (kg/day)	direct atmospheric deposition (kg/day)	benthic flux net (kg/day)
Cotuit Bay	18.374	5.786	-45.788
West Bay	15.970	4.233	3.469
Seaptuit River	3.767	0.452	-5.371
North Bay	4.468	3.953	45.202
Prince's Cove	2.170	1.230	0.323
Warren's Cove	5.052	-	6.225
Prince's Cove Channel	0.770	-	1.541
Marstons Mills Crescent	3.721	-	-
Surface Water Sources			
Marstons Mills River	12.000	-	-
Little River	3.962	-	-

Table VIII-5. Comparison of model average total N concentrations from present loading and the threshold scenario (reduction in septic effluent discharge only), with percent change, for the Three Bays system. Loads are based on atmospheric deposition and a scaled N benthic flux (scaled from present conditions).

Sub-Embayment	monitoring station	present (mg/L)	threshold (mg/L)	% change
Prince's Cove - south	TB2	0.695	0.460	-33.8%
Prince's Cove - north	TB3	0.639	0.446	-30.1%
Warren's Cove	TB4	0.595	0.433	-27.2%
North Bay - north	TB5	0.518	0.400	-22.9%
North Bay - south	TB6	0.500	0.392	-21.7%
North Windmill Cove	TB7	0.511	0.396	-22.5%
West Bay - north	TB8	0.363	0.326	-10.1%
West Bay - west	TB9	0.327	0.307	-6.1%
Eel River	TB10	0.486	0.427	-12.2%
Seapuit River	TB11	0.295	0.287	-2.6%
Cotuit Bay - north	TB12	0.414	0.346	-16.5%
Cotuit Bay - south	TB13	0.321	0.298	-7.1%
South Windmill Cove	TB15	0.402	0.364	-9.5%
Mellon Cove	TB16	0.392	0.367	-6.2%
Dam Pond	TB17	0.523	0.402	-23.3%

