MASSACHUSETTS
watershed·based plans

# WATERSHED-BASED PLAN

## Quaboag (North) Pond (MA36130)
## Quacumquasit (South) Pond (MA36131)

September 2022

WBP ID #1669

**Prepared By:**

Town of Sturbridge, MA
Geosyntec Consultants, Inc.

**Prepared For:**

MassDEP
Commonwealth of Massachusetts
Department of Environmental Protection

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# Contents

# Executive Summary

**Introduction:** The purpose of a Massachusetts Watershed-Based Plan (WBP) is to organize information about Massachusetts' watersheds and present the information in a format that will enhance the development and implementation of projects that will restore water quality and beneficial uses in the Commonwealth. The Massachusetts WBP follows the United States Environmental Protection Agency's (EPA's) recommended format for "nine-element" watershed plans. This WBP was developed by Geosyntec Consultants (Geosyntec) under the direction of the Town of Sturbridge, with funding, input, and collaboration from the Massachusetts Department of Environmental Protection (MassDEP).

This WBP was prepared for the Quaboag (North) Pond/Quacumquasit (South) Pond[1] watershed, which is within the towns of Sturbridge, Brookfield, East Brookfield, Spencer, Charlton, North Brookfield, New Braintree, Leicester, Oakham, Rutland, and Paxton, Massachusetts. Quacumquasit Pond discharges underneath a bridge on Lake Road to an approximately 1,500-foot channel (referred to as the "interbasin connector") to Quaboag Pond. Quacumquasit Pond also receives backflows from Quaboag Pond via this channel; a flow control structure was constructed in 1991 (Baystate Environmental Consultants, 1989; Lycott, 1994) to reduce the potential for backflows to occur, but backflows to Quacumquasit Pond from Quaboag Pond do still occur (MassDEP, 2006).

Quaboag Pond has an area of about 544 acres with an average depth of less than 7 feet, while Quacumquasit Pond has an area of about 223 acres with an average depth of over 32 feet (Lycott Environmental Research, Inc., 1994). Although Quaboag Pond is larger in area, it has about half the volume of Quacumquasit Pond and a much shorter retention time; Quaboag Pond has an estimated retention time of 12 days and Quacumquasit Pond has an estimated retention time of 1.5 years (MassDEP, 2006).

Quaboag Pond discharges into the Quaboag River, which is within the Chicopee River basin. The total area of the Quaboag Pond/Quacumquasit Pond watershed is approximately 48,671 acres[2] (76 square miles). Major streams in the watershed include Fivemile River, East Brookfield River, Sevenmile River[3], Turkey Hill Brook, Cranberry Meadow River, and Great Brook. Other major lakes/ponds in the watershed include Lashaway Lake, Brooks Pond, Dean Pond, Browning Pond, Turkey Hill Pond, Eames Pond, Thompsons Pond, Sugden Reservoir, Lake Whittemore, and Cranberry Meadow Pond .

**Impairments and Pollution Sources:** Quaboag Pond (MA36130) is identified as a category 5 water body on the 2018/2020 Massachusetts Integrated List of Waters (303(d) list) (MassDEP, 2021) due to algae, Eurasian water milfoil (Myriophyllum spicatum), fanwort (Nymphaeles cambombaceae), non-native aquatic plants, mercury in fish tissue, and Total Phosphorus (TP). The listed sources of these impairments include internal nutrient recycling, municipal point source discharges, introduction of non-native plants, and nonpoint sources. Quacumquasit Pond (MA36131) is identified as a category 4A water body on the 303(d) list due to mercury in fish tissue, Eurasian water

[1] Quaboag Pond is within the towns of East Brookfield and Brookfield, Massachusetts. Quacumquasit Pond is within the towns of Sturbridge, Brookfield, and East Brookfield.
[2] In periods of no backflow from Quaboag Pond, the watershed area of Quacumquasit Pond is approximately 1,118 acres (1.7 square miles).
[3] A WBP was previously completed for the Sevenmile River watershed in 2020 (Geosyntec and Town of Spencer, 2020) and is accessible here: WBP – Accepted Plans (geosyntec.com)

milfoil, fanwort, and non-native aquatic plants. The listed sources of these impairments include atmospheric deposition and introduction of non-native plants. The sources for the mercury in fish tissue impairment in Quaboag Pond and Quacumquasit Pond is also listed as unknown on the 303(d) List.

Quacumquasit Pond and Quaboag Pond are both subject to a Total Maximum Daily Load (TMDL) for Total Phosphorus (TP) (MassDEP, 2006).

**Goals, Management Measures, and Funding:** The long-term goal of this WBP is to improve water quality, meet or exceed the TP TMDL (MassDEP, 2006) target, and ultimately remove Quaboag Pond and Quacumquasit Pond from the 303(d) list by 2032. It is expected that these pollutant load reductions will result in improvements to listed impairments throughout the watershed.

The water quality goal (adapted from the TP TMDL) is to reduce land-use-based TP loading by 128 pounds per year (lbs/yr) and 2,473 lbs/yr to Quacumquasit Pond and Quaboag Pond, respectively. Additionally, although not identified as a significant water quality impairment in the ponds, a water quality goal for bacteria (*E. coli*) is also included; *E. coli* is a listed water quality impairment for the Sevenmile River, which is within the watershed.

It is expected that goals will be accomplished primarily through phosphorus inactivation (alum treatment) in Quacumquasit Pond, herbicide treatments, structural best management practices (BMPs), non-structural BMPs (e.g., street sweeping, catch basin cleaning), and watershed education and outreach.

It is expected that funding for future management measures will be obtained from Section 319 and Section 604(b) grants in addition to Town Capital funds, volunteer efforts, and other sources.

**Public Education and Outreach:** The Town of Sturbridge, Quaboag Quacumquasit Lake Association (QQLA) and other stakeholders continually implement a public education and outreach campaign to educate the public about nonpoint source pollution to the Quaboag Pond and Quacumquasit Pond, with the goal of ensuring continued improvements in water quality and environmental stewardship. Recent examples include public education and outreach through their website, watershed events, and their semi-annual newsletter. Watershed events have included photo contests, paddling days, and pond cleanup events.

**Implementation Schedule and Evaluation Criteria:** The WBP implementation schedule includes milestones for BMP implementation, monitoring, public education and outreach, and periodic updates to the WBP. It is expected that continuation and expansion of the current water quality monitoring program will enable improvements to be directly evaluated over time. The WBP will be reevaluated every three years and adjusted as needed.

# Introduction

## What is a Watershed-Based Plan?

### Purpose & Need

The purpose of a Massachusetts Watershed-Based Plan (WBP) is to organize information about Massachusetts' watersheds and present the information in a format that will enhance the development and implementation of projects that will restore water quality and beneficial uses in the Commonwealth. The Massachusetts WBP follows the United States Environmental Protection Agency's (EPA's) recommended format for "nine-element" WBPs, as described below.

All states are required to develop WBPs, but not all states have taken the same approach. Most states develop WBPs only for selected watersheds. Massachusetts Department of Environmental Protection's (MassDEP's) approach has been to develop a tool to support statewide development of WBPs so **that good projects in all areas of the state may be eligible for federal watershed implementation grant funds** under Section 319 of the Clean Water Act.

EPA guidelines promote the use of Section 319 funding for developing and implementing WBPs. WBPs are required for all projects implemented with Section 319 funds and are recommended for all watershed projects, whether they are designed to protect unimpaired waters, restore impaired waters, or both.

### Watershed-Based Plan Outline

This WBP for the Quacumquasit Pond (South Pond)/Quaboag Pond (North Pond) watershed includes nine elements (a through i) in accordance with EPA Guidelines:

a) An **identification of the causes and sources** or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this WBP and to achieve any other watershed goals identified in the WBP, as discussed in item (b) immediately below.

b) An **estimate of the load reductions** expected for the management measures described under paragraph (c) below, recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time.

c) A **description of the nonpoint source management measures** needed to achieve the load reductions estimated under paragraph (b) above as well as to achieve other watershed goals identified in this WBP and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan.

d) An **estimate of the amounts of technical and financial assistance needed**, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan. As sources of funding, States should consider the use of their Section 319 programs, State Revolving Funds, United States Department of Agriculture's (USDA's) Environmental Quality Incentives Program and Conservation Reserve Program, and other relevant federal, state, local, and private funds that may be available to assist in implementing this plan.

e) An **information/education component** that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented.

f) A **schedule for implementing the nonpoint source management measures** identified in this plan that is reasonably expeditious.

g) A description of **interim, measurable milestones** for determining whether NPS management measures or other control actions are being implemented.

h) A set of **criteria to determine if loading reductions are being achieved** over time and substantial progress is being made toward attaining water quality standards and, if not, the criteria for determining whether this WBP needs to be revised or, if a nonpoint source total maximum daily load (TMDL) has been established, whether the TMDL needs to be revised.

i) A **monitoring component** to evaluate the effectiveness of the implementation efforts over time measured against the criteria established under item (h) immediately above.

## Project Partners and Stakeholder Input

This WBP was developed by Geosyntec under the direction of the Towns of Sturbridge, with funding, input, and collaboration from MassDEP. This WBP was developed using funds from the Section 319 program to assist grantees in developing technically robust WBPs using MassDEP's Watershed-Based Planning Tool (WBP Tool).

The following are core project stakeholders:

- Rebecca Gendreau – Town of Sturbridge
- Carl Nielsen – ESS Group, Inc. (ESS)
- Carl (Skip) Nielsen – Quaboag Quacumquasit Lake Association (QQLA)
- Doug Vizard – QQLA

This WBP was developed as part of an iterative process:

- First, a stakeholder conference call was facilitated on December 10, 2021, which included the core project stakeholders listed above as well as additional stakeholders, to solicit input and gain consensus on elements included in the plan relating to the Quacumquasit Pond watershed (identifying problem areas, best implementation practice (BMP) projects, water quality goals, public outreach activities, etc.). At this time, the watershed was delineated to the point where Quacumquasit Pond drains to Quaboag Pond. However, since backflows from Quaboag Pond enter Quacumquasit Pond, it was decided, after this initial stakeholder meeting, that the watershed delineation should be expanded to include the entire drainage area of Quaboag Pond/Quacumquasit Pond. The meeting minutes from the December 10, 2021, stakeholder conference call are included in **Appendix A**.
- Next, the Geosyntec project team collected and reviewed existing data and reports received from the Towns of Sturbridge and stakeholders.
- Next, a second stakeholder conference call was facilitated on March 25, 2022, which included the core project stakeholders listed above as well as additional stakeholders, to solicit input and gain consensus on elements included in the plan relating to the Quaboag Pond/Quacumquasit Pond watershed (identifying problem areas, BMP projects, water quality goals, public outreach activities, etc.). The meeting minutes from this stakeholder conference call are included in **Appendix B**.

- Next, the Geosyntec project team collected and reviewed additional existing data and reports for the Quaboag Pond/Quacumquasit Pond watershed received from the Towns of Sturbridge and stakeholders.
- Finally, the preliminary WBP for Quaboag Pond/Quacumquasit Pond watershed was drafted and reviewed by MassDEP
- The WBP was finalized based on MassDEP input.

## Data Sources

This WBP was developed using the framework and data sources provided by MassDEP's WBP Tool. Additional data sources were reviewed and are included in subsequent sections of this WBP.

# Element A: Identify Causes of Impairment & Pollution Sources

**Element A:** Identify the causes and sources or groups of similar sources that need to be controlled to achieve the necessary pollutant load reductions estimated in the watershed based plan (WBP).

## General Watershed Information

This WBP was prepared for the Quaboag (North) Pond/Quacumquasit (South) Pond[4] watershed, which is within the towns of Sturbridge, Brookfield, East Brookfield, Spencer, Charlton, North Brookfield, New Braintree, Leicester, Oakham, Rutland, and Paxton, Massachusetts. Quacumquasit Pond discharges underneath a bridge on Lake Road to an approximately 1,500-foot channel (referred to as "interbasin connector") to Quaboag Pond. Quacumquasit Pond also receives backflows from Quaboag Pond via this channel; a flow control structure was constructed in 1991 (Baystate Environmental Consultants, 1989; Lycott, 1994) to reduce the potential for backflows to occur, but backflows to Quacumquasit Pond from Quaboag Pond do still occur (MassDEP, 2006).

Quaboag Pond has an area of about 544 acres with an average depth of less than 7 feet, while Quacumquasit Pond has an area of about 223 acres with an average depth of over 32 feet (Lycott Environmental Research, Inc., 1994). Although Quaboag Pond is larger in area, it has about half the volume of Quacumquasit Pond and a much shorter retention time; Quaboag Pond has an estimated retention time of 12 days and Quacumquasit Pond has an estimated retention time of 1.5 years (MassDEP, 2006).

Quaboag Pond discharges into the Quaboag River, which is within the Chicopee River basin. The total area of the Quaboag Pond/Quacumquasit Pond watershed is approximately 48,671 acres[5] (76 square miles). Major streams in the watershed include Fivemile River, East Brookfield River, Sevenmile River[6], Turkey Hill Brook, Cranberry Meadow River, and Great Brook. Other major lakes/ponds in the watershed include Lashaway Lake, Brooks Pond, Dean Pond, Browning Pond, Turkey Hill Pond, Eames Pond, Thompsons Pond, Sugden Reservoir, Lake Whittemore, and Cranberry Meadow Pond .

**Table A-1** summarizes the general watershed information for the Quaboag Pond/Quacumquasit Pond watershed, and **Figure A-1** includes a map of the watershed boundary.

[4] Quaboag Pond is within the towns of East Brookfield and Brookfield, Massachusetts. Quacumquasit Pond is within the towns of Sturbridge, Brookfield, and East Brookfield.
[5] In periods of no backflow from Quaboag Pond, the watershed area of Quacumquasit Pond is approximately 1,118 acres (1.7 square miles).
[6] A WBP was previously completed for the Sevenmile River watershed in 2020 (Geosyntec and Town of Spencer, 2020) and is accessible here: WBP – Accepted Plans (geosyntec.com)

**Table A-1: General Watershed Information for Quaboag Pond/Quacumquasit Pond Watershed**

| | |
|---|---|
| **Watershed Name (Assessment Unit ID):** | Quaboag Pond (MA36130)<br>Quacumquasit Pond (MA36131) |
| **Major Basin:** | Chicopee River |
| **Watershed Area (within MA):** | 48,671 acres |
| **Water Body Size:** | 544 acres (Quaboag Pond)<br>223 acres (Quacumquasit Pond) |

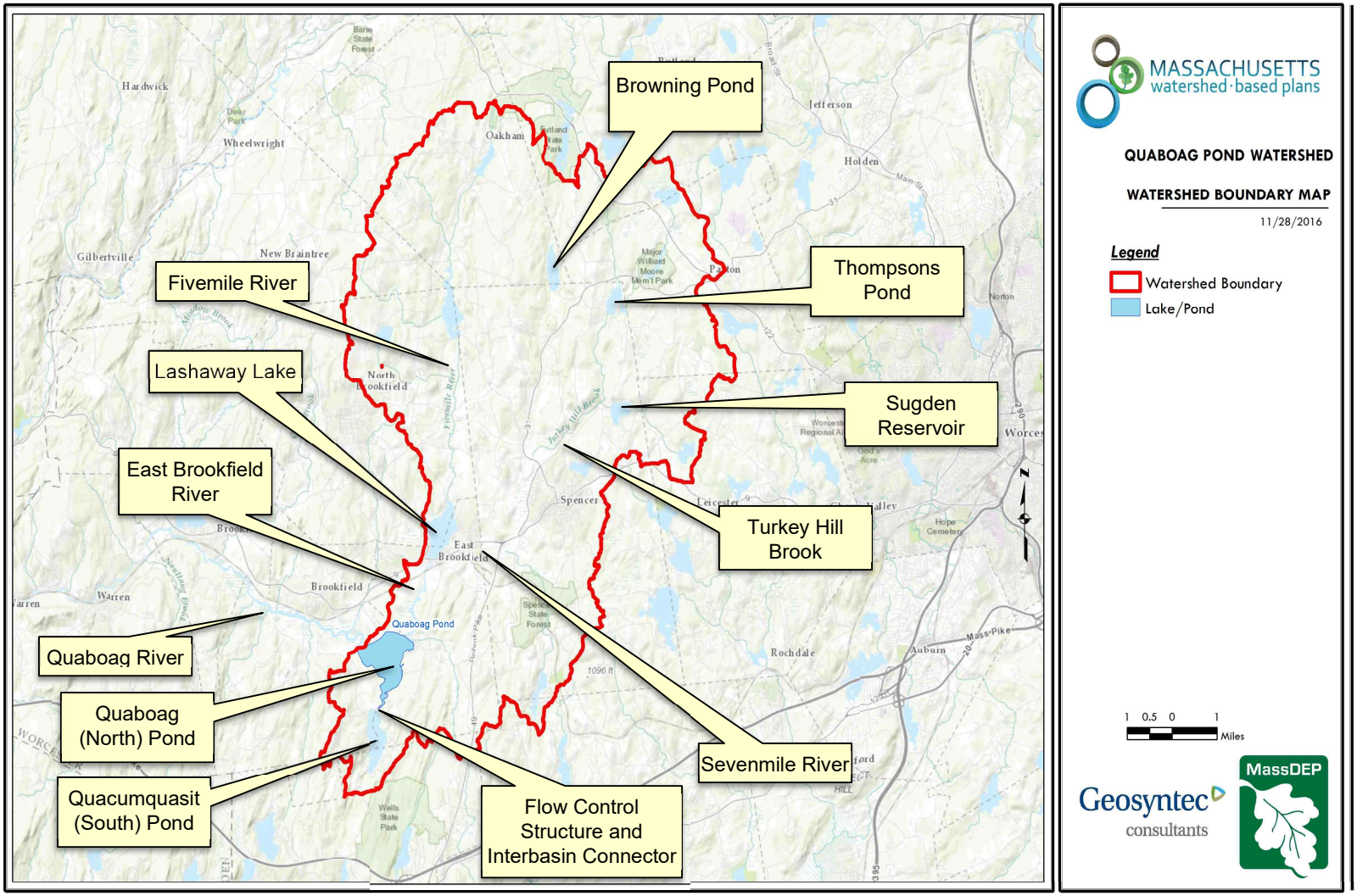


**Figure A-1: Watershed Boundary Map (MassGIS, 1999; MassGIS, 2001; USGS, 2016)**

*Ctrl + Click on the map to view a full-sized image in your web browser.*

## MassDEP Water Quality Assessment Report and TMDL Review

The section below summarizes the findings of the available Water Quality Assessment Reports and/or TMDLs that relate to water quality and water quality impairments in the Quaboag Pond/Quacumquasit Pond watershed[7].

The following reports are available:

- Chicopee River Watershed 2003 Water Quality Assessment Report (MassDEP, 2003)
- Total Maximum Daily Loads of Total Phosphorus for Quaboag & Quacumquasit Ponds (MassDEP, 2006)

Select excerpts from the water quality assessment report (MassDEP, 2003) and TP TMDL (MassDEP, 2006) relating to the water quality in the watershed are included in **Appendix C** (note: relevant information is included directly from these documents for informational purposes and has not been modified).

## Water Quality Impairments and Pollution Sources

### 303(d) List Impairments

Impairment categories from the MassDEP 2018/2020 Massachusetts Integrated List of Waters (303(d) List) are listed in **Table A-2**. Known water quality impairments for Quaboag Pond and Quacumquasit Pond, as documented in the 2018/2020 303(d) List, are listed in **Table A-3**.

Quaboag Pond (MA36130) is identified as a category 5 water body due to algae, Eurasian water milfoil, non-native aquatic plants, fanwort, mercury in fish tissue, and Total Phosphorus (TP). The listed sources of these impairments include internal nutrient recycling, municipal point source discharges, introduction of non-native plants, and nonpoint sources.

Quacumquasit Pond (MA36131) is identified as a category 4A water body due to mercury in fish tissue, Eurasian water milfoil, fanwort, and nonnative aquatic plants. The listed sources of these impairments include atmospheric deposition and introduction of non-native plants.

The sources for the mercury in fish tissue impairment in Quaboag Pond and Quacumquasit Pond is also listed as unknown on the 303(d) List.

[7] Quacumquasit Pond is also part of the Northeast Regional Mercury Total Maximum Daily Load (Connecticut Department of Environmental Protection, et al., 2007), but is included as impaired for Mercury solely as a result of atmospheric deposition.

**Table A-2: 2018/2020 MA Integrated List of Waters Categories (MassDEP, 2021)**

| Integrated List Category | Description |
|---|---|
| 1 | Unimpaired and not threatened for all designated uses. |
| 2 | Unimpaired for some uses and not assessed for others. |
| 3 | Insufficient information to make assessments for any uses. |
| 4 | Impaired or threatened for one or more uses, but not requiring calculation of a Total Maximum Daily Load (TMDL), including:<br>4a: TMDL is completed<br>4b: Impairment controlled by alternative pollution control requirements<br>4c: Impairment not caused by a pollutant - TMDL not required |
| 5 | Impaired or threatened for one or more uses and requiring preparation of a TMDL. |

**Table A-3: Water Quality Impairments (MassDEP, 2021)**

| Assessment Unit ID | Waterbody | Integrated List Category | Designated Use | Impairment Cause | Impairment Source |
|---|---|---|---|---|---|
| MA36130 | Quaboag Pond | 5 | Aesthetic | Algae | Internal Nutrient Recycling |
| MA36130 | Quaboag Pond | 5 | Aesthetic | Algae | Municipal Point Source Discharges |
| MA36130 | Quaboag Pond | 5 | Aesthetic | Algae | Non-Point Source |
| MA36130 | Quaboag Pond | 5 | Aesthetic | Eurasian Water Milfoil (Myriophyllum spicatum) | Introduction of Non-native Organisms (Accidental or Intentional) |
| MA36130 | Quaboag Pond | 5 | Aesthetic | Non-Native Aquatic Plants | Introduction of Non-native Organisms (Accidental or Intentional) |
| MA36130 | Quaboag Pond | 5 | Fish Consumption | Mercury in Fish Tissue | Source Unknown |
| MA36130 | Quaboag Pond | 5 | Fish, other Aquatic Life and Wildlife | Algae | Internal Nutrient Recycling |
| MA36130 | Quaboag Pond | 5 | Fish, other Aquatic Life and Wildlife | Algae | Municipal Point Source Discharges |
| MA36130 | Quaboag Pond | 5 | Fish, other Aquatic Life and Wildlife | Algae | Non-Point Source |
| MA36130 | Quaboag Pond | 5 | Fish, other Aquatic Life and Wildlife | Eurasian Water Milfoil (Myriophyllum spicatum) | Introduction of Non-native Organisms (Accidental or Intentional) |
| MA36130 | Quaboag Pond | 5 | Fish, other Aquatic Life and Wildlife | Fanwort (Nymphaeles cambombaceae) | Introduction of Non-native Organisms (Accidental or Intentional) |
| MA36130 | Quaboag Pond | 5 | Fish, other Aquatic Life and Wildlife | Non-Native Aquatic Plants | Introduction of Non-native Organisms (Accidental or Intentional) |

| Assessment Unit ID | Waterbody | Integrated List Category | Designated Use | Impairment Cause | Impairment Source |
|---|---|---|---|---|---|
| **MA36130** | **Quaboag Pond** | **5** | Fish, other Aquatic Life and Wildlife | Phosphorus, Total | Internal Nutrient Recycling |
| **MA36130** | **Quaboag Pond** | **5** | Fish, other Aquatic Life and Wildlife | Phosphorus, Total | Municipal Point Source Discharges |
| **MA36130** | **Quaboag Pond** | **5** | Fish, other Aquatic Life and Wildlife | Phosphorus, Total | Non-Point Source |
| **MA36130** | **Quaboag Pond** | **5** | Primary Contact Recreation | Algae | Internal Nutrient Recycling |
| **MA36130** | **Quaboag Pond** | **5** | Primary Contact Recreation | Algae | Municipal Point Source Discharges |
| **MA36130** | **Quaboag Pond** | **5** | Primary Contact Recreation | Algae | Non-Point Source |
| **MA36130** | **Quaboag Pond** | **5** | Primary Contact Recreation | Eurasian Water Milfoil (Myriophyllum spicatum) | Introduction of Non-native Organisms (Accidental or Intentional) |
| **MA36130** | **Quaboag Pond** | **5** | Primary Contact Recreation | Non-Native Aquatic Plants | Introduction of Non-native Organisms (Accidental or Intentional) |
| **MA36130** | **Quaboag Pond** | **5** | Secondary Contact Recreation | Algae | Internal Nutrient Recycling |
| **MA36130** | **Quaboag Pond** | **5** | Secondary Contact Recreation | Algae | Municipal Point Source Discharges |
| **MA36130** | **Quaboag Pond** | **5** | Secondary Contact Recreation | Algae | Non-Point Source |
| **MA36130** | **Quaboag Pond** | **5** | Secondary Contact Recreation | Eurasian Water Milfoil (Myriophyllum spicatum) | Introduction of Non-native Organisms (Accidental or Intentional) |
| **MA36130** | **Quaboag Pond** | **5** | Secondary Contact Recreation | Non-Native Aquatic Plants | Introduction of Non-native Organisms (Accidental or Intentional) |
| **MA36131** | **Quacumquasit Pond** | **4A** | Fish Consumption | Mercury in Fish Tissue | Atmospheric Deposition - Toxics |
| **MA36131** | **Quacumquasit Pond** | **4A** | Fish Consumption | Mercury in Fish Tissue | Source Unknown |
| **MA36131** | **Quacumquasit Pond** | **4A** | Fish, other Aquatic Life and Wildlife | Eurasian Water Milfoil (Myriophyllum spicatum) | Introduction of Non-native Organisms (Accidental or Intentional) |
| **MA36131** | **Quacumquasit Pond** | **4A** | Fish, other Aquatic Life and Wildlife | Fanwort (Nymphaeles cambombaceae) | Introduction of Non-native Organisms (Accidental or Intentional) |
| **MA36131** | **Quacumquasit Pond** | **4A** | Fish, other Aquatic Life and Wildlife | Non-Native Aquatic Plants | Introduction of Non-native Organisms (Accidental or Intentional) |

### Long-Term Aquatic Plant Management Program

ESS, in coordination with QQLA, have implemented efforts to manage non-native aquatic plants in Quaboag Pond and Quacumquasit Pond since 2011 under the “Long-Term Aquatic Plant Management Program”. The program

includes pre-treatment aquatic plant mapping and applying targeted herbicide treatments annually (ESS 2012a, 2016, 2020b).

