GUIDANCE DOCUMENT AND CASE STUDY REPORT
FOR THE GREAT SAND LAKES
HARWICH, MASSACHUSETTS

EVALUATION OF WASTEWATER MANAGEMENT OPTIONS
FOR FRESHWATER PONDS

EXECUTIVE SUMMARY

This report has been made possible by a grant from Barnstable County to the Town of Harwich (Town) to evaluate wastewater management options for the Great Sand Lakes and their watersheds as well as the watersheds to several Town water-supply wells downgradient of the lakes. The three main goals of the evaluation are to investigate and determine:

1. The role the lakes play in reducing nitrogen loadings to the Town water-supply wells.

2. The water quality and habitat conditions of the Great Sand Lakes.

3. Recommend future actions to monitor and preserve/improve the overall quality of the Great Sand Lakes.

This evaluation was not intended to be a Comprehensive Wastewater Management Plan or a lake remedial investigation and feasibility study.

The grant and the overall project have been managed by the Harwich Water Quality Task Force. The report has been prepared in the form of a Guidance Document and Case Study Report so that other towns on Cape Cod (and elsewhere) can use it as a guide for their wastewater and watershed management evaluations.

Cape Cod has experienced significant population growth in recent decades, and it is home to a number of sensitive ocean, estuarine, and freshwater ecosystems. Moreover, the aquifer under the Cape is the primary water supply for the population and is classified as a "sole source aquifer" by the U.S. Environmental Protection Agency. A consequence of the increasing population is the potential for adverse impacts on surface and groundwaters as a result of

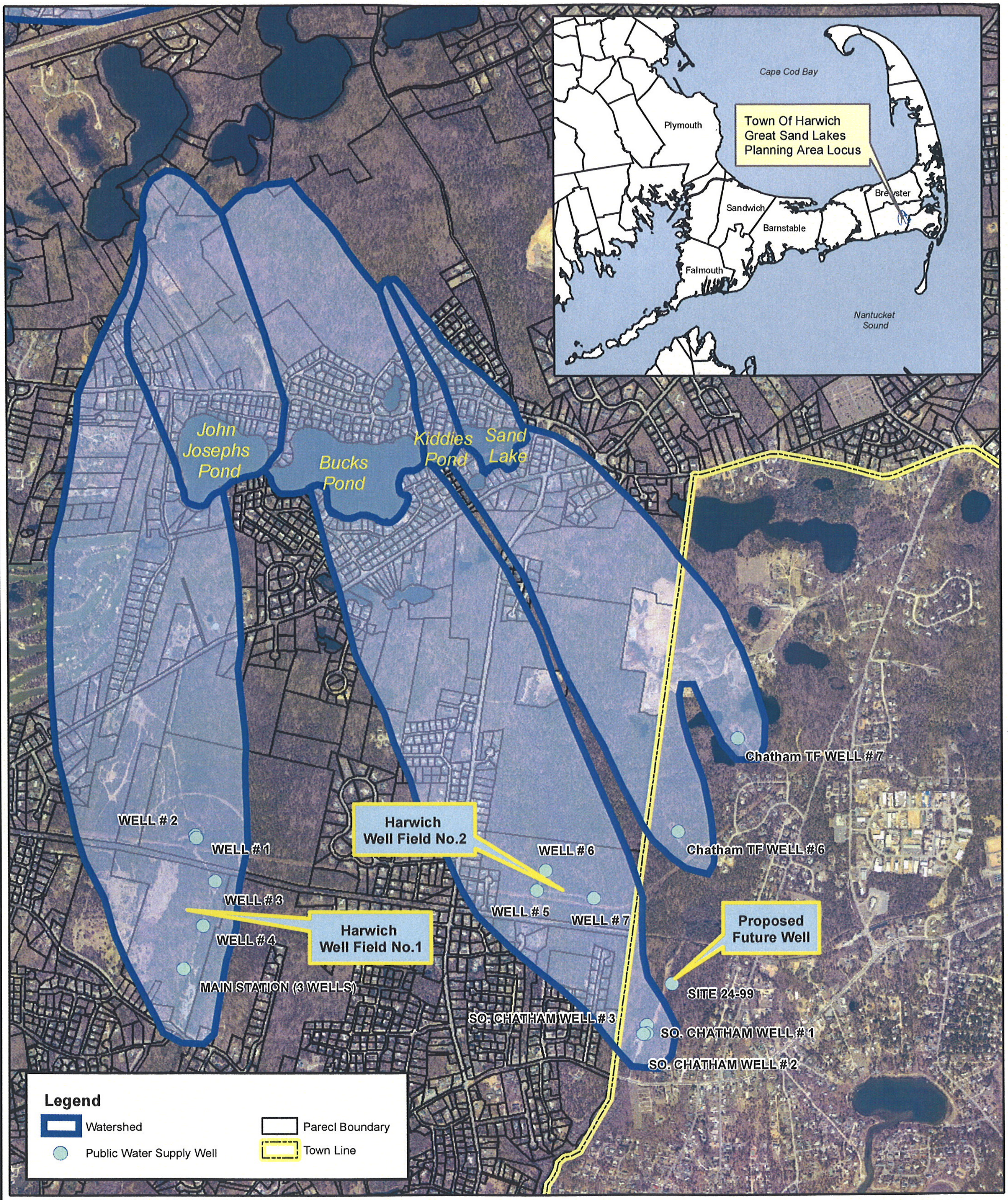
wastewater discharge through individual septic systems that provide minimal removal of nitrogen and phosphorus.

