IX. ALTERNATIVES TO IMPROVE TIDAL FLUSHING AND WATER QUALITY

IX.1 FLUSHING IMPROVEMENTS TO RUSHY MARSH BY RECONSTRUCTION OF THE INLET

Water quality improvements may be possible by improving tidal exchange in an estuary. It is clear from the nitrogen loading (Chapter IV), tidal flushing (Chapter V) and habitat assessment (Chapter VII) that Rushy Marsh Pond supports only significantly impaired to severely degraded sub-tidal habitats as a result of highly restricted tidal exchange with Nantucket Sound waters. In addition, the brackish nature of the Pond waters, the minimal tidal range and prolonged elevation of water levels in previous years during periods of inlet blockage have resulted in the virtual absence of salt marsh within this estuarine system. It is clear from the MEP analysis that Rushy Marsh could benefit from flushing improvements.

At present, tidal attenuation is through the existing culvert is very high, resulting in an average tide range within Rushy Marsh Pond less than 1% that of the offshore range. Attenuation in this system is primarily caused by an undersized inlet and sedimentation. In contrast, for the adjacent estuaries, Three Bays and Popponesset Bay, tide attenuation is near zero, respectively, compared to the range offshore in Nantucket Sound.

Historically, Rushy Marsh was connected to Nantucket Sound through a jettied inlet. The inlet was located at the southern end of the marsh situated between the existing stone groins. Once the inlet closed, rather than reopening the inlet, a culvert was constructed to connect the marsh with the sound. Reconstruction of an inlet and channel provide the most appropriate approach for improving the tidal flushing in Rushy Marsh to achieve habitat restoration. The tidal restriction is the predominant source of the nutrient related habitat degradation in Rushy Marsh Pond. Removal of all of the watershed nitrogen load, would still result in an estuarine system that is significantly impaired. The reason stems from the relatively low present watershed load and the very restricted tidal flushing, which allows the build-up of eutrophying constituents within the pond. A more detailed analysis of inlet stability, maintenance requirements, and potential environmental impacts is required to fully assess inlet reconstruction. To quantitatively assess inlet improvements, two model simulations were executed to simulate Rushy Marsh hydrodynamics with a new 4-ft wide inlet and a new 10-ft wide inlet, each located at the southern end of the marsh.

Hydrodynamic model results for existing and improved inlet conditions are presented in Figure IX-1. In the top plot, tide attenuation is apparent by the lack of a tidal signature in the water surface elevations in the marsh. The middle plot shows a clear tidal signature in the marsh, tidal attenuation is still present with higher elevation of the low tides, and also by the time delay of the tide signal inside the marsh. In the bottom plot of this figure, tidal attenuation is reduced for the proposed 10 ft-wide inlet.

Based on model output, the average tidal prism increases by 6 fold with the improved 4-foot inlet and 20 fold with the 10-foot inlet. Average volumes of Rushy Marsh Pond for existing conditions and for a 20ft-wide inlet scenario are presented in Table IX-1. As a result of the increased tidal prism volume and the reduced mean tide volume of the system, the computed system residence time decreases from 47.6 days for existing conditions, to 4.9 days and 1.6 days for the 4-foot and 10-foot inlets, respectively. The restoration of tidal conditions should also encourage the re-establishment of fringing salt marsh habitat, an important additional benefit of estuarine restoration in this system.