The pre-treatment aquatic plant mapping effort is conducted each year to identify the native plant community and to quantify the distribution and density of invasive aquatic plants. The plant community is mapped so that effective and targeted management recommendations can be made to QQLA. Element C provides more detail on the herbicide treatments and acreage treated annually in Quaboag Pond and Quacumquasit Pond.

The most recent available report (ESS 2020b) indicated that, for year 2019, pre-treatment aquatic plant mapping identified:

- 19 species of aquatic macrophytes, including four invasive species, in Quaboag Pond; the invasive species included Fanwort (Nymphaeles cambombaceae), Variable-leaf milfoil (Myriophyllum heterophyllum), Eurasian milfoil (Myriophyllum spicatum), and Common reed plant (Phragmites australis).
- 21 species of aquatic macrophytes, including one invasive species, in Quacumquasit Pond; the invasive species was Eurasian milfoil.

### Erosion and Drainage Concerns

Issues with erosion and drainage have been noted in areas adjacent to Quacumquasit Pond. A 2012 letter (Yorzyk, 2012) to the Town of Sturbridge described significant erosion occurring from New Boston Road into South Pond. The letter also indicated that the erosion was due to nonpoint sources and was related to road maintenance on New Boston Road, West Sturbridge Road, and Pond View Estates and noted that ditches and other diversion measures had been filled with road sand. In addition, home building within the previous decade (and associated clearing) was cited as a concern as it created additional runoff volume to New Boston Road. The letter requested increased road maintenance activity in the area and included photos shown in **Figure A-2**.

**Figure A-2: Stream with Erosion (left) and Erosion/Sediment in Quacumquasit Pond (right).**

The Town of Sturbridge created a figure (**Figure A-3**), which identified areas of drainage concern (i.e., erosion) adjacent to Quacumquasit Pond. The areas of concern are located on South Shore Drive and Tantasqua Shore Drive, both in Sturbridge, MA (Town of Sturbridge, 2022).


**Figure A-3: Areas of Erosion and Drainage Concern (Town of Sturbridge, 2022)**

### December 10, 2021, Stakeholder Meeting and March 25, 2022, Stakeholder Meeting

Various potential pollution sources to Quacumquasit Pond were discussed during the stakeholder meetings on December 10, 2021, and March 25, 2022 (meeting minutes included in **Appendix A)** including the Spencer Wastewater Treatment Plant (SWWTP), erosion issues, and increased imperviousness from new developments (e.g., along Route 9). It was also noted that residents on Quacumquasit Pond and Quaboag Pond have private septic systems and failing septic systems may also be a pollution source to the pond.

## Additional Water Quality Data

### MassDEP Water Quality Monitoring Program

Historical and current Technical Memoranda (TM) produced by the MassDEP Watershed Planning Program (WPP) are available here: Water Quality Technical Memoranda | Mass.gov and are organized by major watersheds in Massachusetts. Most of these TMs present the water chemistry and biological sampling results of WPP monitoring surveys. The TMs pertaining primarily to biological information (e.g., benthic macroinvertebrates, periphyton, fish populations) contain biological data and metrics that are currently not reported elsewhere. The data contained in the water quality TMs are also provided on the "Data" page (Water Quality Monitoring Program Data | Mass.gov). Many of these TMs have helped inform Clean Water Act 305(b) assessment and 303(d) listing decisions. Water quality monitoring data for TP is available for the deep hole location of Quacumquasit Pond from three sampling events in 2016 (MassDEP, 2020). The TP data is presented in **Table A-4**; all of the near bottom samples were above the TP TMDL (MassDEP, 2006) target concentration for Quacumquasit Pond of 12 parts per billion (12 micrograms per liter (µg/L)). There is no data available for Quaboag Pond from the MassDEP Water Quality Monitoring Program.

**Table A-4: Total Phosphorus Water Quality Data for Quacumquasit Pond (MassDEP, 2020)**

| Date | Station ID | Location Description | Sample Depth (feet) | Relative Depth | Total Phosphorus (TP) (µg/L) |
|---|---|---|---|---|---|
| **7/6/2016** | W1005 | Deep hole, East Brookfield | 0.5 | Surface | <10 |
| **7/6/2016** | W1005 | Deep hole, East Brookfield | 19.0 | Near Bottom | 14 |
| **8/3/2016** | W1005 | Deep hole, East Brookfield | 0.5 | Surface | <10 |
| **8/3/2016** | W1005 | Deep hole, East Brookfield | 20.0 | Near Bottom | 30 |
| **9/8/2016** | W1005 | Deep hole, East Brookfield | - | Surface | <10 |
| **9/8/2016** | W1005 | Deep hole, East Brookfield | 17.5 | Near Bottom | 49 |

### Diagnostic/Feasibility Study of Quaboag and Quacumquasit Ponds [North and South Ponds] (BEC 1985)

A diagnostic/feasibility study was conducted for Quaboag Pond and Quacumquasit Pond to assess the physical, chemical, and biological characteristics of the ponds[8] (BEC, 1985). The sampling locations are shown in **Figure A-**

[8] Note that this study was conducted prior to the installation of the flow control structure in the interbasin connector (1991).

**4**. All stations were sampled biweekly through spring and fall turnovers and then monthly until the following spring. Some noteworthy findings from the study included (BEC 1985):

- The primary source of TP load to Quacumquasit Pond appeared to be flow reversals in the interbasin connector channel, during which nutrient rich water from Quaboag Pond flows into Quacumquasit Pond.
- Deep water TP values were almost always higher than corresponding surface and mid-depth readings in Quacumquasit Pond. This may have been due to internal loading via sediment release of TP.
- The TN/TP ratio indicates that control of TP rather than TN would be a better management approach in Quacumquasit Pond and Quaboag Pond.
- Another major source identified for Quacumquasit Pond was groundwater contaminated by leachate from septic systems serving residences adjacent to the pond.
- Major sources to Quaboag Pond that were identified included the Spencer Wastewater Treatment Plant, nonpoint source loading, and septic systems adjacent to the pond.

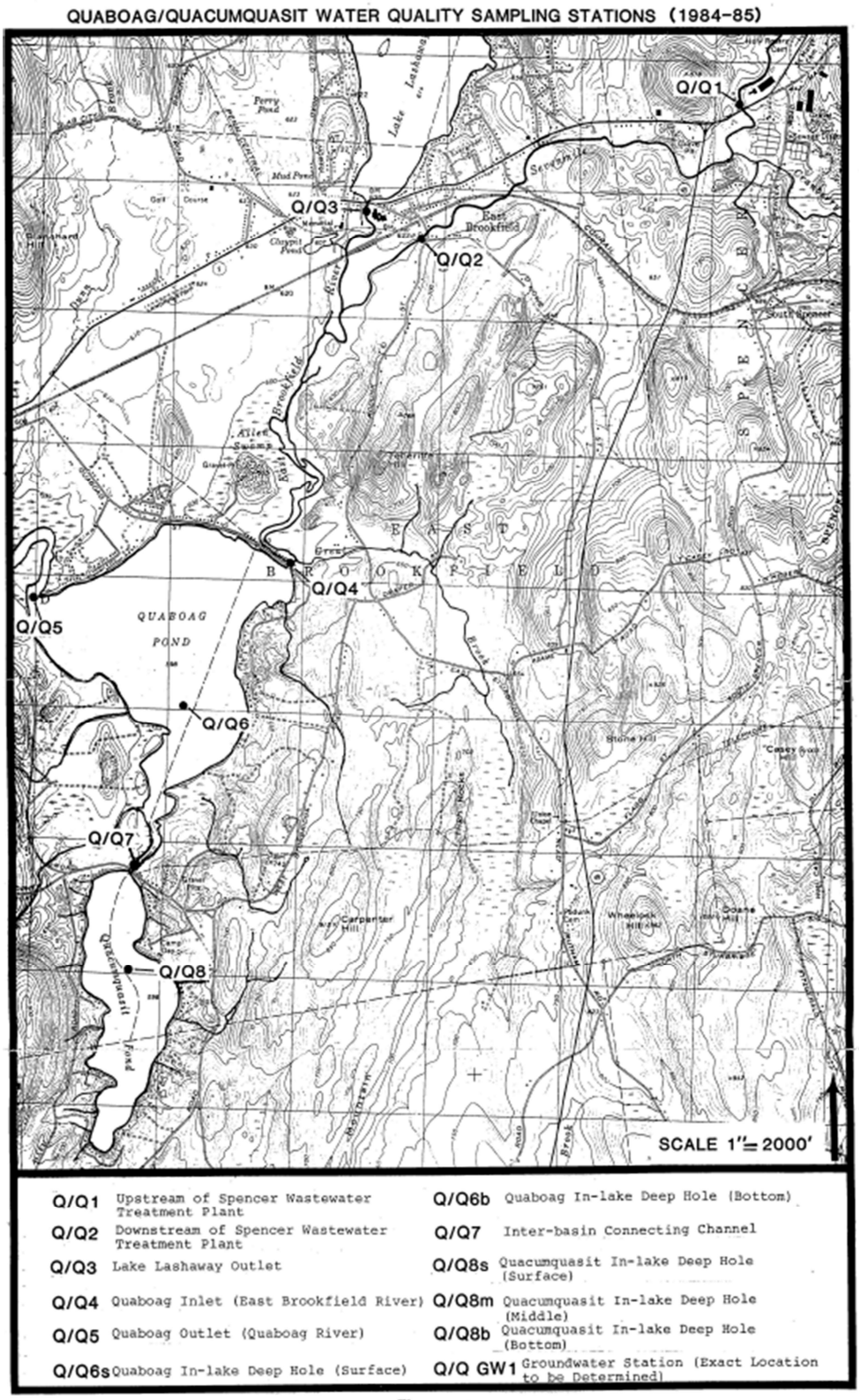


**Figure A-4: Sampling Station Locations from Diagnostic/Feasibility Study of Quaboag and Quacumquasit Ponds [North and South Ponds] (BEC 1985)**

### Site Selections to Implement Best Management Practices for Phosphorus Removal (ESS, 2007)

ESS conducted field assessments of potential nonpoint source pollution areas in the Quaboag Pond watershed on July 19, 2006, and July 27, 2006. From the field reconnaissance, ESS identified 11 priority sites likely to be contributing to the TP and TSS loading of Quaboag Pond and Quacumquasit Pond. **Table A-5** includes the wet weather sampling results for TP for two separate sampling events that were conducted at these 11 sites. The locations of the sampling stations are included in the figure in **Appendix D**. TP Results at sampling station QP-2, QP-6, QP-9, QP-9A, QP-11, QP-17, and QP-18 were above the TP EPA "Gold Book" (EPA, 1986) standard of 50 µg/L.

**Table A-5: Wet Weather Total Phosphorus Sampling Results in Quaboag Pond/Quacumquasit Pond Watershed (ESS, 2007)**

| Date | Sampling Station ID | Total Phosphorus (µ/L) |
|---|---|---|
| 11/8/2006 | QP-2 | 112 |
| | QP-4 | 14 |
| | QP-5 | 13.2 |
| | QP-6 | 123 |
| | QP-7 | 25 |
| | QP-9 | 130 |
| | QP-9A | 62 |
| | QP-10 | 0 |
| | QP-11 | 73 |
| | QP-15 Up | 11 |
| | QP-15 Down | 22 |
| | QP-17 | 476 |
| | QP-18 | 59 |
| 1/5/2007 | QP-2 | 39 |
| | QP-4 | 30 |
| | QP-5 | missing data |
| | QP-6 | 620 |
| | QP-7 | 31 |
| | QP-9 | 47 |
| | QP-9A | 31 |
| | QP-10 | 28 |
| | QP-11 | 73 |
| | QP-15 Up | 25 |
| | QP-15 Down | 25 |
| | QP-17 | 344 |
| | QP-18 | 70 |

### Sediment Testing and Alum Feasibility Analysis (ESS 2019)

ESS conducted a sediment testing and alum feasibility analysis (ESS, 2019), which assessed the chemistry of the deep sediments in Quacumquasit Pond to understand and quantify the amount of TP within the sediments and how it is bound.

ESS collected three sediment grab samples of surficial soft sediment on October 11, 2018 and tested the sediments for TP. ESS also collected wet weather water quality samples on October 11, 2018, at the surface and bottom of Quacumquasit Pond, the inlet to Quaboag Pond, and the inlet to Lake Lashaway; the samples were analyzed for TP. **Table A-6** shows the sediment results and **Table A-7** includes the TP sampling results. Based on the sampling

results, ESS concluded that internal loading of TP from the sediments of Quacumquasit Pond to overlying waters may be a larger source than previously estimated by MassDEP in the TP TMDL, and even with longer-term reductions in watershed TP loading, internal loading could continue to be a substantial source of TP if not addressed. Based on this analysis, ESS proposed the use of alum treatment (aluminum sulfate) to inactivate the nutrients, which could address a large amount of the internal TP loading and continue to reduce the loading for several years, due to the low flushing rate of Quacumquasit Pond. The alum treatment is further detailed in Element C.

**Table A-6: Quacumquasit Pond Sediment Sampling Results, October 11, 2018 (ESS, 2019)**

| Analyte (mg/kg – dry) | Location | | |
|---|---|---|---|
| | North | Mid | South |
| Mobile or Iron-bound Phosphorus | 2,730 | 2,500 | 1,970 |
| Calcium-bound Phosphorus | 210 | 230 | 170 |
| Organic Phosphorus | 410 | 310 | 380 |
| Aluminum-bound Phosphorus | 1,000 | 1,550 | 820 |
| Total Phosphorus | 4,360 | 4,600 | 3,330 |

**Table A-7: Total Phosphorus Water Quality Results, October 11, 2018 (ESS, 2019)**

| Analyte | Location | | | |
|---|---|---|---|---|
| | South Pond (Surface) | South Pond (Bottom) | Sevenmile River (Inlet to North Pond) | Fivemile River (Inlet to Lake Lashaway) |
| Total Phosphorus (µg/L) | 14 | 31 | 22 | 22 |

### Water Quality Testing Report 2019 (ESS, 2020a)

ESS conducted water quality testing to support the planned alum treatment of Quacumquasit Pond. The purpose of the testing was to assess the chemistry of the water during a period of lake stratification when the waters at the bottom of the lake are anoxic for an extended period of time (i.e., during the end of summer). Sampling was conducted at the surface and bottom of Quacumquasit pond on September 16, 2019. The results are presented in **Table A-8**. As described above, Results from 2018 (ESS, 2019) indicated that the TP concentrations ranged from 14 µg/L to 31 µg/L (surface of pond and bottom of pond, respectively); the 2019 results presented in **Table A-8** indicate much higher TP levels at the pond bottom. Based on the sampling results, ESS confirmed their analysis from 2019 (ESS, 2019) that internal loading of TP from the sediments of Quacumquasit Pond to overlying waters, may be a larger source than previously indicated, and even with longer-term declines in watershed TP loading, such as those expected due to improvements at the Spencer Wastewater Treatment Plant (see Element C), internal loading could continue to be a substantial source of TP if not addressed.

**Table A-8: Water Quality Results for 2019 (ESS, 2020a)**

| Analyte | Surface of Pond | Bottom of Pond |
|---|---|---|
| **Total Phosphorus (µg/L)** | 28 | 124 |
| **Dissolved Phosphorus (µg/L)** | 19 | 81 |

### Sturbridge Great Ponds Annual Water Quality Monitoring Database (Sturbridge Conservation Commission [SCC] 2021)

The Sturbridge Conservation Commission (SCC) along with the Sturbridge Lakes Advisory Committee (SLAC) have coordinated the effort to monitor water quality in the six major ponds ("Great Ponds") in Sturbridge, including Quacumquasit Pond since 2002. The major objective of the annual water quality sampling is to systematically collect physical and chemical data from each of the six Great Ponds that are located wholly or partially within the Town of Sturbridge. The TP water quality data for Quacumquasit Pond is included in **Table A-9**. Samples from recent years taken from the bottom of the pond were generally above the TP TMDL (MassDEP, 2006) target concentration for Quacumquasit Pond of 12 parts per billion (12 µg/L).

**Table A-9: Quacumquasit Pond Annual Monitoring: Water Quality Data Results (2002—2021) (SCC, 2021)**

| Year | Date | Station ID | Depth (feet below water surface) | TP (µg/L) |
|---|---|---|---|---|
| **2002** | 08/03/02 | SP-1S | 0.5 | 50.0 |
| **2002** | 08/03/02 | SP-1D | 45.0 | 50.0 |
| **2002** | 08/03/02 | SP-2S | 0.5 | 50.0 |
| **2003** | 07/25/03 | SP-1D | 45.0 | 53.7 |
| **2003** | 07/25/03 | SP-2S | 0.5 | 53.7 |
| **2004** | 08/28/04 | SP-1S | 0.5 | 11.0 |
| **2004** | 08/28/04 | SP-1D | 40.0 | 11.9 |
| **2004** | 08/28/04 | SP-2S | 0.5 | 11.0 |
| **2005** | 07/22/05 | SP-1S | 0.5 | 11.0 |
| **2005** | 07/22/05 | SP-1D | 43.0 | 19.0 |
| **2005** | 07/22/05 | SP-2S | 0.5 | 14.0 |
| **2006** | 08/05/06 | SP-1S | 0.5 | 5.0 |
| **2006** | 08/05/06 | SP-1D | 48 | 17.0 |
| **2006** | 08/05/06 | SP-2S | 0.5 | 5.0 |
| **2007** | 08/11/07 | SP-1S | 0.5 | 63.0 |
| **2007** | 08/11/07 | SP-1D | 41.0 | 44.0 |
| **2007** | 08/11/07 | SP-2S | 0.5 | 29.0 |
| **2008** | 08/08/08 | SP-1S | 0.5 | 1.0 |
| **2008** | 08/08/08 | SP-1D | 46.0 | 3.0 |
| **2008** | 08/08/08 | SP-2S | 0.5 | 7.0 |
| **2009** | 08/14/09 | SP-1S | 0.5 | 8.0 |
| **2009** | 08/14/09 | SP-1D | 39.0 | 14.0 |
| **2009** | 08/14/09 | SP-2S | 0.5 | 6.0 |
| **2010** | 08/14/10 | SP-1S | 0.5 | 21.0 |
| **2010** | 08/14/10 | SP-1D | 45.0 | 44.0 |
| **2010** | 08/14/10 | SP-2S | 0.5 | 15.0 |
| **2010** | 08/14/10 | SP-2S | 0.5 | 13.0 |
| **2011** | 08/12/11 | SP-1S | 0.5 | 17.0 |

| Year | Date | Station ID | Depth (feet below water surface) | TP (µg/L) |
|---|---|---|---|---|
| **2011** | 08/12/11 | SP-1D | 45.0 | 22.0 |
| **2011** | 08/12/11 | SP-2S | 0.5 | 18.0 |
| **2011** | 08/12/11 | SP-1D | 45.0 | 18.0 |
| **2011** | 08/12/11 | SP-4T | - | 153.0 |
| **2012** | 08/03/12 | SP-1D | 45.0 | 19.0 |
| **2012** | 08/03/12 | SP-1D | 0.5 | 13.0 |
| **2012** | 08/03/12 | SP-2S | 0.5 | 17.0 |
| **2013** | 08/10/13 | SP-1S | 0.5 | 16.0 |
| **2013** | 08/10/13 | SP-3S | 40.0 | 17.0 |
| **2013** | 08/10/13 | SP-1D | 0.5 | 17.0 |
| **2013** | 08/10/13 | SP-2S | 1.0 | 17.0 |
| **2014** | 8/1/2014 | SP-1S | 45.0 | 5.0 |
| **2014** | 8/1/2014 | SP-1D | 1.0 | 5.0 |
| **2014** | 8/1/2014 | SP-2S | 1.0 | 5.0 |
| **2015** | 8/2/2015 | SP-1S | 45.0 | 11.0 |
| **2015** | 8/2/2015 | SP-1D | 1.0 | 22.0 |
| **2015** | 8/2/2015 | SP-2S | 45.0 | 12.0 |
| **2015** | 8/2/2015 | SP-3S | 4.0 | 24.0 |
| **2016** | 7/22/2016 | SP-1S | 45.0 | 18. |
| **2016** | 7/22/2016 | SP-1D | 45.0 | 12.0 |
| **2016** | 7/22/2016 | SP-2S | 1.0 | 15.0 |
| **2017** | 7/28/2017 | SP-1S | 1.0 | 11.0 |
| **2017** | 7/28/2017 | SP-1D | 50.0 | 14.0 |
| **2017** | 7/28/2017 | SP-2S | 1.0 | 12.0 |
| **2018** | 7/29/2018 | SP-1S | 1.0 | 11.7 |
| **2018** | 7/29/2018 | SP-1D | 50.0 | 17.0 |
| **2018** | 7/29/2018 | SP-2S | 1.0 | 13.8 |
| **2019** | 7/28/2019 | SP-1D | 50.0 | 11.7 |
| **2019** | 7/28/2019 | SP-2S | 1.0 | 5.0 |
| **2020** | 8/16/2020 | SP-1S | 1.0 | 23.9 |
| **2020** | 8/16/2020 | SP-1D | 48.5 | 30.8 |
| **2020** | 8/16/2020 | SP-2S | 1.0 | 12.8 |
| **2021** | 7/25/2021 | SP-1S | 1.0 | 25.5 |
| **2021** | 7/25/2021 | SP-1D | 50.0 | 18.1 |
| **2021** | 7/25/2021 | SP-1D | 50.0 | 24.4 |
| **2021** | 7/25/2021 | SP-2S | 1.0 | 24.4 |

## Water Quality Goals

Water quality goals may be established for a variety of purposes, including the following:

- For **water bodies with known impairments**, a Total Maximum Daily Load (TMDL) is established by MassDEP and EPA as the maximum amount of the target pollutant that the waterbody can receive and still safely meet water quality standards. If the waterbody has a TMDL for TP or TN, or TSS that information is provided below and included as a water quality goal.
- For waterbodies without a TMDL for TP, a default water quality goal for TP is based on target concentrations established in the Quality Criteria for Water (EPA, 1986) (also known as the "Gold Book"). The Gold Book states that TP should not exceed 50 µg/L in any stream at the point where it enters any lake or reservoir, nor should TP exceed 25 µg/L within a lake or reservoir. For the purposes of developing WBPs, MassDEP has

adopted 50 µg/L as the TP target for all streams at their downstream discharge point, regardless of which type of water body the stream discharges to.

- Massachusetts Surface Water Quality Standards (314 CMR 4.00, 2013) prescribe the minimum water quality criteria required to sustain a waterbody's designated uses. **Table A-10** lists the classifications for Quacumquasit Pond and Quaboag Pond. The water quality goal for *E. coli* is based on the Massachusetts Surface Water Quality Standards.

**Table A-10: Surface Water Quality Classification by Assessment Unit**

| Assessment Unit ID | Waterbody | Class |
|---|---|---|
| **MA36130** | Quaboag Pond | B |
| **MA36131** | Quacumquasit Pond | B |

**Table A-11** lists water quality goals for TP. Although not identified as a significant water quality impairment in the ponds, a water quality goal for bacteria (*E. coli*) is also included; *E. coli* is a listed water quality impairment for the Sevenmile River, which is within the watershed[9]. Element C of this WBP includes proposed management measures to address these water quality goals.

[9] A WBP was previously completed for the Sevenmile River watershed in 2020 (Geosyntec and Town of Spencer, 2020) and is accessible here: WBP – Accepted Plans (geosyntec.com).