Ponds and lakes are a vital part of the aquifer system on Cape Cod. These water resources tend to be areas where the underlying groundwater is higher than the ground surface, and the top of the aquifer is available for all to see; hence the characterization of Cape ponds as “windows on the aquifer.” While these ponds are important ecosystems in their own right, they also function to reduce nutrient loads flowing into coastal estuaries and water-supply wells. With nearly 1,000 ponds on the Cape, many towns are faced with regulatory decisions regarding the proper management of wastewater around the ponds due to concerns about nitrogen or phosphorus loads from the watershed. When making lot-by-lot decisions, the towns often lack a full understanding of the role the fresh water ponds play as nitrogen sinks, and the options available for managing phosphorus from septic systems.

This Guidance Document and Case Study Report is divided into seven sections as outlined in the Table of Contents. Chapter 1 presents general introductory information about the report and other guidance documents. Chapter 2 describes the Great Sand Lakes planning areas. Chapter 3 describes the evaluations completed to delineate the watersheds of the planning areas and to complete the nitrogen loading evaluations. Chapter 4 summarizes the pond and lake water quality assessments and the phosphorus loading evaluations. Chapter 5 summarizes the wastewater and phosphorus management/remediation options. Chapter 6 lists the various references used in the evaluations.

The planning area is the watershed area to the Great Sand Lakes and the downgradient water-supply wells, as illustrated in Figure ES-1. This figure illustrates the dense residential development (typically 1/4-acre subdivisions) around the Great Sand Lakes, and the several large properties owned by the Town and state which provide protection for the water supply wells. This planning area is near its buildout condition, with limited potential for new development. Also, this area is covered by water supply protection and land use restrictions because it is within the Zone II areas of the water-supply wells.

The planning area was identified with the use of a United States Geological Survey (USGS) watershed map based on the regional groundwater model developed by USGS for Cape Cod. The delineation was verified with the use of a hydraulic balance on the water supplies and found to be a good basis for subsequent nitrogen and phosphorus load evaluations.



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Data Source: Mass GIS,USGS,MEP
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Stearns & Wheler, LLC
Environmental Engineers and Scientists
HYANNIS, MASSACHUSETTS

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Watersheds for Great Sand Lakes and Down-Gradient Water Supplies

Great Sand Lakes Case Study Report

FIGURE ES-1

Ten years of nitrogen concentration data for the downgradient water supply wells was reviewed and found to be below 0.6 mg/L nitrate-nitrogen (average concentrations) for the three groups of wells. Nitrogen transport modeling indicated that future average nitrogen concentrations could increase to a range of 1.4 to 1.8 mg/L for the three groups of wells based on conservative modeling assumptions. This range was reduced to a range of 0.7 to 1.5 mg/L when nitrogen attenuation (at 75 percent) from the Great Sand Lakes is considered. Nitrogen attenuation in the Great Sand Lakes was estimated at 75 to 88 percent based on loading calculations and limited groundwater measurements upgradient and downgradient of the Great Sand Lakes.

All of the nitrogen measurements and calculations indicate that the water supplies are well protected from existing and future wastewater and nitrogen loadings as compared to the Massachusetts drinking water standard of 10 mg/L and the Cape Cod Commission standard of 5 mg/L at the wells. This observation further indicates the following findings:

1. The ponds are very effective at removing groundwater nitrogen from their watersheds and protecting the downgradient wells from potential nitrogen contamination.

