First Order Assessment of the Indian Ponds
(Mystic Lake, Middle Pond, and Hamblin Pond)

FINAL REPORT
March, 2006

for the
Indian Ponds Association and the Town of Barnstable

Prepared by:

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Prepared for

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This project was completed under contract by the Cape Cod Commission for the Indian Pond Association

Cover photo: Tom Cambareri, 2003

Executive Summary

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Mystic Lake, Middle Pond, and Hamblin Pond are collectively known as the Indian Ponds. These three ponds which are located in the Town of Barnstable are similar in area (each over 100 acres), but their depth, surrounding land use, and location in the regional aquifer system have resulted in a variety of conditions and public concerns. In order to help discuss and address these concerns, local homeowners formed the Indian Ponds Association (IPA) in 1958. Through a partnership with the Town, the IPA asked the Cape Cod Commission to complete a first order assessment of the ponds, including the development of a 2004 water quality sampling plan, the delineation and development of a water budget, interpretation of water quality data, the development of a phosphorus budget and recommendations for water quality restoration and management and monitoring. The Commission prepared an initial water budget report, which included information on the pond, groundwater, and area water uses and highlighted relevant water management issues concerning the herring run, cranberry irrigation and water supply development. The report that follows refines the water budget findings based on the water quality analysis and collectively summarizes all the assessment activities for a first order assessment of the ponds.

Groundwater is greater than 80% of the inflow portion of the water budget for all the ponds and nearly 90% of the annual flow through the ponds discharges back to the aquifer system. Watershed delineations completed by the US Geological Survey show that groundwater flows from the top of the Sagamore Lens, is captured by three wellfields in Sandwich, flows through Spectacle, Lawrence, and Triangle Ponds and is captured by Crooked Cartway wellfield in Barnstable or Mystic Lake. This water then flows into Middle Pond and then into Hamblin Pond. As would be expected by this close connection to the groundwater, water levels in the ponds move up and down in tandem with regional water table changes and short-term impacts, such as cranberry bog withdraws, releases through the Middle Pond herring run, or large precipitation events, are balanced by opposite changes in flow into or out of the ponds. Recharge from the watersheds causes a given volume of water to remain in Mystic, Middle, and Hamblin for an average of 1.1, 0.56, and 1.0 years, respectively.

Field measurements and water quality samples were collected 10 times between May and November 2004 based on a sampling plan coordinated with the Town of Barnstable and IPA volunteers. Samples were analyzed at the School of Marine Science and Technology (SMAST) water quality lab at the University of Massachusetts, Dartmouth in New Bedford for the following parameters: total phosphorus (TP), total nitrogen (TN), chlorophyll-*a*, alkalinity, and pH. Field measurements included temperature and dissolved oxygen profiles with measurements at one meter increments and Secchi depth readings.

Temperature and dissolved oxygen profiles generally show that Hamblin and Mystic form a warm, well-mixed upper layer or epilimnion overlying a colder deep layer or hypolimnion in a process known as stratification. Because Middle Pond is shallower, normal winds are generally enough to keep its entire water column well mixed. Because there is too much organic matter in the sediments of Hamblin and Mystic, oxygen in their hypolimnia is rapidly consumed once stratification occurs. These anoxic conditions allow phosphorus that is otherwise bound in the sediments to be released back into the overlying water. This release is the primary source of phosphorus in both Hamblin Pond and Mystic Lake.

There is a significant difference, however, between Hamblin and Mystic that allows Hamblin to be relatively less impacted; the upper portion of Hamblin's hypolimnion has high oxygen concentrations. Phosphorus released from the sediments encounters these high oxygen concentrations, is converted back to an insoluble form, and sinks back toward the sediments. Because of this, water quality data shows that the phosphorus released by the anoxic bottom conditions does not impact its upper waters. The phosphorus budget shows a balance between watershed phosphorus loads from properties upgradient and abutting the pond and the TP concentrations measured in the pond. This well oxygenated portion of the hypolimnion is the result of a 1995 alum treatment; comparison of existing conditions to those prior to 1995 not only show the improvement in hypolimnetic oxygen conditions, but also reduced surface TP concentrations (*e.g.*, current is 10 ppb, while 1993 pre-alum was 69 ppb), improved Secchi readings (0.91 m in 1948 compared to a current average of 6.4 m), and reduced hypolimnetic oxygen demand (current average of 182 mg/m2/d, pre-alum 1993 average of 860 mg/m2/d). Hamblin Pond is still somewhat impacted given its on-going sediment oxygen demand, but is much improved compared to its pre-alum treatment conditions.