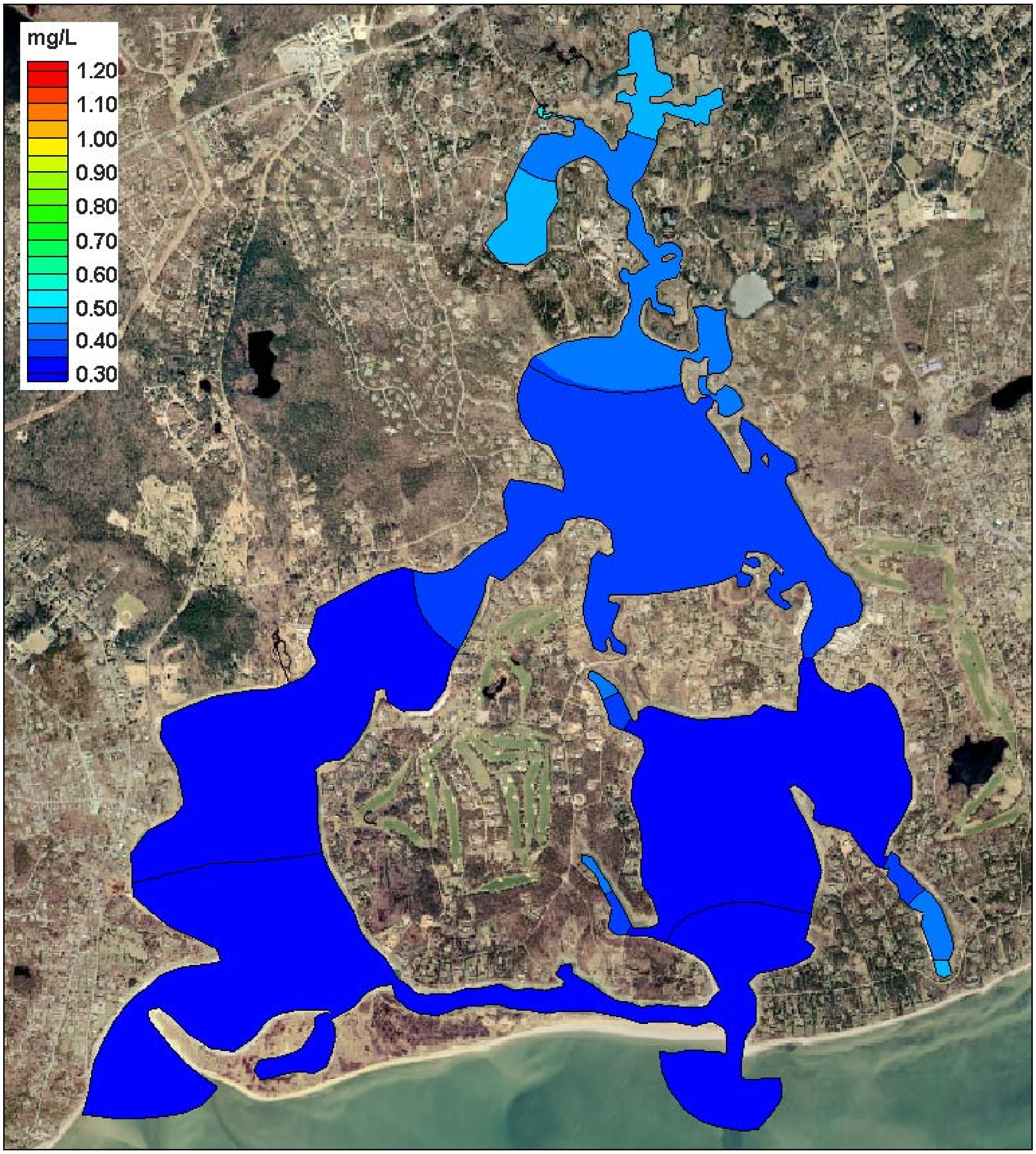

Figure VIII-1. Contour plot of modeled total nitrogen concentrations (mg/L) in the Three Bays system, for threshold conditions (0.38 mg/L at the narrows between North Bay and Cotuit Bay).

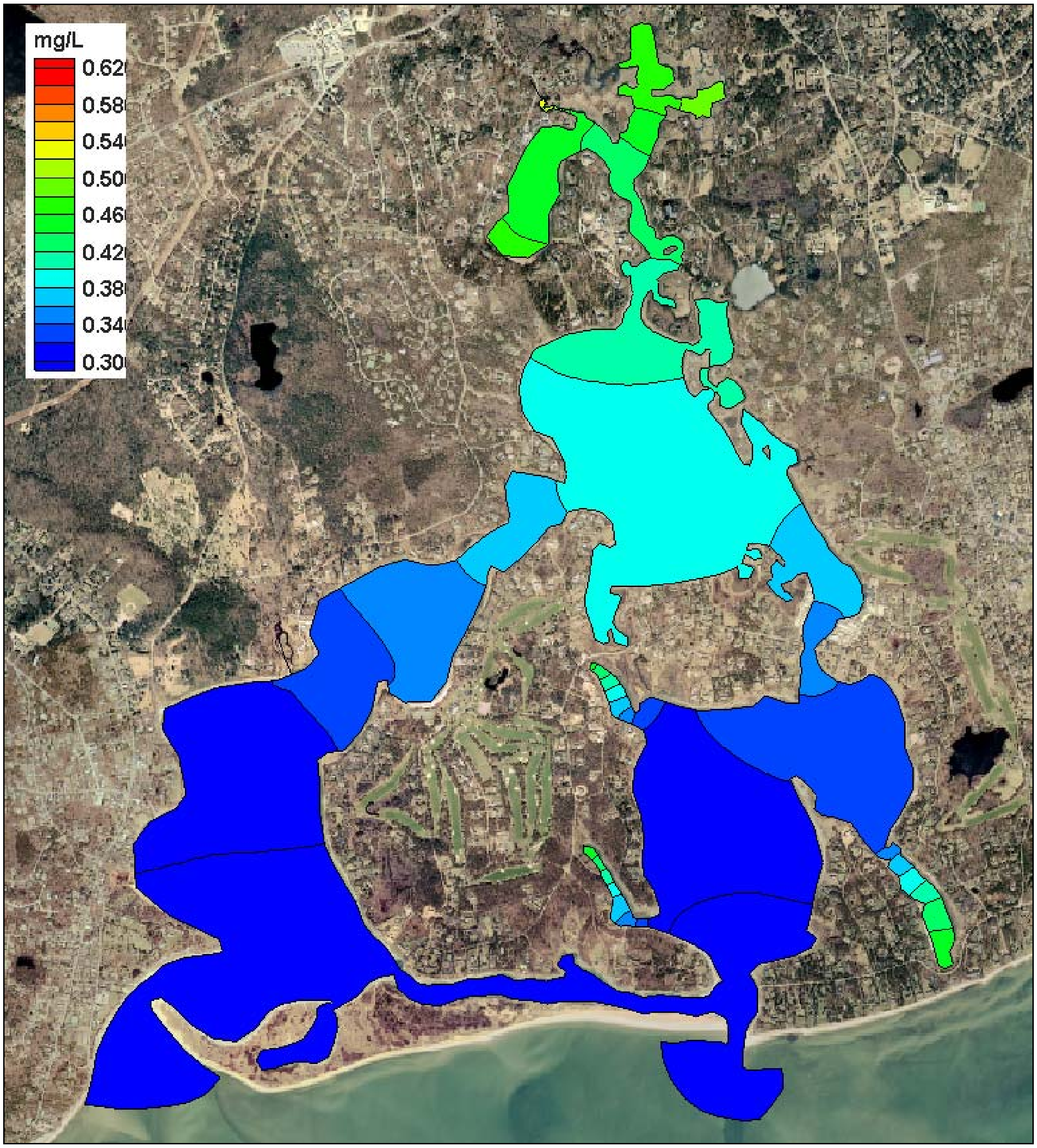

Figure VIII-2. Same results as for Figure VIII-1, but shown with finer contour increments for emphasis. Contour plot of modeled total nitrogen concentrations (mg/L) in the Three Bays system, for threshold conditions (0.38 mg/L at the narrows between North Bay and Cotuit Bay).