2. Many areas of land in the watershed to the water-supply wells are protected from development and will further protect the drinking-water quality.

3. Future wastewater planning efforts should not be focused on managing potential wastewater-nitrogen impacts to the water supply wells, as there does not appear sufficient need to warrant the efforts.

4. Under the existing and projected conditions, it appears that nitrogen loading is not a problem in the watershed(s) of Great Sand Lakes. Phosphorous appears to be the main threat to pond water quality. Future attention should be primarily focused on managing the phosphorous in the watershed and in the ponds, and not on nitrogen-removing septic systems in the pond watersheds.

An extensive evaluation of available pond and lake water quality data and a detailed habitat assessment was completed, and indicated the following findings:

1. The two largest ponds, John Josephs and Bucks Ponds, are the only ponds that have long-term albeit limited monitoring data. Conclusions on Kiddies and Great Sand Lake are limited due to a lack of data.

2. Phosphorus is the limiting nutrient in these ponds and lakes based on the nitrogen-to-phosphorus ratio in the upper waters.

3. Based on several environmental criteria related to the documented water quality, Bucks and John Joseph are in the early stages of nutrient enrichment. The water quality is still considered good based on the criteria, but further water quality monitoring is warranted. Field observations of Kiddies and Great Sand Lake indicate they are much more productive.

4. A thin layer of filamentous algae (periphyton) is evident on near-shore sediments of shallow areas of John Josephs and Bucks Ponds. According to local residents, this extensive algae mat is a relatively recent occurrence.

5. The growth of periphyton is a symptom of nutrient enrichment and merits close monitoring.

6. The ponds, as a whole, are valuable aesthetic assets and provide habitat for a diverse assemblage of aquatic biota as well as swimming, fishing, boating, and general enjoyment of the residents. As such, the ponds are currently meeting their designated uses.

A phosphorus loading evaluation was completed to identify the potential relative mass loading of phosphorus from various sources. The typical sources are wastewater, lawn fertilization, stormwater, atmospheric deposition, and water fowl. In some cases of stratified ponds, recycled phosphorus from the sediments can be a significant source to the upper waters. The following findings are noted for Great Sand Lakes evaluation:

1. Phosphorus from wastewater sources represents 75 to 87 percent of the total estimated phosphorus load from a 300-foot wide strip upgradient of the ponds. Other sources include lawn fertilizers, runoff and infiltration from roads and roofs, waterfowl, and precipitation on the pond surface and on natural (forest and shrub) areas.

2. Phosphorus does not appear to be recycling from the sediments in the lower oxygen-depleted, portion of the ponds (John Joseph and Bucks) to the upper waters during the summer (stratified) season. It does, however, enter the upper waters during fall and spring mixing periods.

3. Most of the phosphorus does get bound up in the soil for an indeterminate time, creating a plume or reservoir of potential loading to the ponds. The vast majority of the estimated load is bound up. This understanding is based on the historic development in the area and the current scientific understanding of how phosphorus is retained in saturated soils.

4. If this reservoir moves at one meter per year (as supported by some recently published findings), the phosphorus from a 300-foot wide area upgradient of the ponds may now be arriving at the pond's shore in sufficient quantity to produce symptoms of excess nutrients as evidenced by the appearance of the periphyton algal mat.

5. The phosphorus travel velocity may be significantly less than 1 meter per year due to soil conditions, groundwater chemistry, and other factors. As a result, there is great uncertainty on when and if the full phosphorus load might arrive at the ponds, and how high the pond phosphorus concentration could increase when and if the load arrives.

6. Watershed modeling (using the Wisconsin Lakes Model) indicates that the water column phosphorus concentration could increase from the current level of less than 10 μg/L (average spring conditions) for the two ponds, to a range of 12 to 43 μg/L. This large range indicates the uncertainty discussed above and the possibility that the concentration could increase significantly. This type of phosphorus concentration increase would be associated with more algal growth, diminished water clarity, and eutrophic conditions.

7. Increased sampling will be necessary to monitor water quality conditions in the future. This is based on the evidence of the recent increased loading (the appearance of the periphyton) and the uncertainty associated with the bound phosphorus.

In addition to increased monitoring, several wastewater and phosphorus management/mitigation options were identified and evaluated to initiate the decision-making process on this issue. Several of the options (most of them educational in nature) could be implemented in the short

term as pond monitoring efforts continue to track the water quality over time. Others will require BOH actions, town highway stormwater remediation, and depending on outcome of increased monitoring, some possible long-range major actions.

