

IX. ALTERNATIVES TO IMPROVE TIDAL FLUSHING AND WATER QUALITY

As part of the MEP analysis, nitrogen management alternatives are evaluated towards the goal of reaching the total nitrogen level at the sentinel station to achieve restoration of embayment habitats supportable by present and historic data. In the case of Little Pond nitrogen management alternatives were conducted related to addressing the restriction to tidal flushing imposed by the present inlet and channel configuration. These alternatives are but one of many potential management pathways, but also serve to indicate the application of the Linked Watershed-Embayment model now that it is fully parameterized, calibrated and validated.

IX.1 FLUSHING IMPROVEMENTS TO LITTLE POND BY MODIFICATIONS TO THE INLET

Water quality improvements may be possible by improving tidal exchange in an estuary. Little Pond could benefit possibly from flushing improvements. Tidal attenuation is high, where the average tide range is less than 74% of the offshore range. Attenuation in this system is primarily caused by an undersized inlet. In contrast, for Great Pond and Green Pond tide attenuation is between 6% and near zero, respectively, compared to the range offshore in Vineyard Sound. Although culvert and jetty improvements were completed in 1995, the overall size of the improved culvert was limited by the existing inlet channel width (i.e. the jetty spacing). Reconfiguration of the inlet channel, as well as culvert modifications, would be required to have a significant impact on tidal flushing. A more detailed analysis of inlet stability, maintenance requirements, and potential environmental impacts would be required to fully assess inlet widening options.

Widening Little Pond inlet would improve tidal flushing. To quantitatively assess inlet improvements, a model simulation was executed to simulate Little Pond hydrodynamics with an improved 20 ft-wide inlet, which is twice the width of the existing jettied inlet.

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 higher elevation of the low tides, and also by the time delay of the tide signal inside the pond. In the bottom plot of this figure, tidal attenuation is reduced for the proposed 20 ft-wide inlet, to the point where there is little difference between the range and phase of both tide signals.

Based on model output, the average tidal prism increases by 42% with the improved inlet. Average volumes of Little Pond for existing conditions and for the 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 to 3.2 days from 4.6 days for existing conditions.

Water quality model runs were performed using the hydrodynamic model output of the proposed 20 ft-wide Little Pond inlet. First, present loading conditions were modeled with the widened inlet. Second, loading conditions necessary to meet the nitrogen loading thresholds described in Chapter VIII were developed for the widened inlet condition. Results from the existing loading conditions with the improved hydrodynamics of the widened inlet are presented in Table IX-2, and plotted in Figure IX-2. Although TN concentrations are significantly reduced (i.e., up to an 18% reduction in the lower portion of the Pond), the reduction is not large enough

to meet the threshold limits set for Little Pond (TN of 0.45 mg/L at water quality monitoring station LP2).