**Table A-11: Water Quality Goals for Quaboag Pond/Quacumquasit Pond Watershed**

| Pollutant | Waterbody (Assessment Unit ID) | Goal | Source |
|---|---|---|---|
| **Total Phosphorus (TP)** | Quaboag Pond (MA36130) | TP should not exceed 30 µg/L (in June—September) | Total Maximum Daily Loads of Total Phosphorus for Quaboag & Quacumquasit Ponds (MassDEP, 2006 |
| | Quacumquasit Pond (MA36131) | TP should not exceed 12 µg/L (in Spring) | Total Maximum Daily Loads of Total Phosphorus for Quaboag & Quacumquasit Ponds, MassDEP, 2006 |
| | Other waterbodies within the watershed | Total phosphorus should not exceed:<br>--50 ug/L in any stream<br>--25 ug/L within any lake or reservoir | Quality Criteria for Water (EPA, 1986) |
| **Bacteria** | All waterbodies within the watershed | **Class B Standards**<br>• Public Bathing Beaches: For *E. coli*, geometric mean of 5 most recent samples shall not exceed 126 colonies/ 100 ml and no single sample during the bathing season shall exceed 235 colonies/100 ml. For enterococci, geometric mean of 5 most recent samples shall not exceed 33 colonies/100 ml and no single sample during bathing season shall exceed 61 colonies/100 ml;<br>• Other Waters and Non-bathing Season at Bathing Beaches: For *E. coli*, geometric mean of samples from most recent 6 months shall not exceed 126 colonies/100 ml (typically based on min. 5 samples) and no single sample shall exceed 235 colonies/100 ml. For enterococci, geometric mean of samples from most recent 6 months shall not exceed 33 colonies/100 ml, and no single sample shall exceed 61 colonies/100 ml. | Massachusetts Surface Water Quality Standards (314 CMR 4.00, 2013) |

## Land Use and Impervious Cover Information

Land use information and impervious cover is presented in the tables and figures below. Land use source data is from 2005 and was obtained from MassGIS (2009b).

### Watershed Land Uses

Land use in the Quaboag Pond/Quacumquasit Pond watershed is mostly forested (approximately 71 percent); approximately 10 percent of the watershed is agriculture, 8 percent is low density residential, 5 percent is water, 2 percent is open land, less than 2 percent is high density or medium density residential, 1 percent is commercial, and less than 1 percent is highway (**Table A-12** and **Figure A-5**).

**Table A-12: Quaboag Pond Watershed Land Uses**

| Land Use | Area (acres) | % of Watershed |
|---|---|---|
| **Forest** | 34582.62 | 71.1 |
| **Agriculture** | 4733.35 | 9.7 |
| **Low Density Residential** | 4044.18 | 8.3 |
| **Water** | 2325.67 | 4.8 |
| **Open Land** | 1074.81 | 2.2 |
| **High Density Residential** | 632.89 | 1.3 |
| **Industrial** | 573.85 | 1.2 |
| **Commercial** | 314.28 | 0.6 |
| **Medium Density Residential** | 234.53 | 0.5 |
| **Highway** | 154.56 | 0.3 |

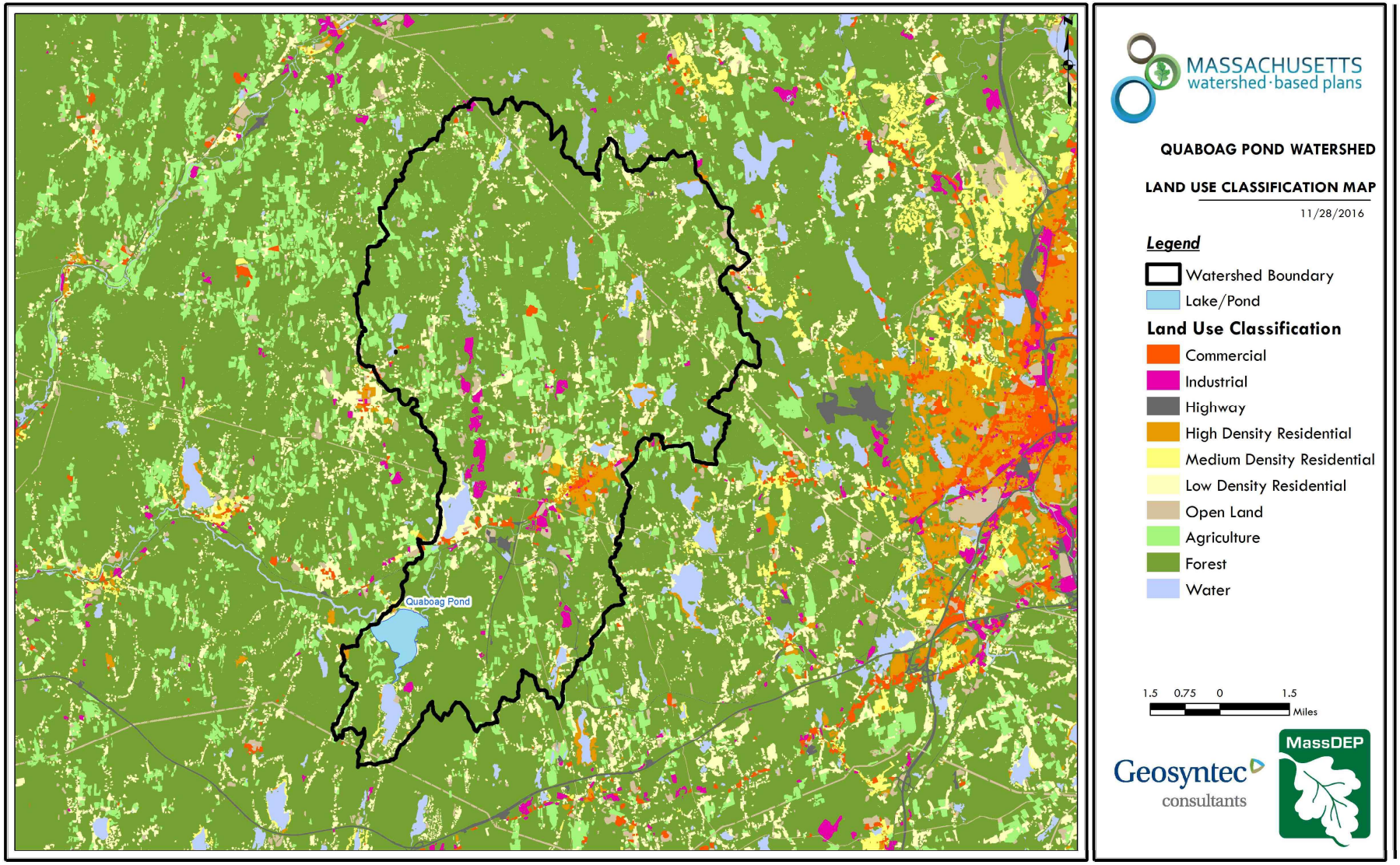


**Figure A-5: Watershed Land Use Map (MassGIS, 2009b; MassGIS, 1999; MassGIS, 2001; USGS, 2016)**

*Ctrl + Click on the map to view a full-sized image in your web browser.*

### Watershed Impervious Cover

There is a strong link between impervious land cover and stream water quality. Impervious cover includes land surfaces that prevent the infiltration of water into the ground, such as paved roads and parking lots, roofs, basketball courts, etc. Impervious cover within the Quaboag Pond/Quacumquasit Pond watershed is mostly concentrated along Route 9 and adjacent to the Fivemile River (**Figure A-6**).

Impervious areas that are directly connected (DCIA) to receiving waters (via storm sewers, gutters, or other impervious drainage pathways) produce higher runoff volumes and transport stormwater pollutants with greater efficiency than disconnected impervious cover areas which are surrounded by vegetated, pervious land. Runoff volumes from disconnected impervious cover areas are reduced as stormwater infiltrates when it flows across adjacent pervious surfaces.

An estimate of DCIA for the watershed was calculated based on the Sutherland equations. EPA provides guidance (EPA 2010) on the use of the Sutherland equations to predict relative levels of connection and disconnection based on the type of stormwater infrastructure within the total impervious area (TIA) of a watershed. The estimated TIA and DCIA for the Quaboag Pond watershed is 4.9 percent and 3.4 percent, respectively.

The relationship between TIA and water quality can generally be categorized as listed by **Table A-13** (Schueler et al. 2009). The TIA value for the Quaboag Pond/Quacumquasit Pond watershed is within the 0-10 percent range; therefore, the pond can be expected to show good to excellent water quality.

**Table A-13: Relationship between Total Impervious Area (TIA) and water quality (Schueler et al. 2009)**

| % Watershed Impervious Cover | Stream Water Quality |
|---|---|
| **0-10%** | Typically, high quality, and typified by stable channels, excellent habitat structure, good to excellent water quality, and diverse communities of both fish and aquatic insects. |
| **11-25%** | These streams show clear signs of degradation. Elevated storm flows begin to alter stream geometry, with evident erosion and channel widening. Streams banks become unstable, and physical stream habitat is degraded. Stream water quality shifts into the fair/good category during both storms and dry weather periods. Stream biodiversity declines to fair levels, with most sensitive fish and aquatic insects disappearing from the stream. |
| **26-60%** | These streams typically no longer support a diverse stream community. The stream channel becomes highly unstable, and many stream reaches experience severe widening, downcutting, and streambank erosion. Pool and riffle structure needed to sustain fish is diminished or eliminated and the substrate can no longer provide habitat for aquatic insects, or spawning areas for fish. Biological quality is typically poor, dominated by pollution tolerant insects and fish. Water quality is consistently rated as fair to poor, and water recreation is often no longer possible due to the presence of high bacteria levels. |
| **>60%** | These streams are typical of “urban drainage”, with most ecological functions greatly impaired or absent, and the stream channel primarily functioning as a conveyance for stormwater flows. |

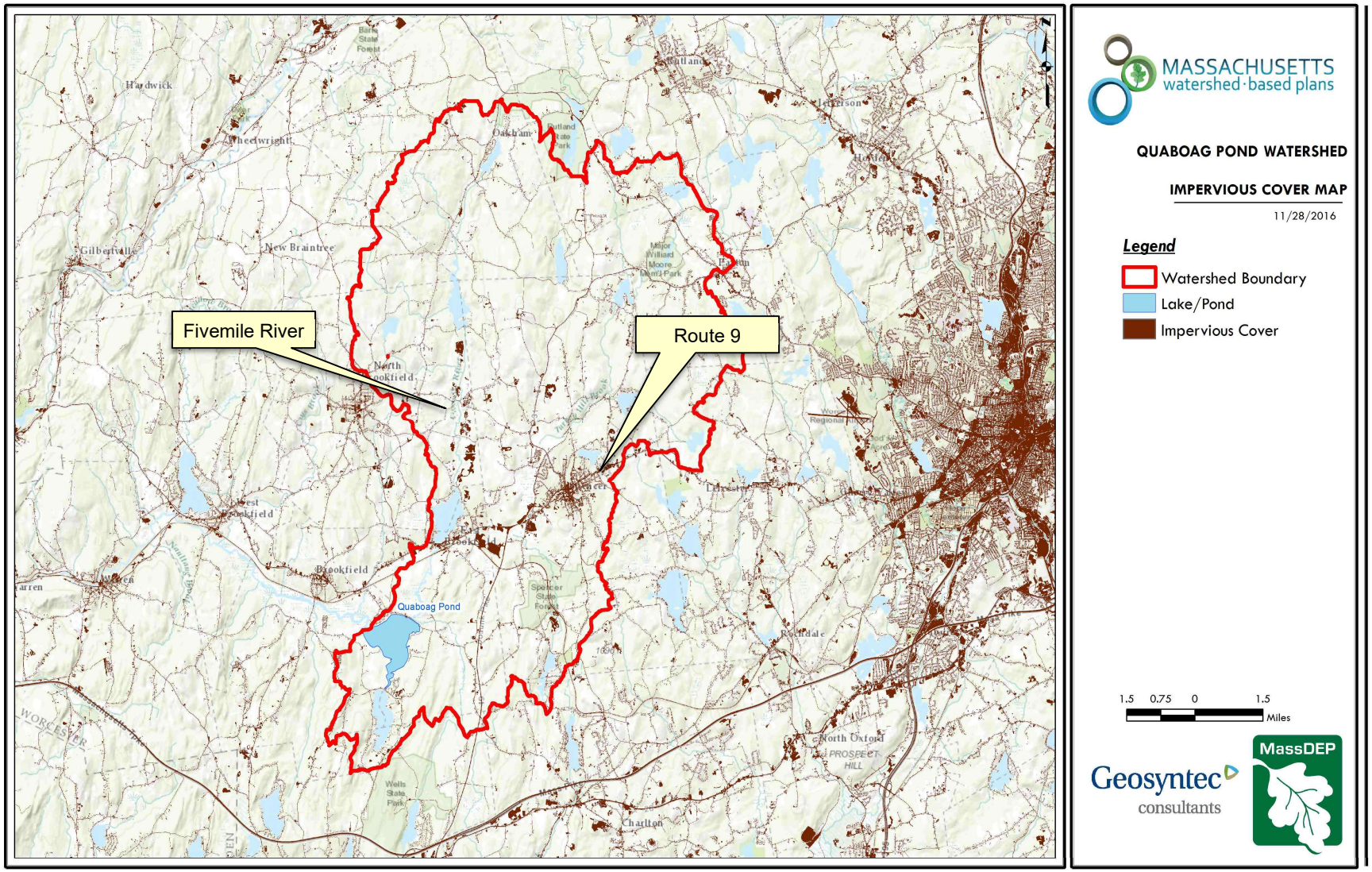


**Figure A-6: Quaboag Pond/Quacumquasit Pond Watershed Impervious Surface Map (MassGIS, 2009b; MassGIS, 1999; MassGIS, 2001; USGS, 2016)**

*Ctrl + Click on the map to view a full-sized image in your web browser.*

## Pollutant Loading

TP loading to Quaboag Pond and Quacumquasit Pond was estimated in the TP TMDL (MassDEP, 2006) and is presented in **Table A-14** and **Table A-15.** The largest contributor of the land-use-based TP load for Quaboag Pond originates from areas designated as forested. TP generated from forested areas is generally a result of natural processes such as decomposition of leaf litter and other organic material; therefore, the forested portions of the watershed are unlikely to provide opportunities for nutrient load reductions through BMPs. Agricultural and Residential areas are the second and third largest contributors of land-use-based TP to Quaboag Pond. Residential areas provide opportunities for pollutant load reductions through public education and outreach and implementation of residential BMPs. Agricultural areas provide opportunities for pollutant load reductions through agricultural BMPs. Internal loading is also a significant source of TP in both Quaboag and Quacumquasit Ponds. The backflows from Quaboag Pond to Quacumquasit Pond is also a significant source of TP loading in Quacumquasit Pond.

**Table A-14: Quaboag Pond (MA36130) TP TMDL May-October Load Allocation (MassDEP, 2006)**

| Source | Current TP Loading (kg/year) | Current TP Loading (pounds/year) |
|---|---|---|
| **Load Allocation** | | |
| Forest | 1,378 | 3,038 |
| Wetland | 64 | 141 |
| Agriculture | 590 | 1,301 |
| Open Land | 163 | 359 |
| Residential (low density) | 375 | 827 |
| Septic System | 48 | 106 |
| Internal recycling | 603 | 1,329 |
| **Waste Load Allocation** | | |
| Spencer WWTP | 131 | 289 |
| Urban & Road stormwater | 358 | 789 |
| **Total Phosphorus Inputs** | **3,710** | **8,179** |

**Table A-15: Quacumquasit Pond (MA36131) TP TMDL May-October Load Allocation (MassDEP, 2006)**

| Source | Current TP Loading (kg/year) | Current TP Loading (pounds/year) |
|---|---|---|
| **Load Allocation** | | |
| Local nonpoint source runoff, not including commercial, high-density housing | 44 | 97 |
| Nonpoint source from backflooding of Quaboag | 54 | 119 |
| Internal Loading | 30 | 66 |
| Septic System | 42 | 93 |
| Other | 0 | 0 |
| **Waste Load Allocation** | | |
| Point source from backflooding of Quaboag | 8 | 18 |
| Point source from local commercial, high density housing runoff (32% of 65) | 21 | 46 |
| **Total Phosphorus Inputs** | 199 | 439 |

Since publication of the TP TMDL (MassDEP, 2006), a more recent study ("Sediment Testing and Alum Feasibility Analysis Report, South Pond") included an updated pollutant load model for the internal loading of Quacumquasit Pond (ESS, 2019). Using the TP measured in the sediment (described above under "Additional Water Quality Data"), the amount of TP biologically available to recycling into the water column was modeled based on the surface area of the lake, the area below the thermocline (transition layer between warmer water on the lake surface and colder water below the surface), and a typical TP release coefficient. The resulting estimate for TP internal loading for Quacumquasit Pond was 258 pounds per year (lbs/yr), and therefore, the ESS study concluded that the TMDL Study most likely significantly underestimated the internal TP load to the lake and internal loading is the greatest source of TP in Quacumquasit Pond. **Table A-16** presents the revised loading estimates for Quacumquasit Pond from the ESS report (ESS, 2019).

**Table A-16: Phosphorus Load Estimates from 2006 TMDL and this 2018 Study (ESS 2019)**

| Source | Modeled TP Load (lbs/yr) 2006 TMDL | Current TP Load (lbs/yr) 2018 Study[1] |
|---|---|---|
| **Load Allocation** | | |
| Local Nonpoint Source Runoff | 90 | 46 |
| Nonpoint Source from Quaboag Backflow | 119 | 60 |
| Internal Loading | 66 | **258** |
| Septic System | 93 | 46 |
| Other | 0 | 0 |
| **Wasteload Allocation** | | |
| Point Source from Quaboag Backflow | 18 | 4 |
| Point Source from local commercial and high density residential | 46 | 24 |
| **Total Phosphorus Inputs** | **439** | **439** |

Note:

1. Loading rates assumed that some improvements have been made for local runoff since the 2006 TMDL and assumed that the new permit for the Spencer WWTP will reduce impacts from point sources in the backflow. It was also assumed that the total starting load to the lake remains as modeled by MassDEP at 199 kg/yr (439 lbs/yr) and that a larger fraction of this load should have been attributed to internal loading rather than external sources. 2018 loading values were scaled accordingly.

# Element B: Determine Pollutant Load Reductions Needed to Achieve Water Quality Goals

**Element B of your WBP should:**

Determine the pollutant load reductions needed to achieve the water quality goals established in Element A. The water quality goals should incorporate Total Maximum Daily Load (TMDL) goals, when applicable. For impaired water bodies, a TMDL establishes pollutant loading limits as needed to attain water quality standards.

## Estimated Pollutant Loads

Estimated TP pollutant loads to Quaboag Pond and Quacumquasit Pond were previously presented in Element A of this WBP. The estimated pollutant load for Quaboag Pond is based on the TP TMDL (MassDEP, 2006); the estimated TP load for Quacumquasit Pond is based on the TP TMDL (MassDEP, 2006) and the sediment testing and alum feasibility analysis report for Quacumquasit Pond (ESS, 2019). *E. coli* loading has not been estimated for this WBP, because there are no known pollutant load export rates (PLERs) for *E. coli*.

## Water Quality Goals

There are many methodologies that can be used to set pollutant load reduction goals for a WBP. Goals can be based on water quality criteria, surface water standards, existing monitoring data, existing TMDL criteria, or other data.

As discussed in Element A, water quality goals for this WBP are focused on reducing TP loading to Quaboag Pond and Quacumquasit Pond. TP water quality goals from this WBP are based on criteria from the TMDL of Total Phosphorus for Quaboag & Quacumquasit Ponds (MassDEP, 2006) as well as the more recent sediment testing and alum feasibility analysis report for Quacumquasit Pond (ESS, 2019). The target and loads for Quaboag Pond focus on summer conditions due to the quick flow of water through the pond, while the target for Quacumquasit Pond is based on spring concentrations and annual loads that are more appropriate for a lake with a long water residence time (MassDEP, 2006; ESS, 2019). Pollutant sources are characterized as either point sources that receive a wasteload allocation (WLA), or nonpoint sources that receive a load allocation (LA).

The TMDL (MassDEP, 2006) established an overall 30 percent load reduction goal of approximately 2,473 lbs/year (1,122 kg/year) for Quaboag Pond, which included approximately 30 percent reduction of TP from nonpoint sources, internal TP loading, and septic systems (See **Table B-1**).

The sediment testing and alum feasibility analysis (ESS, 2019) established an overall 29 percent load reduction goal of approximately 128 lbs/year (58 kg/year) for Quacumquasit Pond, which included 29 percent reduction of TP from internal TP loading (See **Table B-1**).

Although not identified as an impairment in Quaboag Pond or Quacumquasit Pond, water quality goals for *E. coli* are also included[10]. *E. coli* water quality goals of this WBP are based on Massachusetts Surface Water Quality Standards (MSWQS) concentration standards and are difficult to predict based on estimated annual loading (see **Table B-2**).

**Table B-1: TP Load Reduction Goals for Quaboag Pond (Table adapted from "*Total Maximum Daily Loads of Total Phosphorus for Quaboag & Quacumquasit Ponds*" (MassDEP, 2006))**

| Source | Current TP Loading (lbs/year) | Target TP Loading (lbs/year) | Required TP Reduction (lbs/year) |
|---|---|---|---|
| **Load Allocation** | | | |
| Forest | 3,038 | 2,068 | 970 |
| Wetland | 141 | 139 | 2 |
| Agriculture | 1,301 | 886 | 415 |
| Open Land | 359 | 245 | 114 |
| Residential (low density) | 827 | 562 | 265 |
| Septic System | 106 | 73 | 33 |
| Internal recycling | 1,329 | 906 | 423 |
| **Waste Load Allocation** | | | |
| Spencer WWTP | 289 | 289 | 0 |
| Urban & Road stormwater | 789 | 538 | 251 |
| **Total Phosphorus Inputs** | **8,179** | 5,706 | 2,473 |

[10] The Sevenmile River is impaired for *E. coli*. A WBP was previously completed for the Sevenmile River watershed in 2020 (Geosyntec and Town of Spencer, 2020) and is accessible here: WBP – Accepted Plans (geosyntec.com)

**Table B-2: TP Load Reduction Goals for Quacumquasit Pond (Table adapted from "Sediment Testing and Alum Feasibility Analysis Report (ESS, 2019))**

| Source | Current TP Loading (lbs/year) | Target TP Loading (lbs/year) | Required TP Reduction (lbs/year) |
|---|---|---|---|
| **Load Allocation** | | | |
| Local nonpoint source runoff, not including commercial, high-density housing | 46 | 46 | 0 |
| Nonpoint source from backflooding of Quaboag | 60 | 60 | 0 |
| Internal Loading | 258 | 130 | 128 |
| Septic System | 46 | 46 | 0 |
| Other | 0 | 0 | 0 |
| **Waste Load Allocation** | | | |
| Point source from backflooding of Quaboag | 4 | 4 | 0 |
| Point source from local commercial, high density housing runoff (32% of 65) | 24 | 24 | 0 |
| **Total Phosphorus Inputs** | 439 | 311 | 128 |

**Table B-3: Bacteria (*E. coli*) Goals for Quaboag Pond and Quacumquasit Pond**

| Pollutant | Existing Estimated Total Load | Water Quality Goal | Required Load Reduction |
|---|---|---|---|
| **Bacteria** | *MSWQS for bacteria are concentration standards (e.g., colonies of fecal coliform bacteria per 100 ml), which are difficult to predict based on estimated annual loading.* | Class B. **Class B Standards**<br>• Public Bathing Beaches: For *E. coli*, geometric mean of 5 most recent samples shall not exceed 126 colonies/ 100 ml and no single sample during the bathing season shall exceed 235 colonies/100 ml. For enterococci, geometric mean of 5 most recent samples shall not exceed 33 colonies/100 ml and no single sample during bathing season shall exceed 61 colonies/100 ml;<br>• Other Waters and Non-bathing Season at Bathing Beaches: For *E. coli*, geometric mean of samples from most recent 6 months shall not exceed 126 colonies/100 ml (typically based on min. 5 samples) and no single sample shall exceed 235 colonies/100 ml. For enterococci, geometric mean of samples from most recent 6 months shall not exceed 33 colonies/100 ml, and no single sample shall exceed 61 colonies/100 ml. | Concentration Based |

# Element C: Describe management measures that will be implemented to achieve water quality goals

**Element C:** A description of the nonpoint source management measures needed to achieve the pollutant load reductions presented in Element B, and a description of the critical areas where those measures will be needed to implement this plan.

## Existing and Ongoing Management Measures

Management measures addressing nonpoint source pollution sources to Quacumquasit Pond and Quaboag Pond have mainly focused on reducing backflows from Quaboag Pond to Quacumquasit Pond, implementing structural BMPs, addressing erosion on private properties abutting the ponds, and managing non-native aquatic plants within the ponds.

