IX. ALTERNATIVES TO IMPROVE TIDAL FLUSHING AND WATER QUALITY

IX.1 DREDGING OF COTUIT BAY INLET

An investigation of water quality impacts resulting from a proposed widening of Cotuit Bay inlet was performed using the existing calibrated hydrodynamic and total nitrogen model of the Three Bays system. For this dredging scenario, the inlet to Cotuit Bay is widened by 300 feet, and to a depth of 8 feet NGVD. This would be achieved by removing the western tip of Sampsons Island (attached to Dead Neck), which is an accreting sand spit, supplied with sand from the updrift (eastern) portion of the island. Widening the inlet would alleviate erosional pressure on the western shore of the inlet, while returning the inlet to conditions that existed in the 1960's. It was also considered possible that the proposed dredging would benefit tidal exchange between Three Bays and Nantucket Sound, and therefore improve water quality in the system.

To quantitatively assess the water quality impacts resulting from dredging the inlet, the Three Bays hydrodynamic model was modified to include the improvements at the inlet and then re-run with the same offshore tidal boundary conditions as was used for the model runs of present conditions. A comparison of hydrodynamic model output for present and post-dredge model output is presented in Table IX-1. The resulting changes to the Three Bays system hydrodynamics due to dredging are very small. As an example, the tide prism of the entire Three Bays system increases only by 0.1%, while its mean volume is essentially unchanged. The resulting changes to computed flushing rates are similarly small.

Table IX-1. Comparison of modeled hydrologic conditions in the Three Bays system for present conditions and the Cotuit Bay Inlet dredging scenario. Computed residence times are shown to three decimal places in order to show the change resulting from the proposed dredging at the inlet.

Embayment	Mean Volume (ft^3)	Tide Prism Volume (ft^3)	Local Residence Time (days)	System Residence Time (days)
PRESENT				
Three Bays System	429,117,000	140,570,000	1.580	1.580
North Bay	139,666,000	45,824,000	1.577	4.846
Marstons Mills River	25,236,000	10,834,000	1.205	20.497
Prince's Cove	13,007,000	4,553,000	1.478	48.774
Warren's Cove	5,047,000	3,614,000	0.723	61.447
Dam Pond	2,798,000	1,200,000	1.207	185.057
Eel River	4,035,000	1,702,000	1.227	130.475
DREDGED COTUIT INLET				
Three Bays System	429,149,000	140,747,000	1.578	1.578
North Bay	139,655,000	45,887,000	1.575	4.840
Marstons Mills River	25,236,000	10,850,000	1.204	20.469
Prince's Cove	13,007,000	4,560,000	1.476	48.703
Warren's Cove	5,047,000	3,619,000	0.722	61.366
Dam Pond	2,797,000	1,202,000	1.204	184.763
Eel River	4,034,000	1,706,000	1.224	130.179

The small changes in total system tidal volume flux, resulting from widening the inlet, are not unexpected considering that the analysis of tidal energy distribution in the Three Bays system (section V.2.1) showed that there is very little tidal attenuation between the two inlets to Nantucket Sound and even in the most distant reaches of the system, in Prince's Cove. The small degree of tidal attenuation indicates that the system presently flushes efficiently, and therefore increasing the size of either inlet could not significantly increase tidal exchange with Nantucket Sound.

Although the total system-wide tidal volume does not change by a significant amount, there is a quantifiable change in how tidal flows are distributed within the Three Bays system. The distribution of tidal fluxes computed in the model at the two outlet channels from North Bay to West Bay (that the Little Island draw bridge) and Cotuit Bay (at the Narrows) are presented in Table IX-2. For present conditions, 63% of North Bay's total tidal exchange is through the Narrows to Cotuit Bay, for both ebb and flood tides. The remaining 36% is via the channel to West Bay. For the dredging scenario, tidal exchange between North Bay and Cotuit Bay increases further, to about 67% for both the ebb and flood portions of the tide.

A change in flow distribution can also be seen at the inlets to the Three Bays system. As shown in Table IX-3 for present conditions, the total tide exchange between the Three Bays system and Nantucket Sound is evenly split between the two inlets. Dredging of the Cotuit Bay entrance increases the flow through Cotuit inlet to approximately 55% of the system total. Because the total flow in and out of the system remains constant, the flow though West Bay inlet must decrease to 45%. Additional changes occur in the Seapuit River. Based upon the model results, dredging of Cotuit Bay inlet would cause the flow through the Seapuit River to be reduced by approximately 35%, which also means that the maximum velocities in the river channel would be reduced. Model results indicate that maximum channel velocities would be reduced be approximately 25% in the dredged inlet scenario.