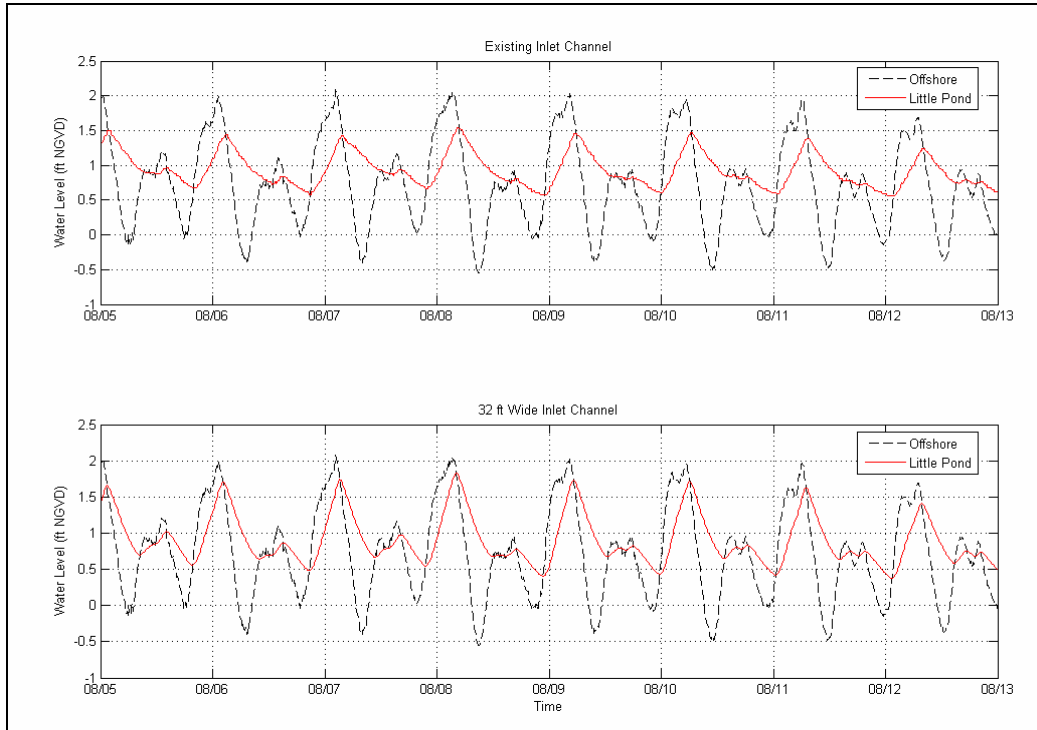


Figure IX-1. Plots showing a comparison of typical tides for modeled existing conditions (top plot) and proposed improved 20 ft-wide inlet (bottom plot) to Little Pond.

Table IX-1. Average high, mid and low tide volumes, with mean tide prism for Little Pond, for existing inlet conditions, and for the proposed 20 ft-wide inlet modification.

	existing inlet ft ³	20 ft-wide inlet ft ³	% change
Mean High Tide Volume	7,479,620	7,611,570	1.8%
Mean Tide Volume	6,986,660	6,930,340	-0.8%
Mean Low Tide Volume	6,573,610	6,253,470	-4.9%
Mean Prism Volume	785,605	1,082,070	37.8%

Table IX-2. Comparison of model average total N concentrations from present loading and the widened inlet channel (20 ft) scenario with present loading, with percent change.

Sub-Embayment	monitoring station	present (mg/L)	Channel mod, present (mg/L)	% change
Little Pond Head (fresh water)	LPHead	2.236	2.202	-1.5%
Little Pond - upper	LP1	0.955	0.838	-12.3%
Little Pond - mid	LP2	0.837	0.714	-14.7%
Little Pond - lower	LP3	0.705	0.577	-18.1%



Figure IX-2. Contour Plot of modeled total nitrogen concentrations (mg/L) in Little Pond, for present loading conditions, and widened inlet channel (20 ft). The approximate location of the sentinel threshold station for Little Pond (LP2) is shown.

However, threshold concentrations can be achieved for the widened inlet scenario as shown in Table IX-3, IX-4, and Figure IX-3. Similar to the threshold evaluation in Chapter VIII, 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) required for the system's lower watershed. In addition, a portion of the septic load entering the pond from the fresh water stream also must be removed to meet the threshold nitrogen concentrations. For the load reduction scenario evaluated, the Little Pond Stream sub-watershed required removal of approximately 30% of the septic load.

Therefore, a combination of removing septic loading to the lower watershed, removing 30% of the freshwater stream load, and increasing the width of the inlet would improve the system to a level that meets the selected restoration threshold. Widening the inlet would certainly make the threshold limit more practically attainable, where significantly less nitrogen load (30 percent) would need to be removed within the watershed. 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.

Table IX-3. Comparison of sub-embayment watershed **septic loads** (attenuated) used for modeling of present and threshold loading for the widened inlet threshold scenario of Little Pond. 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
Little Pond	10.419	0.000	-100.0%
Surface Water Sources			
Little Pond Stream	5.496	3.847	-30.0%

Table IX-4. Comparison of model average total N concentrations from present loading and the modeled widened inlet threshold scenario (lower watershed) with widened inlet channel (20 ft) scenario, with percent change.

Sub-Embayment	monitoring station	present (mg/L)	Channel mod, 20-ft wide (mg/L)	% change
Little Pond Head (fresh water)	LPHead	2.236	1.570	-29.8%
Little Pond - upper	LP1	0.955	0.527	-44.9%
Little Pond - mid	LP2	0.837	0.454	-45.7%
Little Pond - lower	LP3	0.705	0.393	-44.2%



Figure IX-3. Contour Plot of modeled total nitrogen concentrations (mg/L) in Little Pond, for widened inlet threshold scenario (lower watershed) loading conditions, and widened inlet channel (20 ft). The approximate location of the sentinel threshold station for Little Pond (LP2) is shown.