### Flow Control Structure

A flow control structure was constructed in 1991 at the point where Quacumquasit Pond discharges to the channel underneath the bridge on Lake Road. The purpose of the flow control structure was to reduce backflows from Quaboag Pond. The flow control structure consists of a 4.5-foot-high gate, which is approximately 0.75 feet higher than normal water levels of Quacumquasit Pond. The percentage of backflows that are reduced was estimated to be approximately 63% (MassDEP, 2006). Although a recommendation of the TMDL (MassDEP, 2006) was to raise the gate, it was noted during the Quacumquasit Pond stakeholder meeting that political opposition has prevented the gate from being raised (**Appendix A**).

### Erosion and Sediment Controls on Private Properties

Many residents around Quacumquasit Pond have also worked to resolve erosion issues on their private properties, as described in the Stakeholder Meeting Minutes (**Appendix A**). Based on information gathered during the stakeholder meeting, erosion has not been identified as a major issue or source of nonpoint source pollution around Quaboag Pond.

### Long-Term Aquatic Plant Management Program

ESS, in coordination with QQLA, have conducted efforts to manage non-native aquatic plants in Quaboag Pond and Quacumquasit Pond since 2011 including surveying vegetation and applying herbicide treatments[11]. The goal of the non-native aquatic plant management in Quacumquasit Pond and Quaboag Pond is to control the non-native species while encouraging native species to repopulate areas of the pond bottom that were formerly occupied by non-native species. Management has been largely successful with significant decreases in aquatic

[11] Similar efforts have been conducted in other ponds within the watershed including Brooks Pond and Lashaway Lake

invasive species in Quaboag Pond and Quacumquasit Pond (ESS, 2016, 2020b). **Table C-2** summarizes the herbicide treatment by year from 2011—2019 in Quaboag Pond and Quacumquasit Pond (ESS Group Inc., 2016).

**Table C-2: Herbicide Treatment Program by Year for Quaboag Pond and Quacumquasit Pond (ESS Group Inc., 2016 and 2020b)**

| Year | Quaboag Pond Treatment | Quacumquasit Pond Treatment |
|---|---|---|
| **2011** | 19 acres of shoreline | 4.96 acres of milfoil with Diquat |
| **2012** | 20 acres of shoreline | 1.25 acres of milfoil with Diquat |
| **2013** | 20 acres of shoreline | 1.19 acres of milfoil with Diquat |
| **2014** | 24.4 acres of shoreline | 0.24 acres of milfoil with Diquat |
| **2015** | 20.0 acres of shoreline | 0 acres of milfoil – no treatment |
| **2016** | No treatment needed | 2.4 acres of very spare milfoil returning – no treatment |
| **2018** | 10.8 acres of milfoil and fanwort with Diquat | 5 acres of milfoil and fanwort with Diquat |
| **2019** | No treatment | 3 acres of milfoil and fanwort with Diquat |

In 2020, ESS Group recommended more aggressive treatment including treatment of a larger area of Quaboag Pond, treatment of the channel that connects the two ponds (interbasin connector), and treatment of several returning spots in Quacumquasit Pond. ESS noted that the extensive amount of fanwort) within the interbasin connector becomes fragmented by boat traffic, and when backflow occurs and flows reverse, these fragments end up colonizing new beds of fanwort in Quacumquasit Pond (ESS Group, 2020b). Based on information collected during the March 25, 2022, stakeholder meeting (see Appendix A), the fanwort in the interbasin connector has been treated since this recommendation was made.

### Quacumquasit Pond Phosphorus Inactivation (Alum Treatment) Project

The Town of Sturbridge was awarded Fiscal Year 2021 Section 319 grant funding for its "Quacumquasit Pond Phosphorus Inactivation Project" (ESS 2021), which follows the recommendations of the sediment testing and alum treatment feasibility analysis conducted in 2019 (ESS, 2019). The goal of the project is to apply alum to address the build-up of TP in the sediment of Quacumquasit Pond that has occurred over many years and was estimated to be 59 percent of the current annual TP load to Quacumquasit Pond (ESS, 2019). The project is targeting to inactivate the TP in sediment over an 87-acre area (below the 37-foot contour) where anoxia (absence of oxygen) occurs the most frequently. This is estimated to reduce internal TP loading by 130 lbs/year, which exceeds the TP load reduction goal of 128 lbs/yr for Quacumquasit Pond identified in Element B. The treatment is also expected to lead to decreased phosphorus recycling, reduce cyanobacteria abundance, increase water quality, and improve deep water oxygen levels through reduced decomposition of algae that is settling to the bottom of the pond (ESS 2021). This project will also help to reduced TP loading to Quaboag Pond since Quacumquasit Pond discharges to Quaboag Pond.

### Site Selections to Implement Best Management Practices for Phosphorus Removal (ESS 2007)

ESS conducted field assessments of potential nonpoint source pollution areas in the Quaboag Pond watershed on July 19, 2006, and July 27, 2006. From the field reconnaissance, ESS identified 11 priority sites likely to be contributing to the TP and TSS loading of Quaboag Pond and Quacumquasit Pond. Water quality sampling was conducted for pH, dissolved oxygen, conductivity, turbidity, flow rate, temperature, TP, and TSS. Wet weather sampling was performed on November 8, 2006, and January 5, 2007. Dry weather sampling was conducted on November 21, 2006. Elevated sample results for TP were used to calculate the annual TP loads at each respective site.

Site QP-7 in the Town of East Brookfield (location shown in figure in **Appendix D**) was selected as an optimal site for a water quality swale to be designed, permitted, and constructed and funded under a Section 319 grant. The report recommended that the water quality swale be implemented along the southwestern side of West Sturbridge Road and be approximately 500 feet in length with multiple riprap check dams and a sediment forebay. The report calculated that the swale would remove 30% of TP (0.09 lbs/yr of the 0.26 lbs/yr calculated load for the site drainage area) and estimated the cost to be between $5,000 and $9,000 (ESS, 2007). The Town of Brookfield installed two water quality swales (100 feet and 50 feet long with pre-treatment forebays, check-dams, and rip-rap basins at the outlet) to treat approximately 2 acres of road runoff at West Sturbridge Road, East Brookfield targeting phosphorus and sediment. The estimated pollutant load reduction included 0.2 lbs/yr of phosphorus.

### Brooks Pond Aquatic Plant Management Program

Brooks Pond also has an aquatic plant management program in place (Solitude Lake Management, 2021), which includes annual vegetation surveying, water quality testing, and herbicide treatment. Based on plant monitoring and expansion of fanwort areas, the contract was re-written in 2019 to alter the management approach through the 2021 season using primarily Sonar (fluridone) herbicide along with follow-up treatments using flumioxazin & diquat as needed. A similar treatment approach was recommended for 2022 (Solitude Lake Management, 2021).

### Spencer Wastewater Treatment Plant (SWWTP)

Although it is not a nonpoint source, a significant point source to Quaboag and Quacumquasit Ponds is the Spencer Wastewater Treatment Plant (SWWTP) (ESS,2000, 2012b, 2014). During the comment period of the draft National Pollutant Discharge Elimination System (NPDES) permit for the SWWTP, ESS assisted with a variety of assessments and, on behalf of QQLA, submitted comments and proposed permit modifications with stricter TP effluent limits citing the regular exchange of water between Quaboag and Quacumquasit Ponds as a reason for the proposed permit modifications; the final permit included the stricter recommended TP effluent limits of 0.1 mg/L (100 µg/L) between April—October and 0.2 mg/L (200 µg/L) between November—March (EPA and MassDEP, 2019). During the comment period, ESS also requested that the proponent fund and implement a TP TMDL study of Quaboag Pond and Quacumquasit Pond, which led to the creation of the 2006 TP TMDL (MassDEP, 2006).

## Future Management Measures

### Potential BMP Locations

The Town of Sturbridge has identified areas of drainage and erosion concern (as shown and described in Element A) (Town of Sturbridge 2022). The areas of concern are located on South Shore Drive and Tantasqua Drive, on the

south end of the pond. These sites are potential areas for BMP implementation, such as rain gardens, swales, or other methods to manage the stormwater runoff and associated erosion. The sites directly adjacent to the pond are also a concern for pollution loading, as the erosion/sediment contains a pollutant load than runs directly into the pond with minimal treatment from overland flow. Guidance on addressing issues associated with unpaved roads is provided in the *Massachusetts Unpaved Roads BMP* Manual[12].

The locations identified in the figure in **Appendix D** are from the "Site Selections to Implement Best Management Practices for Phosphorus Removal" (ESS 2007) described above and also represent future BMP opportunity locations. As described above, a BMP at location QP-7 has been constructed.

### BMP Hotspot Map

The following GIS-based analysis was performed within the watershed to help identify high priority parcels for BMP (management measure) implementation[13]:

- Each parcel within the watershed was evaluated based on ten different criteria accounting for the parcel ownership, social value, and implementation feasibility (See **Table C-1** for more detail below);
- Each criterion was then given a score from 0 to 5 to represent the priority for BMP implementation based on a metric corresponding to the criterion (e.g., a score of 0 would represent lowest priority for BMP implementation whereas a score of 5 would represent highest priority for BMP implementation);
- A multiplier was also assigned to each criterion, which reflected the weighted importance of the criterion (e.g., a criterion with a multiplier of 3 had greater weight on the overall prioritization of the parcel than a criterion with a multiplier of 1); and
- The weighted scores for all the criteria were then summed for each parcel to calculate a total BMP priority score.

**Table C-3** presents the criteria, indicator type, metrics, scores, and multipliers that were used for this analysis. Parcels with total scores above 60 are recommended for further investigation for BMP implementation suitability. **Figure C-1** and **Figure C-2** presents the resulting BMP Hotspot Map for the watershed. The following link includes a Microsoft Excel file with information for all parcels that have a score above 60: hotspot spreadsheet.

This analysis solely evaluated individual parcels for BMP implementation suitability and likelihood for the measures to perform effectively within the parcel's features. This analysis does not quantify the pollutant loading to these parcels from the parcel's upstream catchment. When further evaluating a parcel's BMP implementation suitability and cost-effectiveness of BMP implementation, the existing pollutant loading from the parcel's upstream catchment and potential pollutant load reduction from BMP implementation should be evaluated. This analysis may be used for future consideration when identifying additional BMP opportunity locations within the Quaboag Pond/Quacumquasit Pond watershed.

[12] Massachusetts Unpaved Roads Manual: dirtroad.pdf (mass.gov).

[13] GIS data used for the BMP Hotspot Map analysis included MassGIS (2015a); MassGIS (2015b); MassGIS (2017a); MassGIS (2017b); MassGIS (2020);MA Department of Revenue Division of Local Services (2016); MassGIS (2005); ArcGIS (2020); MassGIS (2009b); MassGIS (2012); and ArcGIS (2020b).

## Table C-3: Matrix for BMP Hotspot Map GIS-based Analysis

| Criteria | Indicator Type | METRICS | | | | | | | | | | | | | | | | | | | | | | | | | | | Multiplier | Maximum Potential Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Yes or No? | | Hydrologic Soil Group | | | | Land Use Type | | | | | | | | | Water Table Depth | | | | Parcel Area | | | Parcel Average Slope | | | | | | |
| | | Yes | No | A or A/D | B or B/D | C or C/D | D | Low and Medium Density Residential | High Density Residential | Commercial | Industrial | Highway | Agriculture | Forest | Open Land | Water | 101-200 cm | 62-100 cm | 31-61 cm | 0-30 cm | Greater than 2 acres | Between 1-2 acres | Less than 1 acre | Less than 2% | Between 2% and 15% | Greater than 15% | Less than 50% | Between 51% and 100% | | |
| Is the parcel a school, fire station, police station, town hall or library? | Ownership | 5 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | 10 |
| Is the parcel's use code in the 900 series (i.e. public property or university)? | Ownership | 5 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | 10 |
| Is parcel fully or partially in an Environmental Justice Area? | Social | 5 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | 10 |
| Most favorable Hydrologic Soil Group within Parcel | Implementation Feasibility | | | 5 | 3 | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | 2 | 10 |
| Most favorable Land Use in Parcel | Implementation Feasibility | | | | | | | 1 | 2 | 4 | 2 | 4 | 5 | 1 | 4 | X[1] | | | | | | | | | | | | | 3 | 15 |
| Most favorable Water Table Depth (deepest in Parcel) | Implementation Feasibility | | | | | | | | | | | | | | | | 5 | 4 | 3 | 0 | | | | | | | | | 2 | 10 |
| Parcel Area | Implementation Feasibility | | | | | | | | | | | | | | | | | | | | 5 | 4 | 1 | | | | | | 3 | 15 |
| Parcel Average Slope | Implementation Feasibility | | | | | | | | | | | | | | | | | | | | | | | 3 | 5 | 1 | | | 1 | 5 |
| Percent Impervious Area in Parcel | Implementation Feasibility | | | | | | | | | | | | | | | | | | | | | | | | | | 5 | 2.5 | 1 | 5 |
| Within 100 ft buffer of receiving water (stream or lake/pond)? | Implementation Feasibility | 5 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | 10 |

Note 1: **X** denotes that parcel is excluded

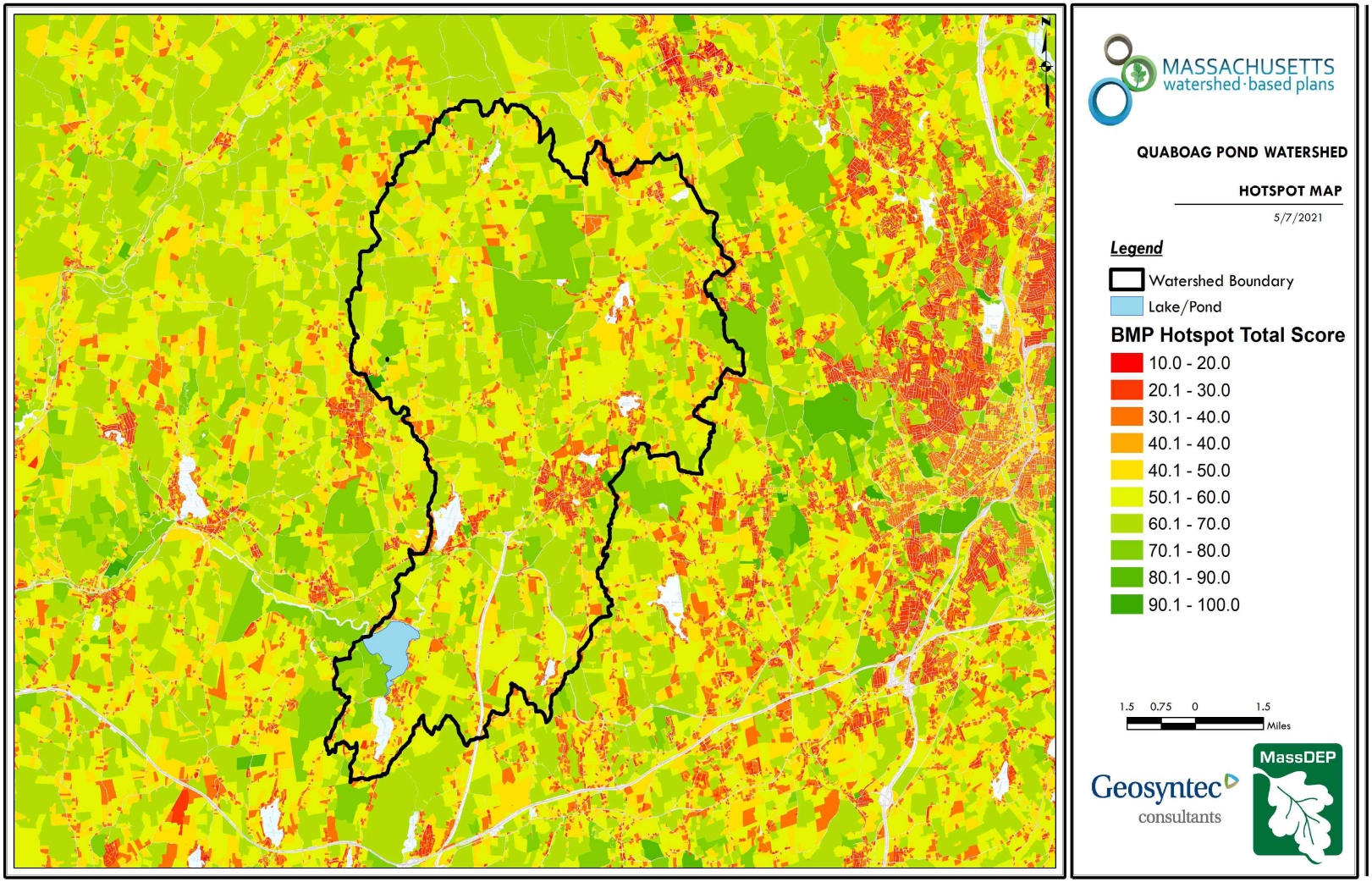


**Figure C-1: BMP Hotspot Map (MassGIS (2015a), MassGIS (2015b), MassGIS (2017a), MassGIS (2017b), MassGIS (2020), MA Department of Revenue Division of Local Services (2016), MassGIS (2005), ArcGIS (2020), MassGIS (2009b), MassGIS (2012), ArcGIS (2020b))**

*Ctrl + Click on the map to view a full-sized image in your web browser.*

### Additional Nonstructural BMPs

Planned management measures can also be non-structural (e.g., street sweeping, catch basin cleaning). It is recommended that nonstructural BMPs that the Towns of Sturbridge, Brookfield, East Brookfield, Spencer, Charlton, North Brookfield, New Braintree, Leicester, Oakham, Rutland, and Paxton currently are implementing, including street sweeping and catch basin cleaning, be evaluated and potentially optimized. First, it is recommended that potential pollutant load removals from ongoing activities be calculated in accordance with Elements H and I of this document. Next, it is recommended that ongoing activities be evaluated to see if potential improvements can be implemented to achieve higher pollutant load reductions, such as increased frequency or improved technology.

# Element D: Identify Technical and Financial Assistance Needed to Implement Plan

**Element D:** Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan.


## Current Management Measures

The funding needed to implement the proposed alum treatment, which is presented in Element C of this WBP, is included in **Table D-1** (ESS 2021).

**Table D-1: Summary of Funding Needed to Implement Proposed Alum Treatment.**

| BMP | Total Cost | Portion of Grant-Funded Total Cost | Grant | Non-Federal Match |
|---|---|---|---|---|
| Alum Treatment | $375,000 | $225,000 | Section 319 | $150,000 |

## Future Management Measures and Monitoring

Funding for future BMP installations to further reduce pollutant loads within the watershed may be provided by a variety of sources. It is expected that funding for future management measures will be obtained from Section 319 grants in addition to Town Capital funds, volunteer efforts, and other sources. Additional grant resources may include the Municipal Vulnerability Program (MVP). Future monitoring efforts could potentially be eligible for a 604(b) grant or a Water Quality Management Grant. The Towns of Sturbridge and other stakeholders will use available guidance on potential funding sources for nonpoint source pollution reduction efforts.[14]

[14] Guidance on funding sources to address nonpoint source pollution: http://prj.geosyntec.com/prjMADEPWBP_Files/Guide/Element%20D%20-%20Funds%20and%20Resources%20Guide.pdf

# Element E: Public Information and Education

**Element E:** Information and Education (I/E) component of the watershed plan used to:

1. Enhance public understanding of the project; and
2. Encourage early and continued public participation in selecting, designing, and implementing the NPS management measures that will be implemented.

The components of the watershed public information and education program are described below. Additional outreach products will be determined when future management measures and activities are planned for implementation in the watershed. It is recommended that this section of the WBP will be updated when the plan is reevaluated in 2025 in accordance with Elements F&G of this document.

### Step 1: Goals and Objectives

*The goals and objectives for the watershed public information and education program.*

1. Provide information to promote watershed stewardship.
2. Provide information to homeowners within the watershed (especially adjacent to Quaboag Pond and Quacumquasit Pond) regarding different types of residential BMPs[15] that they could implement.
3. Provide information about completed and proposed stormwater BMPs and their anticipated water quality benefits.
4. Provide information about the alum treatment and its water quality benefits.
5. Provide information about septic system maintenance.

### Step 2: Target Audience

*Target audiences that need to be reached to meet the goals and objectives identified above.*

1. Watershed residents
2. Businesses, schools, and local government within the watershed
3. Watershed organizations and other user groups
4. Recreational users of Quacumquasit Pond and Quaboag Pond

### Step 3: Outreach Products and Distribution

*The outreach product(s) and distribution form(s) that will be used for each.*

1. QQLA website (http://www.qqla.org/)

[15] Examples of residential BMPs are provided in the "Massachusetts Clean Water Toolkit" (MassDEP, 2016) at https://megamanual.geosyntec.com/NPSManual_2013/HTML/residential.htm

2. QQLA Facebook page (https://www.facebook.com/QQLA.org/)
3. Informational brochure on alum treatment (mailed, emailed, posted on Facebook page).
4. Article in local newspaper about alum treatment project.
5. Watershed events including public demonstration of the alum treatment process, photo contests, paddling days, and pond cleanup events.
6. QQLA semi-annual newsletter (mailed, emailed, posted on QQLA website and Facebook page)
7. Educational flyers (mailed, emailed, posted on Facebook page, and distributed at watershed events)

### Step 4: Evaluate Information/Education Program

*Information and education efforts and how they will be evaluated.*

1. Track number of website and Facebook page visits
2. Track attendance at watershed events
3. Track number of newsletters and flyers distributed

# Elements F & G: Implementation Schedule and Measurable Milestones

**Element F:** Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.

**Element G:** A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.

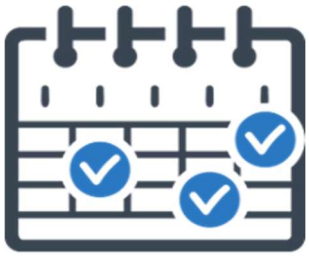

**Table FG-1** provides a preliminary schedule for implementing recommendations provided by this WBP. It is expected that the WBP will be reevaluated and updated at least once every three years, or as needed, based on ongoing monitoring results and other ongoing efforts. New projects will be identified through future data analysis and stakeholder engagement and will be included in updates to the implementation schedule.

**Table FG-1: Implementation Schedule and Interim Measurable Milestones**[16]

| Category | Action | Estimated Cost | Year(s) |
|---|---|---|---|
| Monitoring/Vegetation | Continue performing vegetation surveys and expand annual water quality sampling per Element H&I monitoring guidance. | $10,000 | Annual |
| Pond Treatment | Implement alum treatment in Quacumquasit Pond. | $375,000 | 2022 |
| Structural BMPs | Obtain funding, design, prioritize, and implement structural BMP(s) at one of the future project areas identified in Element C. | $375,000 | 2023 |
| | Obtain funding, design, prioritize, and implement structural BMP(s) at one of the future project areas identified in Element C. | $375,000 | 2024 |
| Nonstructural BMPs | Document potential pollutant removals from ongoing nonstructural BMPs (i.e., street sweeping, catch basin cleaning). | $18,000 | 2022 |
| | Evaluate ongoing nonstructural BMPs and determine if modifications can be made to optimize pollutant removals (e.g., increase frequency). | | 2023 |
| | Routinely implement optimized nonstructural BMPs. | | Annual |
| Public Education and Outreach (See Element E) | Continue public education and outreach efforts (QQLA) described in Element E | $4,000 | Annual |
| Adaptive Management and Plan Updates | Establish a working group that includes stakeholders and other interested parties to implement recommendations and track progress. Meet at least twice per year. | $4,500 | 2022 |
| | Reevaluate WBP at least once every three years and adjust, as needed, based on ongoing efforts (e.g., based on water quality monitoring, 319/604(b) funding, etc.) – Next update February 2025 | | 2025 |
| | Use monitoring results to evaluate BMP effectiveness at reducing TP, *E. coli* and/or other indicator parameters and establish additional long-term reduction goals (if needed). | $45,000 | 2025 |
| | Delist Quacumquasit Pond and Quaboag Pond from the 303(d) list and meet TP TMDL targets. | | 2032 |

[16] Note that goals and milestones of this WBP are intended to be adaptable and flexible. Stakeholders will perform tasks contingent on available resources and funding.

# Elements H & I: Progress Evaluation Criteria and Monitoring

**Element H:** A set of criteria used to determine (1) if loading reductions are being achieved over time and (2) if progress is being made toward attaining water quality goals. Element H asks "**how will you know if you are making progress towards water quality goals?**" The criteria established to track progress can be direct measurements (e.g., E. coli bacteria concentrations) or indirect indicators of load reduction (e.g., number of beach closings related to bacteria).

**Element I:** A monitoring component to evaluate the effectiveness of implementation efforts over time, as measured against the Element H criteria. Element I asks "**how, when, and where will you conduct monitoring?**"

The water quality target concentrations are presented under Element A of this plan. To achieve these target concentrations, the annual loading must be reduced to the amount described in Element B. Element C of this plan describes the various management measures that will be implemented to achieve these targeted load reductions. The evaluation criteria and monitoring program described below will be used to measure the effectiveness of the proposed management measures (described in Element C) in improving the water quality of Quaboag Pond and Quacumquasit Pond.