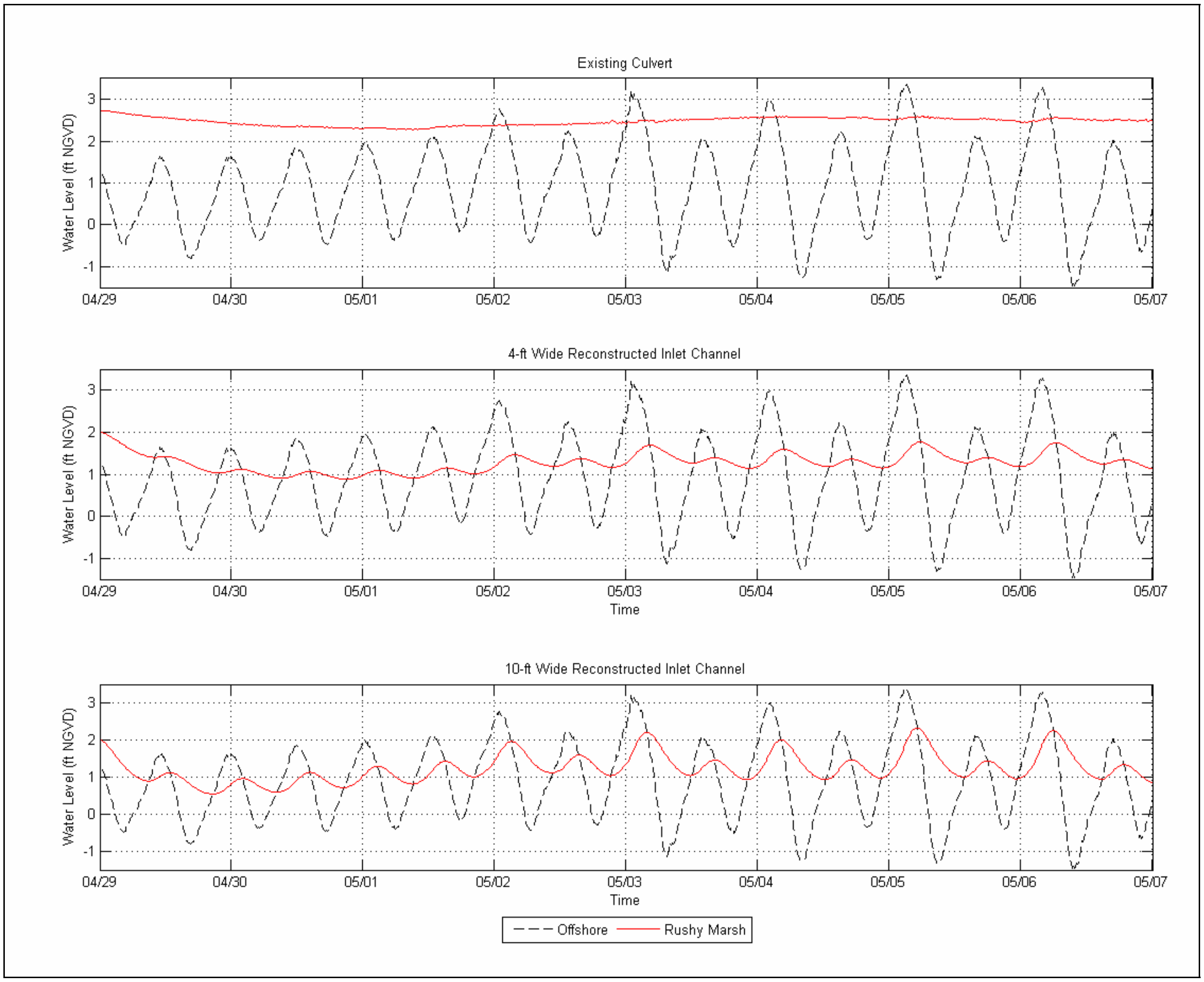

Figure IX-1. Plots showing a comparison of typical tides for modeled existing conditions (top plot), proposed reconstructed 4 ft-wide inlet (middle plot), and proposed reconstructed 10 ft-wide inlet (bottom plot) to Rushy Marsh.

Table IX-1. Average mean tide volumes, mean tide prism, and residence times for Rushy Marsh, for existing inlet conditions, and for the proposed inlet configurations.

	existing inlet	4 ft-wide inlet	10 ft-wide inlet
Mean Volume (ft^3)	2,848,800	1,950,600	1,882,400
Mean Prism Volume (ft^3)	30,936	204,625	629,120
Residence Time (days)	47.65	4.93	1.55

Water quality model runs were performed using the hydrodynamic model output of the proposed reconstructed 4-foot and 10-foot wide inlets. First, present loading conditions were modeled with the reconstructed inlets. Results from the existing loading conditions with the improved hydrodynamics of the reconstructed inlets are presented in Tables IX-2 and IX-3, and plotted in Figures IX-2 and IX-3. The TN concentrations are significantly reduced with the new inlets (i.e., up to an 62% reduction in the northern portion of the marsh), the reduction is large enough to meet the threshold limits set for Rushy Marsh (TN of 0.50 mg/L at water quality monitoring station RM2). Potential environmental and regulatory implications exist for reconfiguration of the inlet; therefore, a complete analysis of the costs, benefits, and impacts of this strategy would be required prior to further consideration of this option. From an engineering cost perspective alone, it likely is cheaper to modify the inlet than to sewer a large portion of the upper watershed, especially as sewering alone will not achieve the nitrogen threshold levels in Rushy Marsh Pond. In contrast, given the low watershed nitrogen load, reconstruction of the tidal inlet alone, will achieve the nitrogen threshold level and restoration of this system. In addition, restoration of tidal exchange (i.e. tide range) will allow the restoration of fringing salt marsh in this system, which has lost its salt water wetlands.

Table IX-2. Comparison of model average total N concentrations from present loading and the reconstructed 4 ft-wide inlet scenario with present loading, with percent change.