The following watershed management options to reduce the existing load should be pursued through educational materials, presentations, and discussions with the residents around the ponds (particularly upgradient of the ponds):

1. The single most effective step is to get all homeowners to reduce the use of phosphorus-containing detergents (especially dishwashing detergents). That alone could reduce phosphorus loads to the wastewater by 37 to 50 percent.

2. Eliminate the use of kitchen sink garbage grinders that could reduce phosphorus loads from food wastes by up to 4 percent.

3. Implement better ways to manage runoff from household roofs, driveways, and other impervious surfaces.

4. Improve landscape practices such as restoring and adding buffers within 50 feet of the shore to reduce stormwater runoff impacts.

5. Improve fertilizer management practices that would focus on proper application and reduced occurrence of over-application.

6. Canada Goose management to prevent nuisance geese populations from expanding, fouling the beaches, and degrading water quality from increased nutrients as well as fecal material.

The Town Board of Health could require design enhancements of Title 5 septic systems upgradient of the ponds to promote additional phosphorus removals. These enhancements would include:

1. Maximizing vertical separation between the bottom of the leaching system and the top of the water table.

2. Providing even distribution across the leaching area to prevent waterlogging or saturating one portion of the system.

3. Requiring periodic pumping of the septic tank effluent to the infiltration system (as opposed to continuous gravity flow) to allow the infiltration system to dry out between doses.

4. Introducing the septic tank effluent into the upper layers of the soil (B layer) where there tends to be more phosphorus adsorption sites and where plant materials may be able to utilize the phosphorus as a nutrient.

As a direct result of a dialogue started during this study, and the ground work done by the Pond Subcommittee of the Water Quality Task Force, the Town Highway Department has initiated and should continue to proceed with efforts to manage the stormwater that comes off the Town roads in the area. The best type of stormwater management (and often the least expensive) is to direct the stormwater to vegetated basins, swales, and wetlands where suspended solids and fecal coliform are settled and nutrients are taken up by the plant materials. Leaching pits are also a good solution when there is not sufficient space for a vegetated swale or basin.

The current pond water quality monitoring includes sampling and measurement of several water quality parameters during the summer (June through September). The following parameters have been measured and are documented on the Harwich Water Quality Task Force Website:

1. Dissolved oxygen.
2. Water temperature.
3. Water clarity as measured by Secchi depth readings.
4. Alkalinity.
5. Total phosphorus.
6. Total nitrogen.
7. Chlorophyll.

The following items should be added to the current monitoring program:

1. Monitoring of the periphyton extent should be initiated and continued in future years.

2. Measurements of the phosphorus concentration through the water column at several depths would provide more detailed information regarding phosphorus content of the ponds and if phosphorus release from the sediments occurs over time. These profiles should be collected in late summer when the ponds (Bucks and John Josephs) are well stratified.

If the monitoring indicates an increase of phosphorus from the watershed or from the sediments, or other symptoms of increasing eutrophication are observed, a remedial investigation/feasibility study (RI/FS) should be initiated to investigate the location and movement of the phosphorus in the ponds and in the watersheds, and evaluate the feasilbity and cost of the most practical remedial solution. This would be a detailed study with soil and groundwater investigations upgradient of the pond.

Several long-term and engineered wastewater and phosphorus management options that should be evaluated during such a study were identified and are presented in the body of this report. They are briefly listed below with some of their benefits and drawbacks:

1. The phosphorus reservoir could be intercepted by an engineered barrier wall before it emerges into the pond. This type of remediation has precedent on Cape Cod and is being monitored by the scientific community, but it is considered experimental. A similar option would be to intercept the ground water using wells to collect the groundwater and discharge it outside the watershed.

2. Phosphorus loading to the watershed (beyond the loadings that can be addressed through educational materials as listed above) can be further reduced with wastewater collection and treatment. This option will do nothing for the phosphorus already in the watershed (over 50 years of loading), but it would reduce the phosphorus loadings into the future. This is an expensive solution. This area should be evaluated in the Town's Comprehensive Wastewater Management Planning Project as a potential future sewered area.

3. The pond water could be "treated" with aeration or water-circulation technologies or with a chemical (typically alum) to manage or tie up the phosphorus that has collected in the ponds. These options are typically used to manage phosphorus recycling from the sediments and not to manage phosphorus loadings from the watershed. It is noted these

“treatments” are not needed at this time due to the current relatively low concentrations of phosphorus in the ponds and no indication that phosphorus is recycling from the sediments.