## Indirect Indicators of Load Reduction

### Vegetation Monitoring

Since 2011, aquatic vegetation is surveyed annually in Quaboag Pond and Quacumquasit Pond and managed with herbicide treatments on an as-needed basis (see Element C). Annual vegetation surveys should continue to be conducted using methods consistent with the past assessments. Results from annual vegetation monitoring will be used as a metric for measuring changes in biomass and as a metric for understanding water quality trends in response to implementing measures recommended as part of this WBP. It is also recommended that annual vegetation assessments continue to include recommendations as feasible for control measures such as previously implemented treatments.

### Nonstructural BMPs

Potential load reductions from non-structural BMPs (i.e., street sweeping and catch basin cleaning) can be estimated from indirect indicators, such as the number of miles of street swept or the number of catch basins cleaned. Appendix F of the 2016 Massachusetts Small MS4 General Permit (EPA, 2020) provides specific guidance for calculating TP removal from these practices. As indicated by **Element C**, it is recommended that potential TP removal from these ongoing activities be estimated. Next, it is recommended that ongoing activities be evaluated to see if potential improvements can be implemented to achieve higher pollutant load reductions such as increased frequency or improved technology. TP load reductions can be estimated in accordance with Appendix F of the 2016 Massachusetts Small MS4 General Permit as summarized by **Figure HI-1 and HI-2**.

$$Credit_{sweeping} = IA_{swept} \times PLE_{IC\text{-}land\ use} \times PRF_{sweeping} \times AF \qquad \textbf{(Equation 2-1)}$$

**Where:**

| | | |
|---|---|---|
| $Credit_{sweeping}$ | = | Amount of phosphorus load removed by enhanced sweeping program (lb/year) |
| $IA_{swept}$ | = | Area of impervious surface that is swept under the enhanced sweeping program (acres) |
| $PLE_{IC\text{-}land\ use}$ | = | Phosphorus Load Export Rate for impervious cover and specified land use (lb/acre/yr) (see Table 2-1) |
| $PRF_{sweeping}$ | = | Phosphorus Reduction Factor for sweeping based on sweeper type and frequency (see Table 2-3). |
| AF | = | Annual Frequency of sweeping. For example, if sweeping does not occur in Dec/Jan/Feb, the AF would be 9 mo./12 mo. = 0.75. For year-round sweeping, AF=1.0[1] |

As an alternative, the permittee may apply a credible sweeping model of the Watershed and perform continuous simulations reflecting build-up and wash-off of phosphorus using long-term local rainfall data.

**Table 2-3: Phosphorus reduction efficiency factors ($PRF_{sweeping}$) for sweeping impervious areas**

| Frequency[1] | Sweeper Technology | $PRF_{sweeping}$ |
|---|---|---|
| 2/year (spring and fall)[2] | Mechanical Broom | 0.01 |
| 2/year (spring and fall)[2] | Vacuum Assisted | 0.02 |
| 2/year (spring and fall)[2] | High-Efficiency Regenerative Air-Vacuum | 0.02 |
| | | |
| Monthly | Mechanical Broom | 0.03 |
| Monthly | Vacuum Assisted | 0.04 |
| Monthly | High Efficiency Regenerative Air-Vacuum | 0.08 |
| | | |
| Weekly | Mechanical Broom | 0.05 |
| Weekly | Vacuum Assisted | 0.08 |
| Weekly | High Efficiency Regenerative Air-Vacuum | 0.10 |

**Figure HI-1. Street Sweeping Calculation Methodology**

$$Credit_{CB} = IA_{CB} \times PLE_{IC\text{-}land\ use} \times PRF_{CB} \qquad \textbf{(Equation 2-2)}$$

**Where:**

| | | |
|---|---|---|
| $Credit_{CB}$ | = | Amount of phosphorus load removed by catch basin cleaning (lb/year) |
| $IA_{CB}$ | = | Impervious drainage area to catch basins (acres) |
| $PLE_{IC\text{-}and\ use}$ | = | Phosphorus Load Export Rate for impervious cover and specified land use (lb/acre/yr) (see Table 2-1) |
| $PRF_{CB}$ | = | Phosphorus Reduction Factor for catch basin cleaning (see Table 2-4) |

**Table 2-4: Phosphorus reduction efficiency factor ($PRF_{CB}$) for semi-annual catch basin cleaning**

| Frequency | Practice | $PRF_{CB}$ |
|---|---|---|
| Semi-annual | Catch Basin Cleaning | 0.02 |

**Figure HI-2. Catch Basin Cleaning Calculation Methodology**

## Project-Specific Indicators

### Number of BMPs Installed and Pollutant Reduction Estimates

Anticipated pollutant load reductions from ongoing (i.e., under construction) and future BMPs will be tracked as BMPs are installed. For example, the estimated TP load removal from the current Phosphorus inactivation (alum treatment) project in Quacumquasit Pond is estimated to be 130 lbs/year (ESS 2021).

## TMDL Criteria

The TP TMDL for Quaboag Pond and Quacumquasit Pond (MassDEP, 2006) states that "additional lake surveys by MassDEP in future years, as resources allow, should include Secchi disk transparency, nutrient analyses, temperature and oxygen profiles and aquatic vegetation maps of distribution and density. At that time the strategy for reducing plant cover and reducing total phosphorus concentrations can be re-evaluated and the TMDL modified, if necessary. Additional monitoring of dissolved oxygen levels and TP concentrations by local volunteer groups is encouraged."[17]

## Direct Measurements

Direct measurements are generally expected to be performed as described below. Water quality monitoring may be performed through a volunteer training program to save on costs in accordance with established practices for MassDEP's environmental monitoring for volunteers.

### River Sampling

Establish regular sampling to understand the water quality in the Quaboag Pond/Quacumquasit Pond Watershed, including determining sources for pollution and tracking achievements toward water quality goals, including analysis of *E. coli* and TP. Additional parameters such as TN, turbidity, chlorophyll-a, dissolved oxygen, temperature, conductivity, pH, and flow rate could provide additional data for consideration. If possible, obtain sampling of the stream segments directly downstream of implemented BMPs to determine the impact of proposed BMPs within the watershed. Monitoring locations should be selected based on accessibility and representativeness and should be appropriate to quantify water quality improvements in the watershed.

### In-Lake Phosphorus and Water Quality Monitoring

Sampling programs specific for the ponds and lakes within the watershed could be established to track the progress of water quality improvements more closely towards water quality goals. Monitoring locations should at minimum include the outlet of the pond, tributaries, and the deepest "in-lake" location[18]. It is recommended that sampling programs include analysis of *E. coli*, secchi disk transparency, TP, chlorophyll-a, turbidity, temperature/oxygen profiles, and aquatic vegetation. These parameters will also enable tracking relative to Carlson's state trophic index to evaluate improvements over time.

As described in Element A, Quacumquasit Pond is monitored annually for TP by the SCC and SLAC (Town of Sturbridge, 2021) and Quaboag Pond does not have an annual TP monitoring plan. The QQLA has also measured lake levels, rainfall, and flow at the interbasin connector for the past approximately four years. It is recommended

[17] Additional guidance for volunteer water quality monitoring is provided at: https://www.epa.gov/sites/production/files/2015-06/documents/stream.pdf and https://www.mass.gov/guides/water-quality-monitoring-for-volunteers#2

[18] Additional guidance is provided at: https://www.epa.gov/sites/production/files/2015-06/documents/lakevolman.pdf

that the water quality monitoring efforts conducted by SCC and SLAC be continued and in coordination with QQLA expand those efforts to include Quaboag Pond. The results can used to indicate progress towards the water quality goals and whether additional BMPs are needed to meet interim and long-term water quality goals.

### Adaptive Management

As discussed by in Element B, continued water quality monitoring will be used to quantify success in meeting and maintaining water quality goals established in Element A and B. Water quality goals will be reevaluated at least once every three years and adaptively adjusted based on additional monitoring results and other indirect indicators. If monitoring results and indirect indicators do not show improvement, the management measures and loading reduction analysis (Elements A through D) will be revisited and modified accordingly.

# References


314 CMR 4.00 (2013). "*Division of Water Pollution Control, Massachusetts Surface Water Quality Standards*"

ArcGIS (2020a). "*USA Soils Hydrologic Group*" Imagery Layer

ArcGIS (2020b). "*USA Soils Water Table Depth*" Imagery Layer

Baystate Environmental Consultants, Inc (1985). "*Diagnostic/Feasibility Study of Quaboag and Quacumquasit Ponds (North and South Ponds).*" Prepared for the Town of Brookfield and the Massachusetts Division of Water Pollution Control. November 1985.

Baystate Environmental Consultants, Inc. (1989). "Board of Selectmen, Town of Brookfield, Contract Documents for the Installation of a Flow Control Structure in Channel Between Quaboag and Quacumquasit Ponds on lake Road." May 1989.

Connecticut Department of Environmental Protection, Maine Department of Environmental Protection, MassDEP, New Hampshire Department of Environmental Services, New York State Department of Environmental Conservation, Rhode Island Department of Environmental Management, Vermont Department of Environmental Conservation, New England Interstate Water Pollution Control Commission. (2007). "Northeast Regional Mercury Total Maximum Daily Load ."

ESS (2000). "*Letter Re: Town of Spencer Wastewater Treatment Plan – Permit No. MA 0100909."* Prepared for QQLA. November 25, 2000.

ESS (2007). "*Site Selections to Implement Best Management Practices for Phosphorus Removal.*" Prepared for Town of Brookfield Conservation Commission. December 28, 2007.

ESS (2012a). "*2011 Plant Management Program for Quaboag and Quacumquasit Ponds.*" Prepared for Quaboag Quacumquasit Lake Association. January 25, 2012.

ESS (2012b). "*Water Quantity and Quality Assessment of the Spencer Wastewater Treatment Facility.*" Prepared for Quaboag Quacumquasit Lake Association. August 20, 2012.

ESS (2014). "*Summary of 2012 to 2014 Investigation at the Spencer Wastewater Treatment Plant.*" Prepared for Quaboag Quacumquasit Lake Association. December 2, 2014.

ESS (2016). "*Quaboag and Quacumquasit Lake Association (QQLA) Long-term Aquatic Plant Management Program Status Report.*" Prepared for the Town of Sturbridge Conservation Commission. Dated November 16, 2016.

ESS (2019). "*Sediment Testing and Alum Feasibility Analysis Report.*" Prepared for Quaboag Quacumquasit Lake Association. February 4, 2019.

ESS (2020a). "*Water Quality Testing Report 2019.*" Prepared for Quaboag Quacumquasit Lake Association. January 18, 2020.

ESS (2020b). "*Quaboag and Quacumquasit Lake Association (QQLA) Long-term Aquatic Plant Management Program Status Report for 2019.*" Prepared for Town of Sturbridge Conservation Commission. June 10, 2020.

ESS (2021). "*319 Grant Proposal: Quacumquasit Pond Phosphorus Inactivation Project.*" Prepared for Massachusetts Department of Environmental Protection. Prepared by Town of Sturbridge. June 30, 2021.

EPA (1986). "*Quality Criteria for Water (Gold Book)*" EPA 440/5-86-001. Office of Water, Regulations and Standards. Washington, D.C.

EPA. (2010). "*EPA's Methodology to Calculate Baseline Estimates of Impervious Area (IA) and Directly Connected Impervious Area (DCIA) for Massachusetts Communities.*"

EPA and MassDEP (2019). "*Authorization to Discharge under the National Pollutant Discharge Elimination System*." NPDES Permit Number MA0100919. February 28, 2019.

EPA. (2020). "*General Permits for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems in Massachusetts (as modified); Appendix F – Requirements for MA Small MS4s Subject to Approved TMDLs.*" 7 December 2020.

Geosyntec and Town of Spencer, MA. (2020). "*Watershed-based Plan, Sevenmile River Watershed within the Towns of Spencer, Leicester, Paxton, Rutland, Oakham, East Brookfield and Charlton*". Prepared for MassDEP. February 2020.

Lycott Environmental Research, Inc. (1994). "Final Report Phase II Implementation Project, Quaboag & Quacumquasit Ponds, Town of Brookfield, Massachusetts. Project #: NF-3491. July 1994.

MassDEP (2003). "*Chicopee River Watershed 2003 Water Quality Assessment Report."*

MassDEP (2006). "*Total Maximum Daily Loads of Total Phosphorus for Quaboag & Quacumquasit Ponds."*

MassDEP (2016a). "*Massachusetts Clean Water Toolkit*"

MassDEP (2021). "*Final Massachusetts Integrated List of Waters for the Clean Water Act 2018/2020 Reporting Cycle*". November 2021.

MassDEP (2020). "Water Quality Monitoring Program Data | Mass.gov"

MassGIS (1999). "*Networked Hydro Centerlines*" Shapefile

MassGIS (2001). "*USGS Topographic Quadrangle Images*" Image

MassGIS (2005). "*Elevation (Topographic) Data (2005)*" Digital Elevation Model

MassGIS (2007). "*Drainage Sub-basins*" Shapefile

MassGIS (2009a). "*Impervious Surface*" Image

MassGIS (2009b). "*Land Use (2005)*" Shapefile

MassGIS (2012). "*2010 U.S. Census Environmental Justice Populations*" Shapefile

MassGIS (2013). "*MassDEP 2012 Integrated List of Waters (305(b)/303(d))*" Shapefile

MassGIS (2015a). "*Fire Stations*" Shapefile

MassGIS (2015b). "*Police Stations*" Shapefile

MassGIS (2017a). "*Town and City Halls*" Layer

MassGIS (2017b). "*Libraries*" Layer

MassGIS (2020). "*Massachusetts Schools (Pre-K through High School)*" Data layer

MassGIS (2021). "*Standardized Assessors' Parcels*" Mapping Data Set

Sturbridge Conservation Commission (SCC). (2021). "*Sturbridge Great Ponds Annual Water Quality Monitoring."* Database. Last updated July 23, 2021.

Schueler, T.R., Fraley-McNeal, L, and K. Cappiella (2009). "*Is impervious cover still important? Review of recent research*" Journal of Hydrologic Engineering 14 (4): 309-315.

Solitude Lake Management (2021). "*Brooks Pond, North Brookfield/Spencer/Oakham/New Braintree, Massachusetts, 2021 Year-End Report*".

Sturbridge, Town of. (2022). "*Map of Drainage Concerns."* Map. Dated January 3, 2022.

United States Geological Survey (2016). "*National Hydrography Dataset, High Resolution Shapefile*"

USDA NRCS and MassGIS (2012). "*NRCS SSURGO-Certified Soils*" Shapefile

Yorzyk, Carrol-Jean. (2011). "*Letter Regarding Erosion at Quacumquasit Pond.*" Letter addressed to East Brookfield and Sturbridge Board of Selectmen. Dated October 12, 2011, with follow up letter on May 8, 2012.

# Appendices

## Appendix A – Stakeholder Meeting Minutes (December 20, 2021)

# Meeting Minutes

| | | | |
|---|---|---|---|
| Project Name: | Quacumquasit Pond Watershed-Based Plan | | |
| Location: | Quacumquasit Pond Watershed (Sturbridge, Brookfield, and East Brookfield, MA) | | |
| Meeting Date, #: | December 10, 2021 | Meeting Time: | 10:00 – 11:30 AM |
| Prepared By: | Emma Williamson | Meeting Location: | Zoom videoconference per Geosyntec invitation |
| Distribution: | All listed below | | |

Attendees:

| Name | Organization | Contact Information |
|---|---|---|
| Emma Williamson | Geosyntec Consultants, Inc | EWilliamson@Geosyntec.com |
| Julia Keay | Geosyntec Consultants, Inc | JKeay@Geosyntec.com |
| Judith Rondeau | Massachusetts Department of Environmental Protection (MassDEP) | Judith.rondeau@mass.gov |
| Meghan Selby | MassDEP | meghan.selby@mass.gov |
| Carl Nielsen | ESS Group | cnielsen@essgroup.com |
| Rebecca Gendreau | Town of Sturbridge Conservation Commission | rgendreau@sturbridge.gov |
| Kelli A. Robbins | Town of Brookfield | townadministrator@brookfieldma.us |
| Doug Vizard | Quaboag Quacumquasit Lake Association (QQLA) | dvizard.sturbridge@gmail.com |
| Jeff Bridges | Town of Sturbridge | jbridges@sturbridge.gov |
| Stephen Lockney | YMCA Camp Frank A. Day | stephanl@wsymca.org |
| Carl (Skip) Nielsen | QQLA | SkipNielsen00@gmail.com |

"*This project has been financed with Federal Funds from the Environmental Protection Agency (EPA) to the Massachusetts Department of Environmental Protection (the Department) under an s. 319 competitive grant. The contents do not necessarily reflect the views and policies of EPA or of the Department, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.*"

*Minutes to be considered final unless comments are received within five (5) business days.*

AGENDA

- Greeting – Julia Keay, Geosyntec & Meghan Selby, MassDEP
- Watershed & Goals Overview – Julia Keay, Geosyntec
- s. 319 Grant Project Spotlight – Carl Nielsen, ESS Group
- Brief Introductions from All Participants – All
- Discussion of Completed, Ongoing, and Future Efforts – All

WATERSHED & GOALS OVERVIEW/SECTION 319 GRANT PROJECT SPOTLIGHT

**Julia Keay** described the goal of creating the watershed-based plan (WBP) for Quacumquasit Pond. A participant indicated that it is often referred to as South Pond.

**Meghan Selby** introduced herself as the 604(b) program manager under the nonpoint source program at MassDEP and stated that EPA requires a WBP for all Section 319 (s. 319) projects. Excited to have everyone on the call today.

**Julia Keay** states that the current project at South Pond is a s. 319 grant project and the reason a WBP is needed for South Pond. It is also beneficial for South Pond to have a WBP for any future grant applications in the watershed.

**Julia Keay** provided an overview of watershed and goals. Small watershed, approximately 1.8 square miles. About 60% forested, 20% water, good amount residential with a little bit of agricultural and industrial land use. Listed as Category 4A for mercury in fish & invasive aquatic plants. Phosphorus TMDL put out in 2006. Long-term goal for WBP and s. 319 grant is to address the Total Phosphorus (TP). Backflow from downstream Quaboag Pond (locally known as North Pond). Work has been done in watershed with structural BMPs. Since it is so small, it sounds like good opportunity sites already addressed. Would be good to get feedback for additional BMP locations. Described watershed map, land use map (residential around pond), and impervious cover map (roads around pond).

**Carl Nielson** described the current s. 319 project. Focused on inactivating phosphorus within sediments of South Pond. Goal is to put in about 100 g/m$^2$ of polyaluminum chloride, remove [inactivate] about 50% of phosphorus load from lake, which is an internal load. Improve water clarity, should last for 15-20 years depending on dose and how well it is implemented. Over next few months once the Town of Sturbridge get the grand funds in place, they will start the process of sediment sampling in the pond to refine the number (100 g/m$^2$) and refine treatment plan to maximize the amount of budget to treat as much of the pond as possible. For the permitting phase; they will need permits in East Brookfield, Brookfield, and Sturbridge (treatment work/pond is in all three towns). Permitting will take 2-4 months depending on hearings and schedule. The Spring of 2023 is the realistic time frame to allow Town of Sturbridge to go out to bid for alum treatment contractors to do work. Once they have the plan set up, they will draft and post request for proposals (RFP). The treatment will work well because of very slow flushing rate for the pond (roughly 2 years for water to be exchanged). Significant portion of the load in pond is from internal recycling. If they can shut that off, they will get many years of good control.

**Julia Keay** asked about backflows from downstream pond and if barrier was installed recently.

**Carl Nielsen** stated that the barrier was done in early 1990s, operated every year since then to minimize backflows from Quaboag Pond watershed, which is extensive; Quaboag Pond has a large watershed. When backflows occur, they are very large. Watershed from Quaboag has a lot more agriculture and significant development (Town of Spencer); high levels of phosphorus back flows into South Pond during big spring rain events or hurricane rain events (rain events of 2 or more inches). This usually happens 2-3 times per year and is a large source of phosphorus. This is why the barrier was put in place. Can't raise flow barrier any higher mainly because of political resistance. Barrier was extensively studied by Army Corps and MassDEP (319 grant). TMDL includes increasing height of the barrier as an option for reducing phosphorus but politically it couldn't be managed.

BRIEF INTRODUCTIONS FROM ALL PARTICIPANTS

Participants were asked to briefly address the following prompts:

⇒ Name?
⇒ Affiliation
⇒ Your connection to [name of watershed]?
⇒ Specific projects, public outreach, and/or monitoring work you do or have done

**Julia Keay, Geosyntec**. Project manager for WBP project. Overseeing and helping draft this plan.

**Emma Williamson, Geosyntec.** Helping to draft this plan.

**Meghan Selby, Nonpoint Source Group (NPS) at MassDEP**. Manages 604(b) grants and looking forward to finding out information for South Pond. Great to have WBP in place for any future funding that might be sought. It really helps organize and plan future projects.

**Judy Rondeau, Nonpoint Source Group (NPS) at MassDEP**. NPS Watershed specialist and outreach coordinator. Can provide any kind of support, tech outreach, etc. as the watershed plan is being developed.

**Rebecca (Becky) Gendreau, Conservation Agent for Town of Sturbridge**. Will be the lead and point of contact on the current s. 319 project. Very excited about this project. There are a lot of concerns in the towns with road runoff around the pond. Excited to see how the WBP can help with other lakes and issues.

**Carl Nielsen, ESS Group**. Managing the water quality and aquatic plant growth at South Pond and North Pond for 20+ years and has worked on most of the existing reports. Written a draft of WBP already and it is included in the s. 319 proposal from 2 years ago. This draft should summarize the issues they are aware of. Can send to Julia. Needs way to send large file (Julia to send email).

**Doug Vizard, QQLA**. QQLA is a lake organization that represents South and North Ponds. Membership includes about half the stakeholders on both ponds. QQLA has promoted for years anything from fundraising to volunteering to conserve watershed, as well as anything from weed treatment to fighting with Spencer wastewater treatment facility (WWTF) to upgrade its facility to limit phosphorus output. Largely successful. Otherwise, we are always involved and doing our best to protect the watershed in many ways.

**Stephan Lockney, Director of YMCA Camp Frank A. Day for West Suburban YMCA.** Serve on board of QQLA. South Pond is a huge part of the camp-largest program area. Pond is of extreme importance for us.

**Kelli Robbins, Town Administrator for Town of Brookfield**. Wants to learn about project and pond and what is expected and needed of Brookfield.

**Carl (Skip) Nielsen, QQLA.** Involved with lake since early 1980s. Lives on the lake and been involved since the early 1980s. Was a diagnostic & feasibility study that identified nutrients at that time. Then we identified some issues coming from the wastewater treatment plan (WWTP) in Spencer including where they were piling sediment that was removed from their wastewater, along the edge of Cranberry Brook. The group (QQLA) got the sediment removed. Has been involved with all upgrades from Spencer WWTP. Recently [the WWTP] received a mandate to upgrade to modern standards. Has been involved in studies there (Spencer WWTP) and diagnostic & feasibility studies. The TMDL study of the watershed around 2008 identified issues. Recently, there was a study of mud sample at bottom of lake done by ESS that indicated that sediments were much higher than TMDL study stated, because the TMDL study used published numbers for a typical lake, not actual measurements. Measurement was taken about 1-1.5 years ago. These numbers were used to apply for this s.319 grant. Along with that, we've had the TMDL and the diagnostic & feasibility study that identified backflows. There was a 1991 s. 319 grant for the barrier installation. Has helped, s. 319 grant for sediment from runoff on roads within the Quaboag watershed and in-kind services by the town and s. 319 grant money to remedy some of those places; has done education as part of grant to have people stop using phosphorus fertilizer on lawns; has lobbied state through statehouse to get phosphorus ban on laundry detergents. Recently achieved a phosphorus ban in lawn fertilizers. Group has been very active in trying to solve this. Discovery of major source of nutrients was due to ESS sediment study; the study was enlightening for us because we can see that the nutrients are a major source. The current grant should give us some longevity on this treatment. Give us clarity on water for years to come, knowing that the backflows aren't a major source anymore.

**Julia.** Do you know how many s. 319 grant projects have been done in this watershed?

**Skip Nielsen.** Offhand, we've done a sediment [project], the flow barrier, also won a grant (during Dukakis administration) to put oxygenator in lake but funds were pulled because of state budgets, oxygenator would have been used to address low oxygen and mud recycling. Carl will have better records on what has been done.