Sub-Embayment	monitoring station	present (mg/L)	Channel mod, present (mg/L)	% change
Rushy Marsh - north	RM1	1.102	0.417	-62.2%
Rushy Marsh - east	**RM2**	**1.107**	**0.414**	**-62.6%**
Rushy Marsh - west	RM3	1.108	0.414	-62.6%
Rushy Marsh - south	RM4	1.156	0.374	-67.7%

Table IX-3. Comparison of model average total N concentrations from present loading and the reconstructed 10 ft-wide inlet scenario with present loading, with percent change.

Sub-Embayment	monitoring station	present (mg/L)	Channel mod, present (mg/L)	% change
Rushy Marsh - north	RM1	1.102	0.336	-69.5%
Rushy Marsh - east	**RM2**	**1.107**	**0.333**	**-69.9%**
Rushy Marsh - west	RM3	1.108	0.333	-69.9%
Rushy Marsh - south	RM4	1.156	0.315	-72.7%

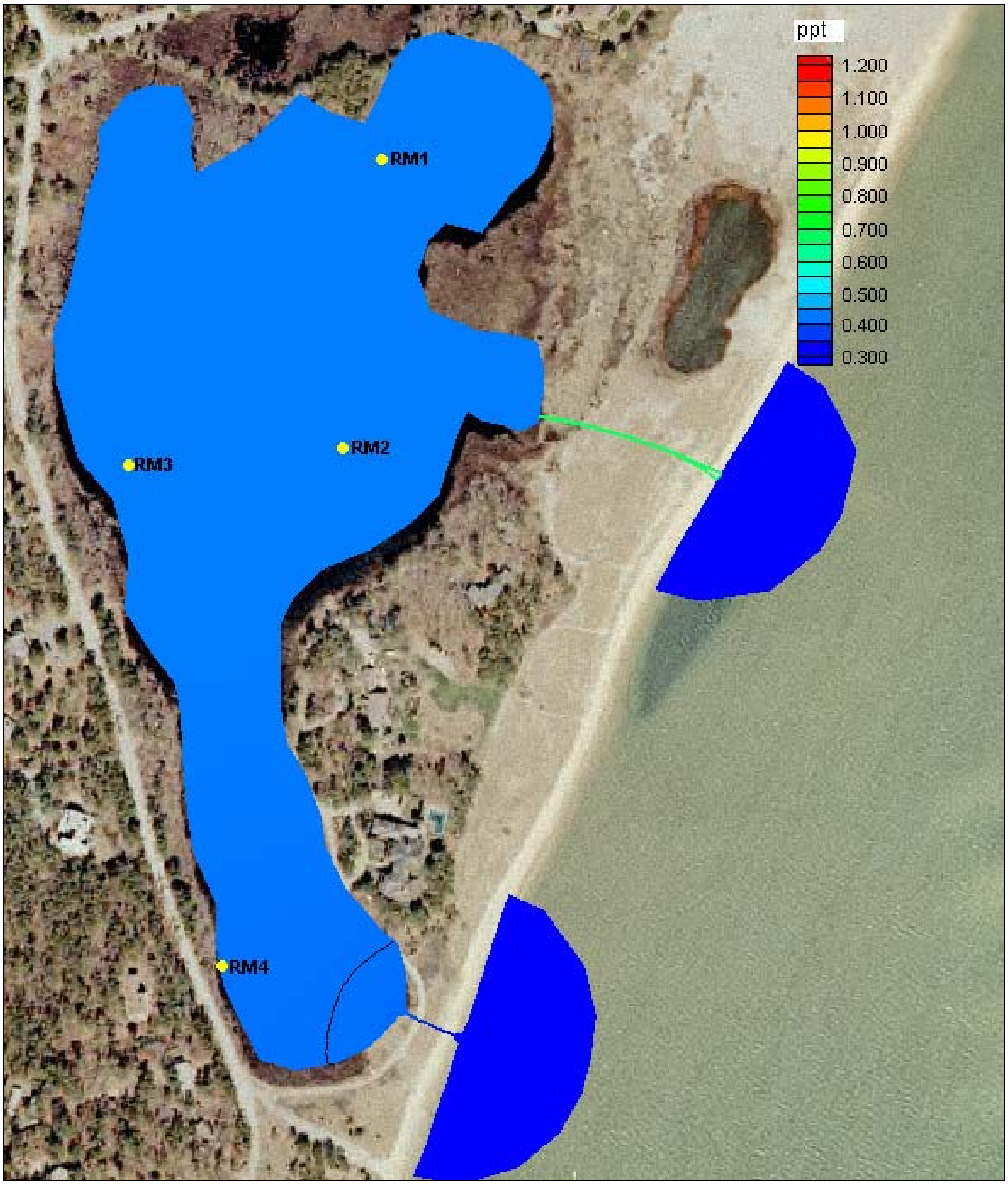

Figure IX-2. Contour Plot of modeled total nitrogen concentrations (mg/L) in Rushy Marsh, for present loading conditions, and reconstructed inlet channel (4 ft), with existing culvert. The approximate location of the sentinel threshold station for Rushy Marsh (RM2) is shown.