Table IX-2. Comparison of the distribution of tidal flows ebbing from and flowing to North Bay (to Cotuit Bay and West Bay) for present conditions and for the Cotuit Bay inlet dredging scenario. Percentages are based on the total hydraulic flux entering or exiting North Bay .

Flow Pathway	Present		Dredged Cotuit Bay Inlet	
	Flood	Ebb	Flood	Ebb
North Bay via Cotuit Bay	62.5%	65.2%	65.9%	68.1%
North Bay via West Bay	37.5%	34.8%	34.1%	31.9%

Table IX-3. Comparison of the distribution of tidal flows ebbing from and flowing to the Three Bays system (via Cotuit Bay inlet and West Bay inlet) for present conditions and for the Cotuit Bay inlet dredging scenario. Percentages are based on the total hydraulic flux entering or exiting the entire Three Bays system .

Flow Pathway	Present		Dredged Cotuit Bay Inlet	
	Flood	Ebb	Flood	Ebb
Cotuit Bay Inlet	49.9%	51.3%	55.41%	54.65%
West Bay Inlet	50.1%	48.7%	44.59%	45.35%

Changes in the Three Bays system resulting from widening Cotuit Bay were further quantified by modeling TN using the modified hydrodynamics. The dredging scenario was modeled using the nitrogen loading distribution and model parameters determined previously for present conditions (Table VI-2). In Figure IX-1, a contour plot is presented that shows TN changes between the dredging scenario and present conditions.