**Carl Nielsen.** Will send information.

| DISCUSSION OF COMPLETED, ONGOING, AND FUTURE PROJECTS |
|---|
| A general discussion was held on the following topics:<br>⇒ Past, current, or planned stormwater best management practice (BMP) projects in the watershed<br>⇒ Pollutant load reduction estimates for BMP projects<br>⇒ Water quality monitoring efforts<br>⇒ Potential pollution sources or problem areas<br>⇒ Public education and outreach<br>⇒ Additional grant funding available<br><br>**Julia Keay**. We can have an open discussion, see slide for talking points. We just talked about s. 319 projects. Are there any past, current, or planned BMP projects in the watershed that anyone wants to share?<br><br>**Becky Gendreau**. I did reach out to DPW; they do lot of outfall monitoring on town roads but not necessarily on private roads around lake. I did not know extent of stormwater monitoring.<br><br>**Carl Nielsen**. There have been a number of projects in Quaboag pond to address the bad water quality flowing back into South Pond. Those projects were done through s. 319 grants, East Brookfield, or through other towns. Some have been successful applications for s. 319. Also tried 604(b) grant applications (that may include information about the watershed) but they have not been awarded. There have been studies that went into identifying problem locations, specifically around Lake Lashaway [which flows into Quaboag/North Pond]. South Pond meets with other watershed associations periodically, they do convey information about who is doing what within the watershed. Doug Vizard may have contact information from other watershed associations.<br><br>**Julia Keay**. What is the name of the other watershed association?<br><br>**Carl Nielsen**. There are different lake and pond associations. Lake Lashaway has an association [Lake Lashaway Community Association, Inc.[1]]. Doug would know more.<br><br>**Skip Nielsen**. Cranberry Meadow is one that we've reached out to.<br><br>**Doug Vizard**. Wickaboag [Lake Wickaboag Preservation Association[2]]. None of which are part of the watershed of concern, they are downstream or entirely different watersheds. Lashaway is of immediate concern because they are directly upstream of South Pond.<br><br>**Carl Nielsen**. Lake Lashaway Community Association has identified sites to be repaired in the Lake Lashaway watershed, they have submitted s.319 and 604b grant applications with that information. They did not receive grants for the repairs but have done the studies; they could probably use additional study. Lake Lashaway is definitely a lake with nutrient issues and a source to Quaboag Pond, which backflows into South Pond periodically.<br><br>**Carl Nielsen**. Public outreach has been done through past s. 319 grants and the QQLA annual newsletter. Public outreach has been conducted related to watershed issues, [such as educating residents on BMPs including] maintaining lawns and buffer zones/strips along private properties abutting the lake. There has been a decent amount of work relating to public education.<br><br>**Julia Keay**. Are those annual newsletters?<br><br>**Doug Vizard**. QQLA newsletter is distributed 3 or 4 times per year; it always has something on issues with regard to water quality. It is primarily for educational purposes; we do a great deal of outreach. When there is any property turnover on either |

[1] https://lakelashaway.org.
[2] https://lakewickaboag.com.

South or North pond, QQLA makes sure to strong-arm any new members into joining and convincing them on educational outreach and using their labor for volunteer work.

**Meghan Selby**. Becky, we should check in with Malcolm; some of the annual newsletters might be able count as match for the current s. 319 project depending on when they were dated and issued. I know there's a date before contract that we can count match toward s. 319, a little bit before contract actually starts.

**Becky Gendreau**. OK, that's a good point.

**Julia Keay**. How are the newsletters distributed? Is there an email list?

**Doug Vizard**. There is an email list which they prefer to use because most of the newsletter is in color. We don't distribute hard copy in color. They are also posted to website[3].

**Becky Gendreau**. A few things to add. QQLA is part of SLAC (Sturbridge Lakes Association Committee), which is a formal committee. SLAC also does outreach and educational things so we could get information from that as to what they are doing. In Sturbridge they also do water quality monitoring each year with local lake associations and SLAC. Information going back on that for yearly effort on South Pond. As far as public outreach and education, we've been working with conservation department with DPW on stormwater runoff impact, vegetated buffers along shorelines. Regarding potential pollution sources, there are quite a few private and town roads. Some of the private roads, noted multiple sources of runoff issues that we've been working with SLAC to identify and work towards solutions. We definitely see issues with road runoff into South Pond. One other thing is South Pond has private septic systems, and we know that when things go through for real estate transactions, septic upgrades are required. There are properties that may have failing systems that could be an issue too.

**Julia Keay**. Is the monitoring data available online?

**Becky Gendreau**. It is not available online. It is available here. We have electronic and hard copy records. Person who leads it lives on South Pond and may have information. Will try to compile data. Someone from Lake Association/ESS can go through documents at office, I can scan whatever isn't a duplicate and can send.

**Julia Keay**. I can see what Carl sends me. Monitoring data would be really helpful and if anyone wanted to volunteer to do that, let me know. Or if there is anything, I think you might have, I can ask. Becky, do you want to point out the roads you were mentioning?

**Becky Gendreau**. There are quite a few private roads. The ones that are of significant concern are South Shore Drive (few issues) and Tantasqua Shore Drive (2 issue areas).

**Emma Williamson.** Shared screen with Google Earth and outline of watershed. Becky, do you know where these roads are located?

**Julia Keay.** Those are dirt roads?

**Becky Gendreau.** Yes, there is erosion and sediment loading. Yes, sections where roads are really steep.

**Becky Gendreau**. Can send an image to Geosyntec identifying problem areas.

**Julia Keay**. Any other problem area locations? Or opportunity areas to implement BMPs?

[3] The most recent newsletter can be found at the following link: 2021 July QQLA Newsletter - COLOR Draft Rev C.pdf

**Doug Vizard**. Was an area that has been sort-of mitigated and that is a recent development on Lane 8. Opposite Lane 8 is Walker Hill Road that comes into New Boston Road from the east side. Lots of erosion at that point, and a couple of years ago, the Conservation Commission started with upgrades on Walker Road as it approaches New Boston [Road] which was dumping [sediment] across road into watershed. I know that something was done about this issue. The construction area off of Lane 8 was a housing development. Southeast of that area, Walker Road had a lot of erosion problems as it merged with New Boston Road. Now, it goes into the swale south of the construction site.

**Emma Williamson.** Is [Walker Road] still a dirt road or has it been paved?

**Doug Vizard**. The intersection with New Boston Road is paved, but [Walker Road] is largely still a dirt road. The upgrade did a pretty good job of containing the runoff or at least infiltrating it.

**Skip Nielsen**. As part of a development on Lane 8, 3 houses were built off of Lane 8, along with a development south of Lane 8. The developer over the past couple of years, removed a lot of material and sold gravel off of that property and then built the houses. The developer contoured the land so that water from a percentage of that property drains down Lane 8. I live on Lane 8. Over the years, I have contoured [graded] my property and my neighbor has contoured her property, so runoff does not go directly into the lake. I put a berm on the road that goes between properties to water. Put extensive amount of gravel to prevent washing out. Low area on property is filling with sediment now that developer contoured his properties to pitch towards Lane 8 instead of absorbing water on property. We have addressed it with the town several times. The Conservation Commission said it is beyond 200 feet limit that they have control of; they have no jurisdiction. Town addressed it somewhat with developer, but it still drains my way. Concern is low area full of sediment. May have to find a place to put an aquifer reclaim or regeneration area to catch water before it gets there. Lane 8 is all dirt.

**Julia Keay**. So basically, that property Sposato Realty Group, the sediment is running off and being contained downstream on residential property. Eventually will be filled and go into lake.

**Skip Nielsen**. Eventually it will, there is no place for it to go. Quite a bit of sediment during or after substantial rainfall. I don't know if we can absorb all that. It may take a few years, but it will.

**Meghan Selby.** Skip, do you mind sharing the property number?

**Skip Nielsen.** 158 Lane 8 is residential property. Between garage and house, low area. The gully where it used to go, used to get a sediment peninsula in between properties. Fountain Drive is the branch to goes to north of property. South branch of Lane 8 also.

**Julia Keay.** Are there any other areas anyone wanted to point out?

**Skip Nielsen**. There is another area to the north of Lane 8, between Lane 6 and 7. It is a new development just over the Brookfield line, there's a pond in there where we had a lot of sediment during construction come down. The brook that constantly runs from little pond, does not dry up. Takes up acreage from area to north and east of that development. During a heavy storm there may be a delta of sediment in the lake from the stormwater discharge.

**Becky Gendreau**. Looking at the wetlands layer [on her own computer], there may be a stream that comes out between Lane 7 and Lane 6?

**Meghan Selby**. I have a map viewer pulled up. Based on topography, it looks like the pond [located at the new development] drains south then takes a turn to the left, to the pond. Stream is located north of Lane 7, almost a straight shot from New Boston [Road] to the pond.

**Becky Gendreau**. I wanted to add that one of the things for permitting, South Pond is mapped as priority habitat (not estimated habitat) for rare plants. Will require a MESA application.

**Julia Keay**. Are there pollutant loading and reduction estimates? Reduction related to the alum treatment.

**Carl Nielsen**. We have all of that information. Will send it to you.

**Julia Keay**. Meghan, did you want to mention anything on additional grant funding?

**Meghan Selby**. There is another s. 319 round closing next week on December 15th. Short notice. Both 604(b) and 319 have spring Request for Responses (RFRs) that come out. They are hoping to schedule 604(b) RFR for end of February and 319 RFR will come out end of March or early April if there is any interest in either of those two programs. One thing to note that if you have any questions or want to talk about a project, contact us before RFR is released, cannot discuss anything project specific after the RFR is released.

**Carl Nielsen**. I have a quick question on that. If the lake association would be able to raise additional funding, could they add to current s.319 grant? Or is it not possible to increase size of ongoing project.

**Meghan Selby**. Will have to check in with Malcolm on that, he's the s. 319 program manager. If just match is increasing, is possible to do under existing project. Depends on what the added or new work would be and the relevancy to existing project.

**Carl Nielsen**. It would be entirely related to the scale and scope of alum project. Right now, they are targeting 87 acres and would benefit from doing 100 acres. It was tough to come up with the match when submitting the grant application, but now there may be additional cash; an extra 20-30K would certainly benefit the project. Looking to increase match contribution and get additional funding through the program.

**Meghan Selby**. If you are looking for s.319 funds it would have to go through new round of funding. May be possible. Wait until after the 15th then give Malcolm a call.

**Carl Nielsen**. When you write the WBP will it just focus on South Pond or will it focus on backflow from Quaboag/North Pond?

**Julia Keay**. That is good question; Quaboag/North Pond will definitely be included as a source.

**Carl Nielsen**. When you look at the TMDL, it acknowledges that backflow is a significant source of loading. When you look at only South Pond, watershed should be perfect since it's just a large watershed and relatively undeveloped. When you throw in the Quaboag Pond backflowing, it changes the nutrient dynamic.

**Julia Keay**. The current thinking is the WBP will focus on South Pond and include the loading from greater Quaboag Pond watershed as an additional source that only contributes during large events. What is the rainfall depth estimated for trigger of backflow from Quaboag Pond? You said 1-2 inches?

**Carl Nielsen**. There is probably information on TMDL related to that. TMDL has a lot of information related to what MassDEP historically has thought the loading from backflow is. Estimated to be on the order of 60% which is a significant load. Even though its infrequent it is a major contributor to the load.

**Julia Keay.** Will make sure to address that in the WBP, but don't think the WBP will be for larger watershed. We haven't done a plan yet with this type of situation with the backflow.

**Meghan Selby**. Would be good to talk about, Julia. We can circle back to that later. This is a unique situation and I don't know if we have the funding to do the bigger watershed but if it's possible, it may be beneficial.

**Carl Nielsen**. Just so you know, when these organizations go for grants, they generally work with all three towns to secure the grants. Brookfield and East Brookfield have both sponsored s. 319 grants on behalf of the lakes. Most of the work has been in Quaboag watershed. They do work together, segregating them is quite challenging, as they are intertwined.

**Meghan Selby**. Julia, can you pull together a list of who is sending what information to you so Becky can see what information she has in the Conservation Commission's office so we can figure out how to tackle any other data we might want. I saw in chat that Kelli is interested in the QQLA website[4]. Where are the newsletters stored?

**Doug Vizard**. If you search that website. There is a button for newsletters, condensed board of directors' notes, etc.

**Emma Williamson**. Can include links in meeting minutes as well[5].

**Doug Vizard**. Wanted to mention, there have been many individual property owners that have been very responsible with regard to runoff and modification of runoff. I've really only mentioned things that have occurred in last 5 years. Prior to that, there were many other equally important improvements by individual landowners, development properties. Sturbridge Conservation Commission has made any development/redevelopment very concerned with runoff and that goes back many years.

**Julia Keay**. Was that addressing erosion?

**Doug Vizard**. Erosion, septic systems, implementation of pump-ups. All of those things. Goes back 10-15 years.

**Meghan Selby**. Would most of that fall under permitting that happens in town?

**Doug Vizard**. Yes, but not all of it. Only some of it under permitting. Homeowners are highly responsible and concerned with runoff and erosion on their property.

**Julia Keay.** That's great.

**Meghan Selby.** Thanks for sharing that Doug.

**Skip Nielsen**. If you go around the lake, you will see very few lawns. Mostly everyone has been educated to keep it natural, keep trees, and prevent erosion from banks. Trees help to prevent shoreline collapse. There is high consciousness as to how to preserve the lake. He can count on one hand, the number of lawns extending down to the lake.

Thank You.

Contact: Julia Keay, JKeay@geosyntec.com
Emma Williamson, EWilliamson@geosyntec.com
Judith Rondeau, Judith.rondeau@mass.gov
Meghan Selby, Meghan.selby@mass.gov

[4] www.qqla.org
[5] The newsletters can be found on the front page of QQLA's website: QQLA: Quaboag Quacumquasit Lake Association.

## Appendix B – Stakeholder Meeting Minutes (March 25, 2022)

# Meeting Minutes

| | | | |
|---|---|---|---|
| Project Name: | Quaboag Pond and Quacumquasit Pond Watershed-Based Plan | | |
| Location: | Quaboag Pond and Quacumquasit Pond Watershed (Sturbridge, Brookfield, East Brookfield, Spencer, Oakham, Paxton, Leicester, New Braintree, and Charlton MA) | | |
| Meeting Date, #: | March 25, 2022 | Meeting Time: | 10:00 – 11:30 AM |
| Prepared By: | Emma Williamson | Meeting Location: | Zoom videoconference per Geosyntec invitation |
| Distribution: | All listed below | | |

Attendees:

| Name | Organization | Contact Information |
|---|---|---|
| Emma Williamson | Geosyntec Consultants, Inc | EWilliamson@Geosyntec.com |
| Julia Keay | Geosyntec Consultants, Inc | JKeay@Geosyntec.com |
| Judith Rondeau | Massachusetts Department of Environmental Protection (MassDEP) | Judith.Rondeau@mass.gov |
| Meghan Selby | MassDEP | Meghan.Selby@mass.gov |
| Padmini Das | MassDEP | Padmini.Das@mass.gov |
| Carl Nielsen | ESS Group | cnielsen@essgroup.com |
| Rebecca Gendreau | Town of Sturbridge Conservation Commission | rgendreau@sturbridge.gov |
| Doug Vizard | Quaboag Quacumquasit Lake Association (QQLA) | dvizard.sturbridge@gmail.com |
| Jeff Bridges | Town of Spencer | JBridges@spencerma.gov |
| Rick Manser | Lake Lashaway Community Association | Manser.Rick@gmail.com |
| John Knight | Brooks Pond Conservation Association | jgknight83@gmail.com |
| Lauren Trifone | Town of Spencer Conservation Commission | LTrifone@spencerma.gov |
| Mia McDonald | MassDEP | Mia.McDonald@mass.gov |
| Sadie Constantine | Worcester County Conservation Department | Sadie.Constantine@usda.gov |

"*This project has been financed with Federal Funds from the Environmental Protection Agency (EPA) to the Massachusetts Department of Environmental Protection (the Department) under an s. 319 competitive grant. The contents do not necessarily reflect the views and policies of EPA or of the Department, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.*"

*Minutes to be considered final unless comments are received within five (5) business days.*

AGENDA

- Greeting – Julia Keay, Geosyntec & Meghan Selby, MassDEP
- Watershed & Goals Overview – Julia Keay, Geosyntec
- s. 319 Grant Project Spotlight – Rebecca Gendreau, Town of Sturbridge
- Brief Introductions from All Participants – All
- Discussion of Completed, Ongoing, and Future Efforts – All

| WATERSHED & GOALS OVERVIEW/SECTION 319 GRANT PROJECT SPOTLIGHT |
|---|

**Julia Keay.** Hello everyone and thank you for coming to the Quaboag Pond and Quacumquasit Pond watershed-based plan meeting. I will also refer to Quaboag Pond as North Pond and Quacumquasit Pond as South Pond.

**Meghan Selby**. The Section 319 grant is for the Town of Sturbridge. Looking forward to chatting with you all today. A watershed-based plan helps identify opportunities for projects in the future. The goal is to have a watershed-based plan that meets the 9 elements required by EPA and to also have a planning document to improve water quality within the watershed. I manage the 604b grant program that focuses on planning. The section 319 grant is focused on implementation. My contact information is included at the end of the presentation [and is included at the end of the meeting minutes]. I look forward to hearing from everyone.

**Julia Keay**. I am going to go over the watershed briefly. The North Pond/South Pond watershed is about 76 square miles and also the South Pond watershed (in periods of no backflow) is almost 2 square miles. The retention time in South Pond is a lot longer than in North Pond even though it is a much smaller area. There is a good percentage of agricultural and residential land use, with not too much industrial and commercial land use. There is a lot of forested. The impairments include non-native plants, algae, total phosphorus, and mercury in fish tissue. The long-term goal of the watershed-based plan will be based on the Total Phosphorus TMDL. We have also looked at the 2019 ESS study and will use the updated loading estimates and goals for the South Pond from that study. The study indicated that the section 319 project would resolve the loading and achieve the TMDL goal. This map shows the waterbodies in the watershed (Dean Pond, Brooks Pond, Fivemile River, Lashaway Lake, East Brookfield River, Quaboag River, Quaboag (North) Pond, Quacumquasit (South) Pond, Browning Pond, Turkey Hill Pond, Eames Pond, Thompsons Pond, Sugden Reservoir, Turkey Hill Brook, Lake Whittemore, Sevenmile River, Cranberry Meadow River, Cranberry Meadow Pond, and Great Brook). There are backflows from North Pond into South Pond and the discharge point is into the Quaboag River. Showed land use map. Most of the industrial land is located along Route 9 and agriculture is concentrated in the northern area. Showed impervious cover map. A lot of the impervious cover is also concentrated along Route 9 and the Fivemile River area. Rebecca, can you describe the section 319 project?

**Rebecca Gendreau**. We are working with the [Spencer] Department of Public Works and had a meeting a couple weeks ago to talk about the pending approval for the section 319 project. We are working on that now and also need forms to be signed and to coordinate with other towns.

**Julia Keay**. The time frame for the project is by June 2023 and the goal is to address the TMDL and to meet the goal. ESS determined that the internal loading from the TMDL was underestimated and believed that it was a lot higher. They believe that if the internal loading is addressed by the alum treatment, it should meet the internal goal.

**Carl Nielsen**. You've got it correct. That is exactly what we found, that the old TMDL used a "plug-in" number for sediment loading and assumed a background value. When we did the sediment testing, the phosphorus concentrations ended up being a much greater fraction of the internal loading due to internal recycling. The project will address the internal recycling and resolve the water quality issues.

**Julia Keay**. The TMDL for North Pond requires an overall 30% reduction for nonpoint source (NPS) pollution. The focus of this plan is to see what is being done for NPS pollution.

**Carl Nielsen**. South Pond flows most of the time into North Pond. Does this mean that North Pond get a reduction in their TMDL for a reduction in pollution in South Pond?

**Julia Keay**. We should include that in the plan.

**Meghan Selby**. That would apply because that is the way that the water flows primarily. For the structure, we are having two stakeholder meetings, but we are creating one single watershed-based plan document for South Pond and North Pond.

| BRIEF INTRODUCTIONS FROM ALL PARTICIPANTS |
|---|

**Julia Keay**. Project manager for Geosyntec and has worked with grantees and stakeholders to develop these WBPs.

**Emma Williamson**. Also works for Geosyntec and has worked on the WBPs.

**Judy Rondeau**. NPS water specialist and coordinator for MassDEP.

**Padmini Das**. The section chief for the NPS pollution at MassDEP. It is my first month at MassDEP and I am excited about learning about this project. Thanks for having this meeting.

**Rick Manser**. Vice president of the Lake Lashaway Community Association. Connection to Quaboag Pond is that we have had studies done by ESS for the past couple of years. We decided to do treatment of invasive weeds and will continue that this summer. We will have water quality checked by ESS as part of that process.

**Julia Keay**. Is the work at Lake Lashaway similar to North and South Ponds?

**Carl Nielsen**. There is a different process for Lake Lashaway. I am a certified lake manager at ESS (24 years). Worked with QQLA for 25 or 30 years; grew up in the area on South Pond. Has a long history of experience with the North Pond and South Pond; whereas Lake Lashaway brought me in to assist with assessments a few years ago. We are just starting out at Lake Lashaway.

**Doug Vizard**. Representing QQLA. Asked about the boundaries of the watershed. I noticed that you had asked me questions about Cranberry Meadow. There is a history there that goes back more than 50 years with that particular area. I thought it was in a different watershed that drains to Glen Echo Lake [in Charlton, MA]. I also noted in your list of participants is that you were talking to Spencer wastewater treatment facility (WWTF) and Conservation Commission. There was no mention of North Brookfield, which also is going through a renovation of their WWTF that may be quite relevant to their watershed. Cranberry Pond may drain in both directions though.

**Julia Keay**. The boundaries are based on the MassGIS subbasins layer. Where is the North Brookfield WWTF?

**Doug Vizard**. North Brookfield is undergoing a renovation of their WWTF. Are you working with the Connecticut River/Long Island watershed groups? And what about nitrogen? Nitrogen is part of the historical argument with the WWTF.

**Julia Keay**. That is a good point about involving the Connecticut River Conservancy. Right now, we are more focused on the general Quaboag subwatershed. But it is within the Connecticut River major basin.

**Meghan Selby**. Looks like the WWTF discharges to Dun Brook and then to Quaboag River.

**Julia Keay**. There is a watershed-based plan for Sevenmile river. We have information from that plan that we will adapt for this plan. That river is impaired for E. Coli. In our plan, we will have a separate goal for E. Coli based on the MA water quality standard.

**Rebecca Gendreau**. Conservation agent for the Town of Sturbridge. Applied for the section 319 grant working with QQLA. Taken over this project since our town administrative left. Our involvement is that we are the grant holder and a portion of South Pond is in Sturbridge. We don't have an affiliation, do monitoring, or have experience with North Pond.

**John Knight**. Member of Brooks Pond Conservation Association and Brooks Pond Conservation Commission. We monitor water quality and invasives and do regular treatment of invasives. Glad to be a part of conversations in the watershed and also with other pond associations in the watersheds.

**Jeff Bridges**. Town of Spencer administrator. Here to familiarize myself with Spencer's participation. Lauren [Trifone] will be the contact going forward.

**Lauren Trifone**. Conservation Agent for Town of Spencer and interim Town Planner. Quite a few bodies of water in the North Pond watershed are in Spencer. Not sure if our previous agent is part of this as this is new to me at this point.

**Sadie Constantine**. Conservation Planner for Worcester County Conservation District (WCCD) and also work with National Resources Conservation Service. I am here representing the district and to see if we can help in any way. Personally, I grew up on the Spencer side of Brooks Pond.

**Mia McDonald**. Circuit rider for the central region of MassDEP. Very interested in the project.

DISCUSSION OF COMPLETED, ONGOING, AND FUTURE PROJECTS

A general discussion was held on the following topics:

- ⇒ Past, current, or planned stormwater best management practice (BMP) projects in the watershed
- ⇒ Pollutant load reduction estimates for BMP projects
- ⇒ Water quality monitoring efforts
- ⇒ Potential pollution sources or problem areas
- ⇒ Public education and outreach
- ⇒ Additional grant funding available

**Julia Keay**. This can be an open discussion now. We can start with any past, current, or planned projects. I had one question. In the Sevenmile River WBP, we had a bunch of projects that were listed (in 2020). There were also some projects in design: I'm curious if any of those have been constructed. Projects include an infiltration project on 84 North Spencer Road, infiltration chambers on Hillsview Road and Meadowbrook Lane, and raingardens on Meadow Lane. I believe all of the projects are in Spencer. [Nobody was aware of any projects]. Is there anything else? I will include a map in the plan where we point out project locations. If there is anything else to include in the plan (planned or current projects), I can add a pin to it now to include in the plan. We can move on to potential pollution sources or public education/outreach.

**Emma Williamson**. This includes any areas with significant erosion.

**Carl Nielsen**. There is not a tremendous amount of erosion right around the pond itself, but there is some. North Pond in particular is relatively flat around that area. The vast majority of pollutant loading to the pond comes from the watershed area. There is a record of a section 319 grant that was funded 15 years ago with the Town of Brookfield; designed to go out into the watershed and locate sources of erosion and potential pollutants with the goal of finding BMPs and sites for BMPs. My suspicion is that those sites have not been improved. May be from 2008/2009. Town of Brookfield was the grant applicant. Many of the sites were along that Route 9 area (commercial/industrial) with more impervious surfaces. It was a section 319 grant but had a lot of other information in it. One component of it was some implementation. The challenge was that the Town of Brookfield was the applicant and some of the sites they were finding were not in Brookfield. In terms of implementing solutions, they did not have staff to go as in-kind services to make improvements of the watershed. There really needs to be a section 319 grant that is pursued independently by the towns that issues were identified in. I think they were mostly in East Brookfield. There is knowledge of more sites that are problematic, and they also did water quality testing.