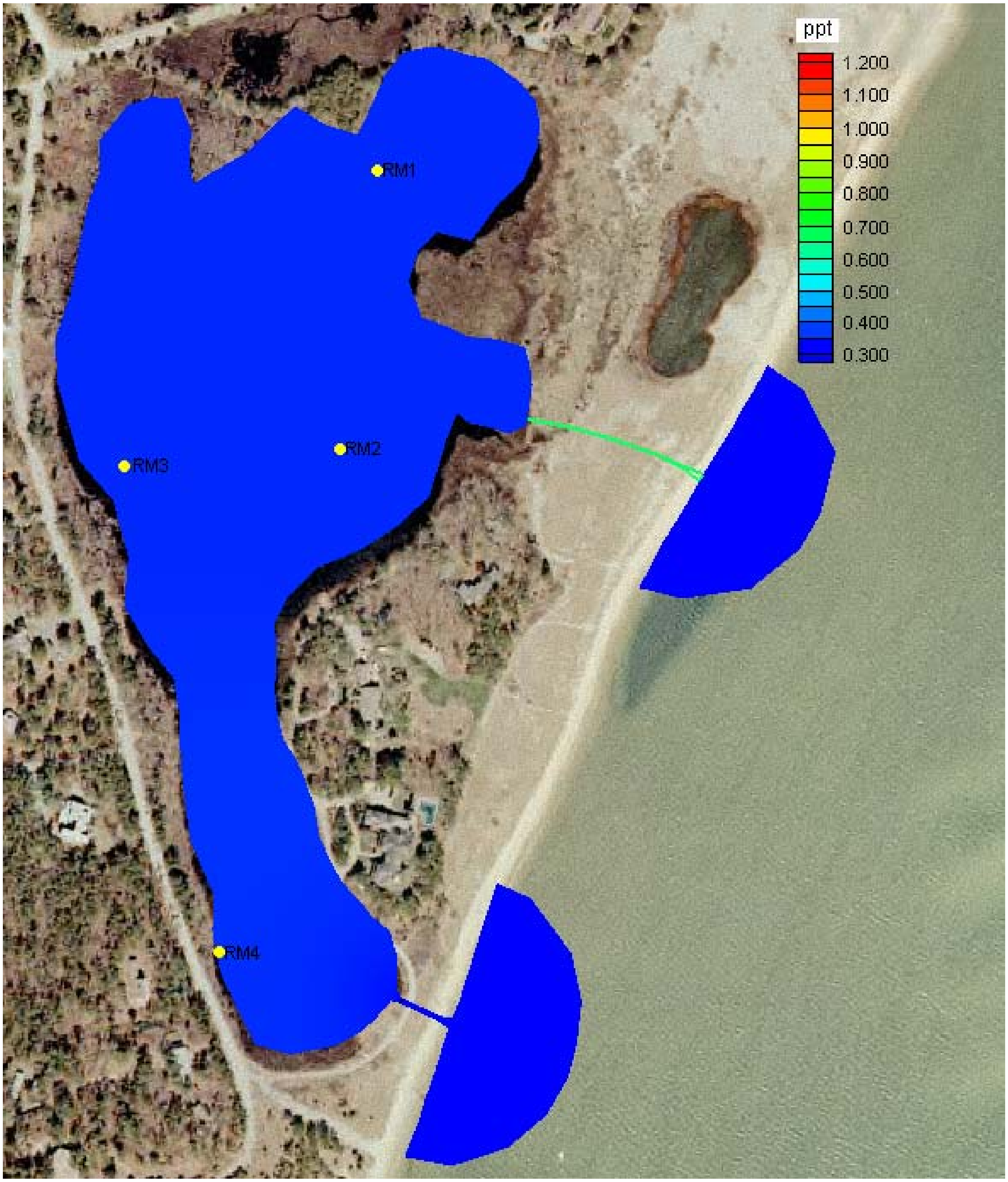

Figure IX-3. Contour Plot of modeled total nitrogen concentrations (mg/L) in Rushy Marsh, for present loading conditions, and reconstructed inlet channel (10 ft), with existing culvert. The approximate location of the sentinel threshold station for Rushy Marsh (RM2) is shown.