Mystic Lake, on the other hand, is clearly impaired. It has the highest average surface TP concentrations among the Indian Ponds (16 ppb), the worst Secchi readings (3 m average or 22% of its total depth), and the highest hypolimnetic oxygen demand (358 mg/m2/d). Because the dissolved oxygen profiles show that anoxic conditions exist up to the bottom of the epilimnion, some of the TP released into the hypolimnion from the sediments can seep into the epilimnion. The phosphorus budget confirms this scenario; watershed sources are insufficient to balance the measured epilimnetic TP concentrations. In order to match these concentrations, internal regeneration of TP from the sediments must add 12 kg/yr or roughly a quarter of the budget.

Middle Pond is relatively unimpacted compared to the other two ponds. It has the highest relative Secchi average (60%), average TP concentration of 10.6 ppb throughout its water column, and generally well oxygenated conditions even down to the sediments. It does develop some low oxygen conditions late in the summer or, apparently, during fairly quiescent periods. The phosphorus budget for the pond shows that an additional source of TP must be added to the pond to balance measured concentrations; potential sources are either water flowing from Mystic Lake or phosphorus released from the sediments during these intermittent low oxygen conditions.

After reviewing the water quality data, it is clear that Mystic Lake is impaired. Water quality in the other two ponds shows some issues of concern, but water quality conditions are generally good. Mystic Lake's impairments will require addressing phosphorus loads from both

the sediment regeneration and the watershed sources. If the Cape Cod 10 ppb TP threshold in the epilimnion of Mystic Lake is used as a planning target, ~35 kg/yr would be the acceptable load to this layer. If a phosphorus reduction occurred similar to that achieved by the alum treatment in Hamblin Pond, a layer of well-oxygenated water in the hypolimnion would effectively isolate the phosphorus regenerated by the sediments and remove this load from the epilimnion. This would reduce the current epilimnion mass to the 35 kg/yr target, but it is estimated that there is an additional 12 kg/yr already in the groundwater from existing development and an additional 3 kg/yr is projected from buildout around the shoreline.

Project staff recommends that the IPA and the Town consider a series of three parallel steps to remediate Mystic Lake. The first step would be to address the phosphorus regenerated from the sediments; this can be done a number of ways (*e.g.*, alum application, hypolimnetic aeration, etc.) and the selected option will likely require a permit and associated public hearings from the town Conservation Commission. The second step would be a number of activities to address the watershed loading; based on the phosphorus budget, 15 kg of TP would have to be removed. Steps to address this reduction are discussed. A third step would be to review existing regulatory programs (*i.e.*, board of health, conservation commission, and planning board) and their regulations and bylaws to evaluate potential changes to better protect water quality and, eventually, preserve the benefits of whatever investment is made to reduce the sediment phosphorus regeneration.

It is further recommended that the town and/or the IPA continue to monitor all three ponds, albeit on a reduced frequency compared to the sampling completed during this assessment. The recommended monitoring program should include, at a minimum, the same parameters, detections limits, depths, and sampling procedures utilized during this project; sampling should occur, at a minimum, in early April and late August. The late August sampling could occur via the regular PALS Snapshot, if this project is still occurring. Regular review of the results from the sampling program can be used to monitor conditions in the ponds and allow whatever management strategies are selected to be adapted to address concerns that may arise.

The Cape Cod Commission staff is available to elaborate on these recommendations and assist the town and IPA in the development of strategies to address the long term remediation and protection of the Indian Ponds.

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