**Julia Keay.** Do we have access to that plan?

**Meghan Selby**. I am trying to pull it up now. If I can't grab it now, I can get it from Malcolm. Rick or John, I know you are familiar with your lakes, do you know of any issues or opportunities for BMPs to be installed?

**Rick Manser**. Part of the ESS study included some recommendations for BMPs as part of the report.

**John Knight**. At Brooks Pond, we don't have anything specific. Phosphorus load comes from the north for us. There is an area of concern, but we are currently dealing with it, but we do not have other ideas or plans.

**Carl Nielsen**. I know that DCR does some work in the watershed but not much on water quality; their focus is more on aquatics and invasive species. This is for the lakes and ponds group that is separate from the DCR operations group. Ann Carol would be the best person to speak with. She is with lakes and ponds and heads up that division.

**Julia Keay**. Carl, I had a question on the long-term aquatic plant management program. Is there a 2021 report?

**Carl Nielsen**. Yes, there should be a 2021 report; it is in progress. There has not been water quality data included, historically.

**Julia Keay**. I might email you about a figure that was in an appendix that was not included.

**Carl Nielsen**. I can help you with that.

**Julia Keay**. I had another question. In 2020, the report recommended more aggressive treatment, including more aggressive treatment in the channel that connects the two ponds. Is this still planned?

**Carl Nielsen**. It was done. There was a bridge repair/replacement that was done over the last full year of work, maybe longer. As part of that bridge repair, they closed the barrier between the two lakes and put up a cofferdam. The two lakes were separated which reduced the amount of flow going through the canal. They applied Sonar to address the fanwort that was pretty dense within the interbasin connected.

**Julia Keay**. There was a site selected for a water quality swale to be designed, permitted, and constructed along the west side of West Sturbridge Road. The pollutant load reduction was calculated in 2007. Does anyone know if that was actually constructed?

**Carl Nielsen**. I'm not sure if that was built or not.

**Doug Vizard**. I would assume East Brookfield would know something about it.

**Carl Nielsen**. Was it located northeast of South Pond?

**Doug Vizard**. Yes.

**Carl Nielsen**. And was it part of a section 319 grant?

**Julia Keay**. Yes.

**Carl Nielsen**. It was built but it was not maintained.

**Julia Keay**. Asked about public education and outreach and watershed events that any of the organizations do, including newsletters. That would be helpful.

**Rick Manser**. We have newsletters almost quarterly; we mail them and one is going out next week. They are available online.

**Doug Vizard**. Ditto for QQLA. There are usually three, sometimes four newsletters per year. Everything is compiled on the website anyway. We mail them, although we prefer electronic media. We have another one coming out soon. The current one is a "last year in review" and includes everything from photo contests from birds and mushrooms. The newsletter also includes all of the lake events that we are connected to or sponsor from kayak outings to this year, a big lake-wide swim event. There are also articles on water quality, weeds, how to best manage your lawn, good housekeeping practices, etc. We also have hardcopies and information stuffers that we use when we look at real estate records and ask new residents to become a member

of the lake association. We have a membership packed with information from weeds to wildlife. We also have an annual meeting with experts, to talk about on-goings with regards to lake science, water quality, weeds, and similar issues.

**Rick Manser**. Ditto for Lashaway. We have those types of meetings twice (spring/fall). The website is lakelashaway.org. The meetings are pretty well attended and we have been impressed with the turnout.

**Doug Vizard**. We combined meetings for South and North Ponds. We tried to make an effort to get equal participation amongst the ponds and keep the same number of people on the board of directors. Historically, the focus was all about South Pond but now it includes both ponds. Right now, our membership hosts more than 50% of shoreline residents along both ponds.

**Rick Manser**. Ditto for Lashaway.

**Julia Keay**. Do you think there has been work for residential best management practices (BMPs)?

**Doug Vizard**. Yes, we encourage that. We encourage joint participation in cleaning up and helping your neighbor and discouraging green lawns all the time.

**Julia Keay**. What about for Lake Lashaway?

**Rick Manser**. I would say yes. On the 23rd we are doing a full lake cleanup as part of the 100th anniversary for East Brookfield. We work on educating our abutters.

**Meghan Selby**. Rick, did you say you also have more than 50% participation.

**Rick Manser**. Last year out of 180 abutters, we had 140 members.

**Meghan Selby**. That's great.

**Julia Keay**. One other topic to touch on is septic systems. Septic systems be an issue in all of the ponds. Is there anything anyone wanted to add about how that is being addressed?

**Rick Manser**. Title V applies.

**Doug Vizard**. There have been some efforts but no inroads with regards to septic pumping efforts, schedule, records. We found a major complication there that many properties go through family deeds which are immune from Title V. We are all concerned and make a lot of noise about it with regards to information sharing and we will at least continue with those efforts. We are worried about the invasion of privacy issues with pulling septic records. We can do that, but we try to do everything we can, at least from an educational perspective. There is virtually no enforcement other than Title V during deed transfer.

**Carl Nielsen**. We did a study almost 20 years ago looking at the influence of septic system. The finding was that 4% of the nutrient loading was coming from septic at the time. It was not a major concern but doesn't mean that it hasn't worsened over the years. I believe that it is less than 10% of loading to South Pond, and even less for North Pond. I believe it is a very small fraction. But obviously managing your property and system well is still important.

**Doug Vizard.** With modern improvements and Conservation Commission scrutiny of newer properties, they have done a pretty good job at promoting pump-up systems away from the lake which helps. Certainly, the major impact is Title V as well as the fertilizer laws that went into effect ~3-4 years ago. We continue to push that information forward. I don't know if there is any enforcement in that area. I know that a few years ago I was inspecting the various stores around to see evidence that their lawn care items (fertilizers) were segregated from agricultural fertilizers to diminish the amount of phosphorus that people were using on their lawns.

**Julia Keay**. What about septic around Brooks Pond?

**John Knight**. The interesting thing about Brooks Pond is that it's privately owned by about 10 families and that 95% of the land abutting the lake is owned by those family. We could do a better job of reminding people to do regular maintenance and replace systems that need it. I'm certainly open to good websites, etc. or places to look for that information.

**Meghan Selby**. There are a lot of resources that we can share with you.

**John Knight**. Unfortunately, our ownership group has a number of people in it that want to stay under the radar (with regards with website, etc.). So, we have a reduced capacity to educate but we are working on it. The more that we can remind people that we are part of something bigger is good. I appreciate having these conversations that it's not just about them and there are impacts all around us. We are pretty thoughtful about the pond, so we need to be more thoughtful about how we use the pond and what enters the pond.

**Julia Keay**. Has there been anything done in the river segments with regards to cleanup?

**Doug Vizard**. C4R [Chicopee 4 Rivers Watershed Association] does an E. Coli measurement program that we contribute to and help to monitor in the Sevenmile River and all along its course into the Quaboag River. Other than that, there are no other water quality measurements. They have an established water route for canoers and kayakers all the way to Ware from East Brookfield and they sponsor activities.

**Meghan Selby**. I don't know how many of you are familiar with section 319 and 604b grants. 604b grants are for planning projects and section 319 grants are for implementation projects. The goal is to get watersheds delisted from the 303(d) list. We are getting ready to issue our spring 604b RFR for the regular base funding amount. This year we are expecting new funds under the Bipartisan Infrastructure Law that just signed last year. We are expecting funds for the next 5 years that would more than double what we typically have. We are starting to generate our own ideas for projects. One thing we are focusing on is putting WBPs in place and funding those projects. I am happy we have Sadie on the line. There is a larger pool of eligible entities for 604b projects. We can only award funding to eligible entries to municipalities, conservation districts, etc. but couldn't directly fund lake associations. I want to have another conversation offline in the future to see how we can get more money into the watersheds. We want to give as much support as we can to improve water quality overall. I'm excited that we are getting additional funds and I am not exactly sure how we will allocate them. If anyone wants to be on the distribution list. Please let me know. You will get notifications.

**Julia Keay**. There will be a pre-RFR meeting.

**Meghan Selby**. Next week there will be a nonpoint source (NPS) management forum. It will be a great overview of the NPS program and a little information on each of the grant programs. We will have a couple past grantees describe their projects and will run through tools that help applicants and support them in applying for grants and things like that.

**Meghan Selby**. The announcement list will let you know when the pre-RFR meeting is. We do this a few weeks before the RFR comes up so we are able to talk to applicants. Once the RFR is issued there is a "cone of silence" and we can only help with administrative issues. We do those pre-meetings for 604 and 319 grants. If anyone has questions, we are available and are hoping we can produce a plan that meets EPA requirements and also increases awareness. We want a planning document in place that can help support the watershed and improve water quality

**Julia Keay**. We can send today's presentation as well.

Contact: Julia Keay, JKeay@geosyntec.com
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Meghan Selby, Meghan.Selby@mass.gov

## Appendix C – Select excerpts from the Chicopee River Watershed 2003 Water Quality Assessment Report (MassDEP, 2003) and the Total Maximum Daily Loads of Total Phosphorus for Quaboag & Quacumquasit Ponds (MassDEP, 2006) relating to the water quality in the Quaboag Pond/Quacumquasit Pond watershed (note: relevant information is included directly from these documents for informational purposes and has not been modified).

**Chicopee River Watershed 2003 Water Quality Assessment Report (MA36130 - Quaboag Pond)**

Aquatic Life Use
Biology
According to field notes there was a fish kill after a July 21st, 2004 herbicide treatment. A blue-green bloom that may have been exacerbated by the herbicide treatment was later noted in July 2004. After the herbicide treatment the blue-green bloom was extensive, although high nutrient loading also likely contributed to the bloom.

In August 2003, during baseline TMDL sampling, three non-native species (Myriophyllum heterophyllum, Cabomba caroliniana, and Myriophyllum spicatum) were observed in Quaboag Pond (MassDEP 2006b). The macrophytes density and biovolume was very dense for the majority of the pond in August 2003 (MassDEP 2006b). The density and biovolume of macrophytes was much larger than found in the 1980's and macrophytes also occurred deeper in the water column (3 m versus <2 m) (MassDEP 2006b). These same non-native species were also observed in Quaboag Pond during the 1998 synoptic surveys (MassDEP 1998).

MA DFG conducted fish population sampling in Quaboag Pond (Site 1018) in Brookfield using a boat shocker on 30 June 2004. One hundred and twenty-nine chain pickerel and one alewife were collected (130 fish total) (Richards 2006). MA DFG fish biologists noted the targeted fish, Escocidae (chain pickerel and pike), only during their collection. Given the target nature of this sampling no conclusions on the fish population dynamics in Quaboag Pond can be made.

Water Chemistry
The selected target phosphorus concentration and loads necessary to achieve surface water quality standards for Quaboag Pond are 30 ppb (June through September) and 2588 kg/year, respectively (MassDEP 2006b). For the complete detailing of estimated nutrient loading to Quaboag Pond see the Total Maximum Daily Loads of Total Phosphorus for Quaboag Pond & Quacumquasit Pond (MassDEP 2006b). For the most recent water quality data see Appendix C.

The Aquatic Life Use for this segment is assessed as impaired based on the presence of non-native plant species and excessive algal growth resulting from high total phosphorus. The TMDL estimates nutrient loading from the municipal point source discharge (Spencer WWTP), multiple nonpoint sources, and internal nutrient recycling.

Fish Consumption Use
MA DPH (2005) has issued a fish consumption advisory due to Mercury contamination for Quaboag Pond, Brookfield/East Brookfield as follows:
"Children under 12, pregnant women, women of childbearing age who may become pregnant and nursing mothers should refrain from consuming any fish from Powder Mill Pond in order to prevent exposure to developing fetuses, nursing infants and young children to Mercury.
The general public should refrain from consumption of Largemouth Bass fish from Quaboag Pond. The general public should limit consumption of non-affected fish from Quaboag Pond to two meals per month".

Due to the site specific fish consumption advisory this waterbody is assessed as impaired for the Fish Consumption Use.

Primary and Secondary Contact Recreation Uses
Large populations of the non-native Eurasian milfoil (Myriophyllum spicatum) and fanwort (Cabomba carolinina) were found in August 2003 (MassDEP 2006b). Macrophyte density in the range of 75-100% was found over the majority of the pond. Macrophytes also occupied 50 to 75% of the biovolume in the majority of the pond and around the edges macrophytes often occupied 75-100% of the biovolume, especially along the northeastern and northwestern shores of the pond. In July 2003 the macrophyte density and biovolume were so great that frequent cleaning of the outboard motor was needed to traverse the pond although conditions improved in August. In July of 2004 an herbicide treatment occurred on Quaboag Pond.

According to MassDEP (2006b), "A bloom of algae was reported to be in the water at the time, but this bloom expanded to become a large, persistent surface bloom of blue-green algae (cyanobacteria) that raised concerns about health impacts." It was estimated that the herbicide treatment likely released a sufficient amount of nutrients to significantly contribute to a large bloom, although it was also noted that phosphorus concentrations in East Brookfield River (an upstream tributary to Quaboag Pond) were also high (50 ug/L) in July (MassDEP 2006b).

The Recreational Uses are impaired due to high density and biovolume of aquatic macrophytes, including non-natives and excessive algal growth.

Aesthetics Use
MassDEP DWM field crews noted objectionable deposits on two occasions during field visits conducted in 2003 and 2004. Noxious weeds were noted on the two occasions and a bloom of blue-greens (cyanobacteria) was noted in July 2003. On three occasions surface scums were noted, consisting of pollen sheen on one occasion, streaks of foam on one occasion and a blue-green bloom on another occasion. Water odors or other objectionable deposits were not noted during field sampling. The Aesthetic Use is impaired due to high density and biovolume of aquatic macrophytes including non-natives and excessive algal growth.

A 319 grant entitled "Phosphorus and Sediment Load Reduction at Quaboag and Quacumquasit Ponds" has been awarded. The goal of this project is to support the TMDL development and implementation by prioritizing and addressing pollutant sources within the sh

**Report Recommendations:**
Follow aquatic macrophytes management plan outlined in TMDL (MassDEP 2006b).

Follow TMDL recommendations in terms of nutrient loading with specif ic emphasis on non-point source loading reductions (MassDEP 2006b).

Conduct monitoring to assess the progress of TMDL implementation.

**Chicopee River Watershed 2003 Water Quality Assessment Report (MA36131 - Quacumquasit Pond)**

**Aquatic Life Use**
Habitat and Flow
Flow of water out of Quacumquasit Pond is controlled by means of a gate structure and the backflow of water from Quaboag Pond to Quacumquasit Pond has been noted (MassDEP 2006b). This backflow of water from Quaboag has been identified as a source of nutrient loading to Quacumquasit Pond (MassDEP 2006b).

**Biology**
Three non-native species (Myriophyllum heterophyllum, Myriophyllum spicatum, and Cabomba caroliniana) were observed in Quacumquasit Pond during the 1998 synoptic surveys (MassDEP 1998). Macrophyte mapping was not conducted at this pond in 2003.

**Water Chemistry**
For a complete detailing of estimated nutrient loading to Quacumquasit Pond please see the Draft Total Maximum Daily Loads of TP for Quaboag Pond & Quacumquasit Pond (MassDEP 2006b).

The Aquatic Life Use for this segment is assessed as impaired based on the presence of a non-native species.

**Fish Consumption Use**
MA DPH (2005) has issued a fish consumption advisory due to Mercury contamination for Quacumquasit Pond, Brookfield/East Brookfield as follows:
"Children under 12, pregnant women, women of childbearing age who may become pregnant and nursing mothers should refrain from consuming any fish from Quacumquasit Pond in order to prevent exposure to developing fetuses, nursing infants

and young children to Mercury. The general public should limit consumption of all fish species from Quacumquasit Pond to two meals per month".

Due to the site-specific fish consumption advisory this waterbody is assessed as impaired for the Fish Consumption Use.

A TMDL was recently approved for mercury by the U.S. EPA. The Northeast Regional Mercury Total Maximum Daily Load (TMDL) was prepared by the New England Interstate Water Pollution Control Commission (NEIWPCC) in cooperation with the states of Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont.

The TMDL covers waterbodies including Quacumquasit Pond that are impaired primarily due to atmospheric deposition of mercury (Northeast States 2007). The TMDL target for Massachusetts is 0.3 ppm or less of mercury in fish tissue. The plan calls for a 75% reduction of in-region and out of region atmospheric sources by 2010 and a 90% or greater reduction in the future (NEIWPCC 2007).

**Primary and Secondary Contact Recreation and Aesthetics Uses**
There are two beaches along the shoreline of Quacumquasit Pond: South Pond Beach and Camp Frank A Day. Currently there is uncertainty associated with the accurate reporting of freshwater beach closure information to the Massachusetts DPH, which is required as part of the Beaches Bill. Therefore, no Primary Contact Recreational Use assessments (either support or impairment) decisions are being made using Beaches Bill data for this waterbody.

No objectionable deposits, scum or odors were noted by DWM field crews during baseline TMDL sampling in 2003. Macrophyte mapping was not conducted at this pond.

Due to the lack of recent quality-assured bacteria information the Recreation Uses are not assessed. Due to the lack of objectionable conditions noted at Quacumquasit Pond by DWM field crews, the Aesthetics Use is supported for Quacumquasit Pond.

A 319 grant entitled "Phosphorus and Sediment Load Reduction at Quaboag and Quacumquasit Ponds" has been awarded. The goal of this project is to support the TMDL development and implementation by prioritizing and addressing pollutant sources within the watershed.

**Report Recommendations:**
Follow aquatic macrophytes management plan outlined in TMDL (MassDEP 2006b).

Efforts should be taken through appropriate gate management and/or raising the gate height to prevent unnecessary nutrient fluxes into the pond (MassDEP 2006b).

**Total Maximum Daily Loads of Total Phosphorus for Quaboag & Quacumquasit Ponds (MA36130 - Quaboag Pond)**

Quaboag Pond in Brookfield/East Brookfield is a large 540-acre natural pond with a maximum depth of only 14 feet and a short annual retention time of about 12 days. The main inlet of the pond is the East Brookfield River and the outlet is the Quaboag River. The watershed is 60 percent forested. Rural land use accounts for about 25 percent that includes agricultural (14%), low density residential housing (7%) and some open land. About 9 percent of the watershed consists of water and wetlands. The remainder of the watershed is composed of high-density residential housing (4%) and some commercial-industrial land (2.5%). The north and east shorelines are developed with housing. A numbers of cemeteries including Green Hollow Cemetery, Southwest Cemetery and Pine Grove Cemetery, several campgrounds, the Moose Hill Wildlife Management Area, Spencer State Forest as well as some sand pits/sand and gravel pits are within the rather large watershed. Segments of Route 9, Route 31, Route 122 and small section of Route 56 all crosses the watershed. Population in Brookfield ranged between 2,397 and 2,968 from 1980 to the 1990 census. The University of Massachusetts (MISER) predictions on growth are 3,152 for the year 2000 and 3,566 for the year 2010 with an estimated 20-year growth rate of about 20 percent. Population in East Brookfield ranged between 1,955 and 2,033 from 1980 to the 1990 census. MISER predictions on growth are 2,163 for the year 2000 and 2,198 for the year 2010 with an estimated 20-year growth rate of about 8 percent.

**Table. Quaboag Pond Characteristics.**

| Quaboag Pond Characteristics | | |
|---|---|---|
| Lake area | 2,200,000 $m^2$ | 540 acres |
| Max. Depth | 4.25 m | 14 feet |
| Mean Depth | 2.03m | 6.6 feet |
| Volume | 4,460,000 $m^3$ | 3,590 acre-feet |
| Retention time | 12 days (annual) | 19-43 days (summer) |
| Watershed area (includes pond) | 19867 Ha | 76.7 sq. mi. |

Quaboag Pond has a long history of nutrient related impairment of recreation. A study of 1986 noted a high weighted average total phosphorus concentration at the inlet to Quaboag Pond of 71 ppb. Much of the phosphorus at the time was coming from the Spencer WWTP that at the time was discharging 45% of the total phosphorus loading to the pond. The WWTP had no specific total phosphorus limit in the discharge permit but was estimated to discharge 3.25 mg/l. In the 1980's the pond itself had an average TP concentration of about 45 ppb and a summer Secchi disk transparency of about 1.25 m with some readings below the swimming target of four feet (1.2 m). The study noted some surface scums of bluegreen algae (cyanophytes) at times. The high turbidity was apparently limiting the extent of rooted macrophytes to a depth less than 2m as noted in the BEC (1986) study. The ESS (2000) report notes that after the upgrades to the Spencer WWTP between 1987 and 1990 the concentrations in Quaboag Pond dropped from about 0.045mg/l to 0.020mg/l. The pond also shows signs of high sedimentation, particularly in the area near the East Brookfield River inlet to the pond, were water depths are now so shallow it is difficult to maneuver motor boats in this area. Control of sedimentation (which is often associated with total phosphorus) is called for in this TMDL even though the pond is not currently listed as impaired specifically by sediments.

Years ago the Spencer WWTP was a major source of nutrients to both Quaboag and Quacumquasit Ponds but today it is a relatively minor source. The BEC (1986) D/F study recommended a number of actions including an upgrade to the Spencer WWTP and the installation of a flow reversal gate at the outlet of Quacumquasit Pond and these improvements were all implemented. The Spencer treatment plant has a NPDES permit (MA0100919) with a permit final effluent flow rate of 1.08 MGD (million gallon per day) and growing season TP limit of .2 mg/l (1.8 lbs/day) and winter limits of 0.75 mg/l (6.8 lbs/day) with an overall permitted load of 708 kg/yr (1,563 lbs/yr) although they are operating under an interim Total Phosphorus growing season limit of 0.3 mg/l pending results of an optimization study (i.e. optimizing the use of chemicals such as aluminum to remove phosphorus). It should be noted that influent to the plant may be higher (in the study year it was 0.86 MGD). During the study year about 43% of the total flow is lost, presumably to groundwater infiltration in the final constructed wetlands and thus the final effluent flow averaged 0.49 MGD (0.76 cfs) and that is discharged to Cranberry Brook. Recent reports suggest most of the P load to the downstream ponds is not due to the treatment plant, but rather is from nonpoint sources in the watershed. ESS completed a NPS study that sampled and modeled TP and other pollutants in the Quaboag sub-basin (ESS, 2001).

Both lakes have seen deceases in total phosphorus concentrations and increases in transparency, however, bluegreen cyanobacteria blooms have continued to occur on Quaboag Pond (and to a lesser extent on Quacumquasit Pond) and Quaboag has experienced an expansion of submersed rooted plant growth out to a depth of about 9 feet as a result of the improved light penetration. In addition the aluminum flood control gate was installed at the outlet to Quacumquasit Pond, which appeared to further reduce nutrient concentrations in Quacumquasit, but did not eliminate the problem of backflooding entirely (Lycott, 1994).

Although the lakes were not officially listed as impaired by nutrients on the 2002 Integrated List, in 2003 the Department began a 12-month study of the lake in preparation to develop a protective total phosphorus TMDL in response to concerns about continuing nutrient loads from the Spencer WWTP. The focus of the study is to determine how much phosphorus input to the ponds comes from point sources vs. nonpoint sources and how to reduce the sources to meet a target in-lake concentration. The discharge from the Spencer WWTP is complicated by the fact that about half of the discharge is lost to groundwater in the constructed wetlands and further retention of phosphorus might occur in wetlands enroute to the pond. The study was designed to determine total phosphorus loads to the lakes with an emphasis on estimating the proportion of the load to Quaboag that is due to the Spencer WWTP (particularly during the summer period) and what proportion of the load to Quacumquasit is due to the backflooding past the flood control gate either when it is left open or when it is overtopped. The Town of Spencer also has a MS4 NPDES stormwater discharge permit (MAR041162) and has stormwater discharges to streams tributary to Quaboag Pond.

The results of measured phosphorus mass loads for the subwatersheds, the loads estimated for extrapolated areas and unknown loads estimated by difference are all presented for the study year in the table below. The loadings were recalculated to include only

the summer months (June-September), but the results were very similar in both loading rates (when annualized) and in proportions coming from each source with the exception that the internal Quaboag source was essentially calculated by difference to be negative in the summer, so only the annual budget will be discussed. It is possible that during an extended period of exceptionally dry weather the Spencer WWTP could become a relatively large source of phosphorus to the pond and this will require further monitoring.