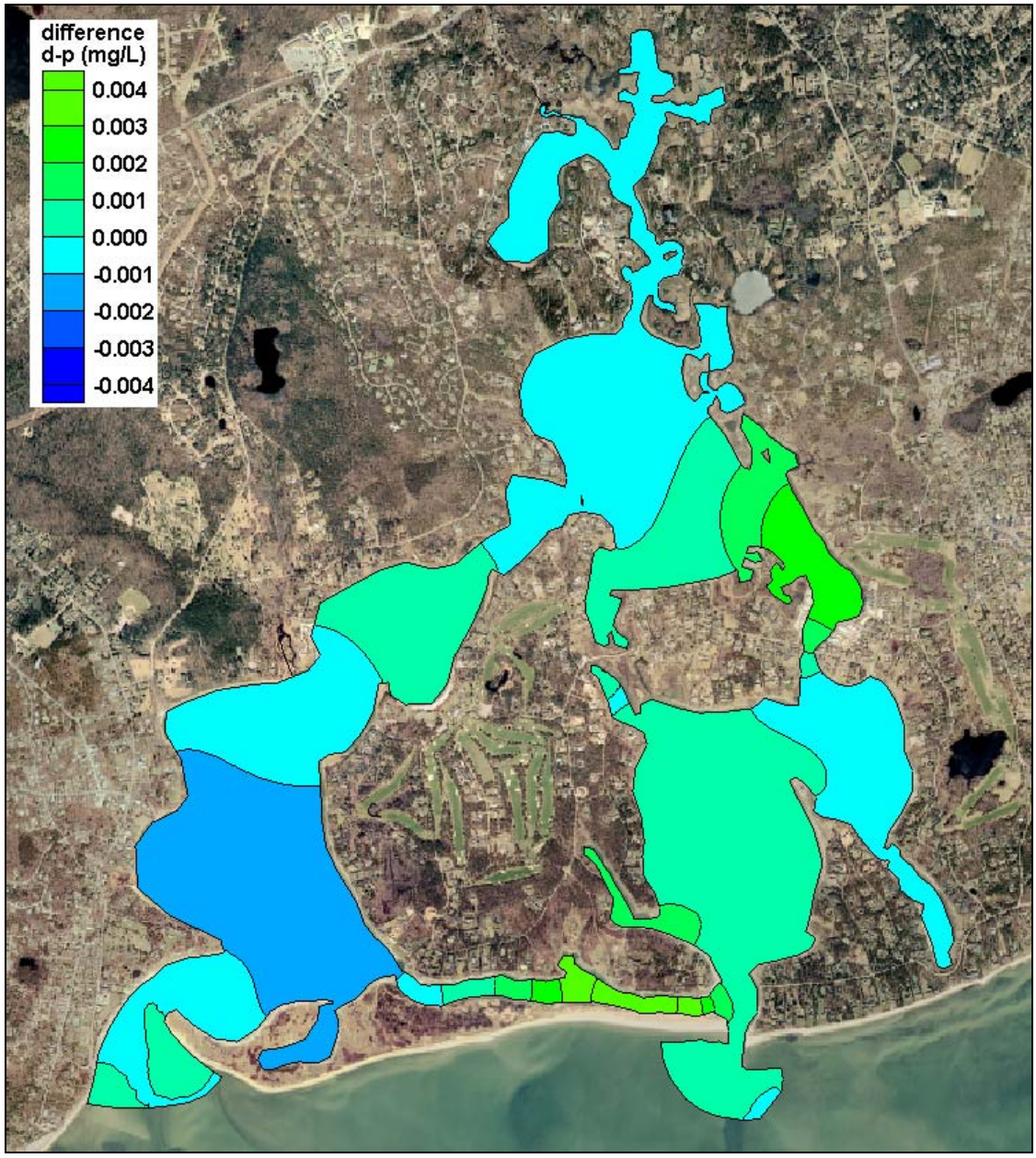

Figure IX-1. Contour plot of total nitrogen concentration change between present hydrodynamic conditions and the dredging scenario where Cotuit Bay inlet is widened to by approximately 300 ft to a depth of 8 ft NGVD. The difference is computed as dredged minus present (d-p) concentrations. Therefore, minus values indicate nitrogen concentration reductions associated with Cotuit Inlet dredging.

Similar to the hydrodynamic model results, changes to nitrogen concentrations throughout the Three Bays system are relatively small, with a maximum range of +0.004 to -0.002 mg/L, as

a result of Cotuit Inlet dredging. Pre- and post-dredge TN concentrations at each of the water quality monitoring stations are shown in Table IX-4. The largest increase in modeled TN occurs in the eastern end of the Seapuit River, near West Bay Inlet; however, this slight increase would not cause any type of ecological shift for this region. The greatest decrease in TN occurs in the southeastern extent of Cotuit Bay, specifically in Treasure Cove and near the western mouth of the Seapuit River. Generally, water quality improvements are seen in the main basin of Cotuit Bay, as well as in North Bay, Prince's Cove, and Warren's Cove. Small increases in average modeled TN concentrations are seen in West Bay, the Seapuit River, and the southeastern portion of North Bay. None of the changes are large enough to substantially impact water quality, either in a positive or negative way. However, it should be noted that dredging of the Cotuit Bay Inlet would return the system to similar conditions to the 1950s (the basis for the eelgrass restoration target). During this time period, Cotuit Inlet was the dominant inlet to the Three Bays estuarine system. Due to the larger overall volume and depth of Cotuit Bay relative to West Bay, it is beneficial from a water quality perspective to have the dominant inlet be the Cotuit Bay entrance. Based upon information from the Town of Barnstable, navigation and safety also remain concerns at the existing Cotuit Bay Inlet. These factors, along with the quantifiable improvements to Cotuit Bay water quality, may prove to be viable reasons for moving forward with Cotuit Inlet dredging.

Table IX-4. Comparison of model average total N concentrations from present loading and the threshold scenario, 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	0.695	0.0%
Prince's Cove - north	TB3	0.639	0.638	-0.2%
Warren's Cove	TB4	0.595	0.594	-0.2%
North Bay - north	TB5	0.518	0.518	-0.2%
North Bay - south	TB6	0.500	0.501	+0.2%
North Windmill Cove	TB7	0.511	0.511	0.0%
West Bay - north	TB8	0.363	0.363	0.0%
West Bay - west	TB9	0.327	0.328	+0.3%
Eel River	TB10	0.486	0.485	-0.2%
Seapuit River	TB11	0.295	0.298	+1.0%
Cotuit Bay - north	TB12	0.414	0.415	+0.2%
Cotuit Bay - south	TB13	0.321	0.320	-0.3%
South Windmill Cove	TB15	0.402	0.402	0.0%
Mellon Cove	TB16	0.392	0.393	+0.3%
Dam Pond	TB17	0.523	0.523	-0.2%