**Table . Quaboag Pond Annual TP budget.**

| Subwatershed | Area Ha | | TP export kg/yr | TP Percent | Export rate kg/ha/yr |
|---|---|---|---|---|---|
| Sevenmile Rt 9 SM01* | 8083 | | 1147 | 31 | 0.14 |
| | | | | | |
| Cranberry Br Rd CR01* | 1461 | | 203 | 5 | 0.14 |
| | | | | | |
| Spencer WWTP SPEFF* | 0 | | 131 | 4 | |
| | | | | | |
| Extrapolated area to SM02** | 295 | | 41 | 1 | 0.14 |
| | | | | | |
| Unknown Source SM02*** | 0 | | 167 | 5 | |
| Subtotal to SM02* | 9839 | | 1690 | | 0.17 |
| | | | | | |
| Lashaway Rt 9 EB04* | 6390 | | 815 | 22 | 0.13 |
| | | | | | |
| Extrapolated area to Inlet EB04a** | 2248 | | 313 | 8 | 0.14 |
| | | | | | |
| Unknown Source EB04a*** | 0 | | 120 | 3 | |
| Subtotal to Inlet EB04a* | 18477 | | 2937 | | 0.16 |
| | | | | | |
| Net export of South Pond* | 466 | | 42 | 1 | 0.09 |
| | | | | | |
| Extrapolated area to Quaboag** | 925 | | 129 | 3 | 0.14 |
| **Total fluvial input to Quaboag** | 19868 | | **3107** | | 0.16 |
| Unknown internal source*** | | | 603 | 16 | |
| **Annual Total*** | | | **3710** | **100** | |

* Measured TP and flow

** TP estimated from Cranberry Br. Export rate x area

***TP estimated by difference between upstream sources and TP measured at site.

BEC. 1986. Diagnostic/Feasibility Study of Quaboag and Quacumquasit Ponds (North and South Ponds). Prepared for the Town of Brookfield and Massachusetts Div. Water Pollution Control... Baystate Environmental Consultants, Inc. East Longmeadow, MA.

ESS, 2000. Quaboag and Quacumquasit Lake Management Summary and Recommended Actions. ESS Wellesley, MA.

## Total Maximum Daily Loads of TP for Quaboag & Quacumquasit Ponds (MA36131 - Quacumquasit Pond)

Quacumquasit Pond (also known locally as South Pond) is located just to the south of Quaboag Pond, in the towns of Brookfield, East Brookfield and Sturbridge. Quacumquasit Pond is a large (225 acre) and deep (74 feet) natural pond with essentially no permanent inlets and an outlet to the interbasin connector that is partially regulated by a backflood control gate at the north end of the pond. The watershed is 55 percent forested. Water and wetlands account for about 21 percent of the watershed. Approximately 16 percent is in the rural category most of which consists of low-density residential housing (11%), some open space (about 3%) and little agricultural land (2%). The rest of the watershed consists of urban land that includes mostly high-density residential housing (about 8%) and commercial-industrial landuse (1%). Camp Day and several gravel pits are within the watershed. Populations in the towns of Brookfield and East Brookfield have been stated above. Population in the town of Sturbridge ranged between 5,976 and 7,775 from 1980 to the 1990 census. Miser predictions on growth are 8,133 for the year 2000 and 9,091 for the year 2010 with an estimated 20-year growth rate of about 17 percent.

**Table. Quacumquasit Pond Characteristics.**

| Quacumqausit Pond Characteristics | | |
|---|---|---|
| Lake area | 911,000 $m^2$ | 225 acres |
| Max. Depth | 22.5 m | 74 feet |
| Mean Depth | 9.24m | 30.3 feet |
| Volume | 8,330,000 $m^3$ | 6,800 acre-feet |
| Retention time | 1.46 years | 534 days |
| Watershed area | 454. Ha | 1.8 sq. mi. |

The history of the ponds is detailed in the 1986 Diagnostic/Feasibility (D/F) study of the ponds (BEC, 1986) which notes the interbasin connector was deepened and widened sometime after the mid-1800's and again in the mid-1960's. While this allowed boat traffic between the ponds it also allowed a greater degree of floodwaters from the Quaboag Pond to enter into Quacumquasit Pond in a process known as backflooding as the floodwaters reverse the flow of the outlet of Quacumquasit Pond. Unfortunately, this also allowed nutrients associated with the floodwaters to enter the relatively clear waters of Quacumquasit Pond.

The BEC (1986) reported with no gate backflows occur 17% of the time, which account for 4.56 million m3 of water enter Quacumquasit from Quaboag backflows annually in the absence of a flow controls (and that was in a relatively dry year). This also accounted for an estimated 205 kg of phosphorus loading from Quaboag to Quacumquasit Pond that at the time accounted for about 53% of the total load.

The 4.5 foot high gate was installed in July of 1991. However, the gate was installed with a maximum elevation at the top of the gates of only 599.5 feet (above sea level) compared to normal water levels of about 598.75 feet from the USGS topographic map. Thus the present gate can normally hold back only 0.75 feet of additional floodwater above median water levels. As noted in the Lycott (1994) report, the gates were successful at reducing late spring, summer and fall flow reversals (with the gate being left open winter and early spring), and in mid-1993 the order was amended to focus on spring flow reversals while attempting to leave the gate open in summer to minimize interference with boat traffic. Lycott (1994) also noted that the gate prevented backflows 22% of the time in 1992 (a wet year) and 6% of 1993 (a dry year) until it was closed in October of 1993. Lycott (1994) concluded the gate prevented 63% of the flow reversals during the post construction monitoring period. However, the largest flows occurred in early spring when the gate was left open, and because the gate was overtopped on several occasions the percentage of water stopped was less than 63%; perhaps roughly half of the back flooding was stopped. This combined with lower concentrations of TP in Quaboag (due to improvements in the Spencer WWTP and other inputs) resulted in an estimated 41% reduction in phosphorus loading or an estimated

load of 84 kg of phosphorus.

Some of the backflooding reported in the BEC (1986) report was due to drawdown of Lake Lashaway and subsequently the operating procedures were changed to regulate the flow out of Lashaway by opening the gates over a seven day period beginning with 4 inches on Nov. 1st and progressively increasing the gate opening daily to reach 22 inches (one half open) by Nov. 7 and 24 inches open after that with a note that in case of rainy weather the gate may have to be closed to 4 inches to avoid impacts on downstream environment. The order of conditions has expired and the Town of East Brookfield should reapply for a new Order of Conditions which should include a slower release of water (initially opening to a maximum of 22 inches over 10 day period) and include a requirement to contact the South Pond gatekeeper prior to starting drawdown and more specific language stating that in the event of rainfall of .2 inch or more the gates should be closed to a maximum of 4 inches and consult with the South Pond gatekeeper to ensure no backflooding to South Pond is occurring before opening further.

It was also noted in the management recommendations of BEC (1995) that the then present operation of the gate 'may be ineffective at addressing the loading of South Pond with nutrients and plant fragments'; and that more frequent monitoring and immediate closing of the gate may reduce nutrient levels (BEC, 1995).

Historically, backflooding contributed to the high phosphorus concentrations in Quacumquasit Pond. Quacumquasit Pond had TP concentrations, averaging 33ppb over the year and 22 ppb for the mid-summer period (mid-June thru mid-September) of 1984. The Secchi disk transparency averaged 3.5 m in 1984 with some values as high as 4.6 m in mid-summer. The pond had chlorophyll a concentrations that were slightly less than 10 ppb (some higher values may have been lab errors or due to flow reversals (BEC, 1986). The ESS (2000) report notes the after the upgrades to the Spencer WWTP between 1987 and 1990 and following the installation of the flood control gate the TP concentrations fell to 0.012 mg/l in Quacumquasit Pond in 1992.

Years ago the Spencer WWTP was a major source of nutrients to both Quaboag and Quacumquasit Ponds but today it is a relatively minor source. The BEC (1986) D/F study recommended a number of actions including an upgrade to the Spencer WWTP and the installation of a flow reversal gate at the outlet of Quacumquasit Pond and these improvements were all implemented. The Spencer treatment plant has a NPDES permit (MA0100919) with a permit final effluent flow rate of 1.08 MGD (million gallon per day) and growing season TP limit of .2 mg/l (1.8 lbs/day) and winter limits of 0.75 mg/l (6.8 lbs/day) with an overall permitted load of 708 kg/yr (1,563 lbs/yr) although they are operating under an interim TP growing season limit of 0.3 mg/l pending results of an optimization study (i.e. optimizing the use of chemicals such as aluminum to remove phosphorus). It should be noted that influent to the plant may be higher (in the study year it was 0.86 MGD). During the study year about 43% of the total flow is lost, presumably to groundwater infiltration in the final constructed wetlands and thus the final effluent flow averaged 0.49 MGD (0.76 cfs) and that is discharged to Cranberry Brook. Recent reports suggest most of the P load to the downstream ponds is not due to the treatment plant, but rather is from nonpoint sources in the watershed. ESS completed a nonpoint source study that sampled and modeled TP and other pollutants in the Quaboag sub-basin (ESS, 2001).

Both lakes have seen deceases in TP concentrations and increases in transparency, however, bluegreen cyanobacteria blooms have continued to occur on Quaboag Pond (and to a lesser extent on Quacumquasit Pond) and Quaboag has experienced an expansion of submersed rooted plant growth out to a depth of about 9 feet as a result of the improved light penetration. In addition the aluminum flood control gate was installed at the outlet to Quacumquasit Pond, which appeared to further reduce nutrient concentrations in Quacumquasit, but did not eliminate the problem of backflooding entirely (Lycott, 1994).

Although the lakes were not officially listed as impaired by nutrients on the 2002 Integrated List, in 2003 the Department began a 12-month study of the lake in preparation to develop a protective TP TMDL in response to concerns about continuing nutrient loads from the Spencer WWTP. The focus of the study is to determine how much phosphorus input to the ponds comes from point sources vs. nonpoint sources and how to reduce the sources to meet a target in-lake concentration. The discharge from the Spencer WWTP is complicated by the fact that about half of the discharge is lost to groundwater in the constructed wetlands and further retention of phosphorus might occur in wetlands enroute to the pond. The study was designed to determine TP loads to the lakes with an emphasis on estimating the proportion of the load to Quaboag that is due to the Spencer WWTP (particularly during the summer period) and what proportion of the load to Quacumquasit is due to the backflooding past the flood control gate either when it is left open or when it is overtopped. The Town of Spencer also has a MS4 NPDES stormwater discharge permit (MAR041162) and has stormwater discharges to streams tributary to Quaboag Pond.

The annual TP budget estimated for each of the sources described above is summarized in the table below (from "Total Maximum Daily Loads of TP for Quaboag & Quacumquasit Ponds", 2006). The best estimate of loading during the study year is 199 kg/yr. Most of the loading is due to landuse export within the local watershed that accounts for 33 percent of the loading. Backflooding was the second highest source and accounted for 62 kg/yr. Septic systems (42 kg) and internal loading (30 kg) accounted for the remainder.

The net output from Quacumquasit Pond based on estimated flow rates (daily flow factors from Sevenmile gage multiplied by in lake concentrations of TP) are estimated to be 42 kg/yr (this method does not include return flows from backfloods). Thus, it appears Quacumquasit Pond acts like a nutrient sink and retains about 95 kg/yr (excluding backflooding contributions).

**Table . Annual TP Budget for Quacumquasit Pond.**

| Subwatershed | TP export kg/yr | TP Percent | Export rate kg/ha/yr |
|---|---|---|---|
| Extrapolated Export of 466 ha watershed** | 65 | 33 | 0.14 |
| Backflooding from Quaboag.* | 62 | 31 | |
| Septic Systems | 42 | 21 | |
| Internal (sediment) recycling summer*** | 30 | 15 | |
| Total | 199 | 100 | |
| | | | |
| Unknown source (sink) | -95 | | |
| Net Export from South (excluding backflooding) | 42 | | |

* Measured TP and extrapolated flow

** TP estimated from Cranberry Br. Export rate x watershed area (includes deposition to pond surface).

***TP estimated by difference between surface and bottom TP concentrations and volumes

BEC. 1986. Diagnostic/Feasibility Study of Quaboag and Quacumquasit Ponds (North and South Ponds). Prepared for the Town of Brookfield and Massachusetts Div. Water Pollution Control... Baystate Environmental Consultants, Inc. East Longmeadow, MA.
Lycott, 1994. Final Report, Phase II Implementation Project Quaboag & Quacumquasit Ponds Town of Brookfield, MA. Lycott Environmental Research. Southbridge, MA.
BEC, 1995. Aquatic Macrophyte Survey. Quaboag/Quacumquasit Ponds, Brookfield, East Brookfield, Sturbridge, MA. For East Brookfield, MA. Baystate Environmental Consultants, Inc. East Longmeadow, MA.
ESS, 2000. Quaboag and Quacumquasit Lake Management Summary and Recommended Actions. ESS Wellesley, MA.

## Total Phosphorus (Quaboag Pond - MA36130)

The TMDL is the sum of the wasteload allocations (WLA) from point sources (e.g., sewage treatment plants and urban stormwater) plus load allocations (LA) from nonpoint sources (e.g., landuse sources) plus a margin of safety (MOS). Thus, the TMDL can be written as:

TMDL = WLA + LA + MOS

The margin of safety is set by establishing a target that is below that expected to meet the visibility target of 4-feet for swimming (about 40 ppb TP) and below the concentration levels needed to maintain current uses, particularly warmwater fisheries in Quaboag Pond and the trout space for the coldwater fishery in Quacumquasit Pond. Both uses are currently being supported and the reduction from the current concentration represents an additional margin of safety. There is some uncertainty concerning how the streams and Quaboag Pond will respond under drought conditions. Because droughts may cause stream TP concentrations to naturally rise and low flows will also result in a higher proportion of TP loading from the Spencer WWTP the Department is requiring additional monitoring to target this issue. As such the TMDL will be considered a phased TMDL and subject to modification based on additional data collection.

**Allocation for Quaboag Pond**

The TMDL process requires that loads be allocated to point and non-point sources.

Wasteload allocations include all point sources. In this case point sources include the loading from the Spencer wastewater treatment plant (NPDES permit MA0100919) and loading from urban stormwater runoff that may or may not be specifically included in stormwater Phase II permits. The only area included within a Phase II permit is the urbanized area of parts of downtown Spencer, which has submitted a Notice of Intent (NOI transmittal number W039544) for a NPDES Phase II permit (MAR041162). The map of urbanized area and the Spencer Notice of Intent are available on the web at http://www.epa.gov/region01/npdes/stormwater/ma.html.

The current loading from the Spencer WWTP is based on flow and concentrations reported in the DMR reports by the facility. Because the plant contributes a minor portion of the nutrient load to either pond during the summer the allocation for the WWTP for May-October will remain at current loading levels (131 kg/yr or 0.79 lb/day) which can be achieved at the 0.2mg/l as long as discharge flow rates are 0.47 MGD or less. This represents a significant reduction compared to the current permit with the interim limit of 0.3 mg/l and permit flow rate of 1.08 MGD. This will require any future increases in flow at the plant during May-October to be compensated by proportional decreases in effluent TP concentrations. Because Quaboag Pond has a short retention time and winter loadings are not expected to directly impact the pond during the critical summer period, the Spencer WWTP may be allowed to operate with somewhat relaxed winter limits. There is no specific information concerning the possible effect of winter adsorption or storage of phosphorus with subsequent release and so it is prudent to continue to reduce winter phosphorus concentrations and loads somewhat. Because winter stream flows are typically 50 percent higher the winter limits (November-April) can be set 50% higher (1.19 lb/day). This is considered is also considered protective to limit winter loading to both the groundwater and soils between the constructed wetlands and nearby surface waters and to winter limit loading to wetlands boarding the East Brookfield river which may release phosphorus at other times of the year. More strict treatment limits above and beyond this TMDL, may be required in the future at the Spencer WWTP to comply with 314CMR4.04(5) regarding the requirement for highest and best practical treatment.

The stormwater point sources and all other nonpoint sources that constitute the majority of the loading to Quaboag Pond will have to be reduced by approximately 32 percent except for wetlands which have no BMPs to improve phosphorus retention. Effective BMPs exist for urban stormwater, highway runoff, septic systems and residential housing and it is expected that these proposed nutrient reductions are possible and should be targeted first. The targeted reductions for forest lands, agricultural and open lands will be more difficult to attain given that most forests are not being harvested, and much of the intensive farming such as dairy farming is no longer present in the watershed. DEP is currently examining the effect of wetland types to determine the amounts of phosphorus exported by different types of wetlands and it remains a possibility that natural wetlands may be a significant source of loading in the watershed.

**Quaboag Pond MA36130 TMDL May-October Load Allocation.**

| *Source* | *Current TP Loading (kg/yr)* | *Current TP Loading (kg/day)* | *Target TP Load Allocation (kg/yr)* | *Target TP Load Allocation (kg/day)* |
|---|---|---|---|---|
| **Load Allocation** | | | | |
| Forest | 1378 | 3.77 | 938 | 2.57 |
| Wetland | 64 | 0.18 | 63 | 0.17 |
| Agriculture | 590 | 1.62 | 402 | 1.10 |
| Open Land | 163 | 0.44 | 111 | 0.30 |
| Residential (Low den.) | 375 | 1.03 | 255 | 0.70 |
| Septic System | 48 | 0.13 | 33 | 0.09 |
| Internal recycling | 603 | 1.65 | 411 | 1.13 |
| **Waste Load Allocation** | | | | |
| Spencer WWTP NPDES(MA0100919)* | 131 | 0.36 | 131 | 0.36 |
| Urban & road stormwater. | 358 | 0.99 | 244 | 0.67 |
| **Total Inputs** | 3710 | 10.16 | 2588 | 7.09 |

*The Target load for the Spencer WWTP is set at the current phosphorus load of 0.79 lb/day (0.36 kg/day) or approximately 0.2mg/l at a flow of 0.47 MGD during May-October as shown above. Recommended winter limits of 1.19 lb/day are not reflected in the table. Note for NPDES permits the seasonal values should be used.

*Total Maximum Daily Loads of Total Phosphorus for Quaboag & Quacumquasit Ponds*

## Total Phosphorus (Quacumquasit Pond - MA36131)

The TMDL is the sum of the wasteload allocations (WLA) from point sources (e.g., sewage treatment plants and urban stormwater) plus load allocations (LA) from nonpoint sources (e.g., landuse sources) plus a margin of safety (MOS). Thus, the TMDL can be written as:

TMDL = WLA + LA + MOS

The margin of safety is set by establishing a target that is below that expected to meet the visibility target of 4-feet for swimming (about 40 ppb TP) and below the concentration levels needed to maintain current uses, particularly warmwater fisheries in Quaboag Pond and the trout space for the coldwater fishery in Quacumquasit Pond. Both uses are currently being supported and the reduction from the current concentration represents an additional margin of safety. There is some uncertainty concerning how the streams and Quaboag Pond will respond under drought conditions. Because droughts may cause stream TP concentrations to naturally rise and low flows will also result in a higher proportion of TP loading from the Spencer WWTP the Department is requiring additional monitoring to target this issue. As such the TMDL will be considered a phased TMDL and subject to modification based on additional data collection.

**Allocation for Quacumquasit Pond**

TMDL process requires nutrients to be allocated between point and nonpoint sources.

The target allocation is based on meeting the target load of 146 kg/yr by modifying the flood gate height and thus reducing backflooding loads by 75 percent and reducing local watershed loading by about 5 percent. Thus the nonpoint backflooding from Quaboag is targeted to be reduced to 13 kg/yr and the point source loading from Quaboag is targeted to be reduced to 2 kg/yr (a negligible amount). If the modifications to the flood control gate cannot be made, the allocation of reductions can be shifted to other local sources (internal and septic systems) as needed to meet the TMDL of 146 kg/yr. While Quacumquasit Pond is potentially sensitive to winter as well as summer loading the Quacumquasit nutrient budget indicates that the implementation of the improvements to the backflooding gate will eliminate nearly all loading from Quaboag Pond including the small amount of point source loading contained in the Quaboag water. Therefore extending the summer loading limits at the Spencer WWTP into the winter period are not required to protect the water quality at Quacumquasit Pond.

**Quacumquasit Pond MA36131 TMDL Load Allocation.**

| *Source* | *Current TP Loading (kg/yr)* | *Current TP Loading (kg/day)* | *Target TP Load Allocation (kg/yr)* | *Target TP Load Allocation (kg/day)* |
|---|---|---|---|---|
| **Load Allocation** | | | | |
| Local NPS runoff, not including commercial, high density housing | 44 | 0.12 | 42 | 0.12 |
| Nonpoint source from backflooding of Quaboag* | 54 | 0.15 | 13 | 0.04 |
| Internal Loading | 30 | 0.08 | 29 | 0.08 |
| Septic System | 42 | 0.12 | 40 | 0.11 |
| Other | 0 | 0 | 0 | 0 |
| **Waste Load Allocation** | | | | |
| Point source from backflooding of Quaboag* | 8 | 0.02 | 2 | 0.01 |
| Point source from local commercial, high density housing runoff (32% of 65) | 21 | 0.06 | 20 | 0.06 |
| **Total Inputs** | 199 | 0.55 | 146 | 0.40 |

*The loading from backflooding is divided in this table to account for both point and nonpoint source contributions. Note that for purposes of NPDES permits the seasonal TMDL values should be used.

*Total Maximum Daily Loads of TP for Quaboag & Quacumquasit Ponds*

## Appendix D – Field Sampling Locations from "Site Selections to Implement Best Management Practices for Phosphorus Removal" (ESS, 2007)

Date: 11/1/2007
Project #: B365

Calc By: ELF
Approved By:

**Best Management Practices Matrix**
**Quaboag Watershed**

| SITE (SAMPLE LOCATION) | SITE DESCRIPTION | LAND-USE | APPROXIMATE DRAINAGE AREA ( ACRES ) | APPROXIMATE DRAINAGE AREA ( SQ MI ) | AVERAGE ANNUAL RUNOFF PER SQUARE MILE (CFS) | TOTAL APPROXIMATE RUNOFF (CF/Yr) | WEIGHTED PHOSPHORUS LOAD ( Kg/Yr) | APPLICABLE BMP | BMP DESCRIPTION | TSS REMOVAL | TOTAL PHOSPHORUS | ESTIMATED PHOSPHORUS REMOVED (Kg/Yr) | BMP COST BASIS (incl. materials) | TOTAL COST OF BMP (incl. design, permit., and const.) | APPROXIMATE COST RANGE OF BMP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| QP-2 | Located near the Sevenmile River in East Brookfield. Accessible from Podunk Road, Howe Streets, and Stevens Road. Sevenmile River converges with the East Brookfield River before discharging to Quaboag Pond downstream. The site includes storm drains EB-OP7 and EB-OP8. Sampled storm drain EB-OP7. | Medium-density Residential | 2.0 | 0.003 | 2.0 | 197,100 | 0.31 | No BMP Suggested | | | | | | | |
| QP-6 | Located downtown East Brookfield. The surrounding area is commercial and heavily paved. The site is located on the East Brookfield River just downstream of Lake Lashaway and the Route 9 bridge. There are several outfall pipes on the south side of the bridge including a 6-inch diameter concrete pipe. Sampled 6-inch pipe. | Commercial | 2.0 | 0.003 | 2.0 | 197,100 | 0.34 | No BMP Suggested | | | | | | | |
| QP-7 | Located on a tributary in East Brookfield. Accessible from West Sturbridge Road, Wildwood Road, and Oakwood Drive. Bordered by gravel pits and dense woods. A dirt road extended from Oakwood Drive leads to several concrete culverts approximately 48-inches wide. Sampled tributary upstream of culverts. | Low-density Residential | 2.0 | 0.003 | 2.0 | 197,100 | 0.12 | Vegetated Swale & Sediment Forebay | Open surface channel vegetated to dissipate storm water runoff, remove sediment, and uptake minerals. Sloped to convey storm water from one point to another. Place vegetated buffer at outlet of swale. | 70% | 30% | 0.04 | $1,500 | $7,500 | $5,000 - $9,000 |
| QP-9 | Located on a tributary in East Brookfield. Accessible from Lashaway Drive and Harrington Lane. The tributary flows to the Sevenmile River through a concrete culvert under Route 9. Focal landmarks include the Evergreen Cemetery. Sampled tributary near culvert. | Medium-density Residential | 0.5 | 0.001 | 2.0 | 49,275 | 0.04 | No BMP Suggested | | | | | | | |
| QP-9A | Located near the Sevenmile River in East Brookfield. Accessible from Route 9 and Cove Road. Focal landmarks include the Evergreen Cemetery. A 12-inch outlet pipe is located to the west of Cove Road. Sampled 12-inch pipe. | Medium-density Residential | 1.0 | 0.002 | 2.0 | 98,550 | 0.09 | No BMP Suggested | | | | | | | |
| QP-11 | Located near storm drain SP-OP4 on Turkey Hill Brook where it crosses Wire Village Road in Spencer. Storm drain SP-OP4 is a 24-inch corrugated steel pipe that discharges from the storm water sewer system on Hasting Road. Sampled storm drain SP-OP4. | Medium-density Residential | 2.0 | 0.003 | 2.0 | 197,100 | 0.20 | Vegetated Swale & Sediment Forebay | Open surface channel vegetated to dissipate storm water runoff, remove sediment, and uptake minerals. Sloped to convey storm water from one point to another. Place vegetated buffer at outlet of swale. | 70% | 30% | 0.06 | $1,500 | $7,500 | $5,000 - $9,000 |
| QP-15 | Located on Sevenmile River after converging with Turkey Hill Brook in Spencer. Accessible from Meadow Road past the intersection with Pleasant Street. Adjacent to Sevenmile River is a farm on Route 31 with agricultural fields. Sample Sevenmile River upstream and downstream of agricultural fields. | Low-density Residential | 3.0 | 0.005 | 2.0 | 295,650 | 0.22 | Widen Existing Vegetated Buffer Strip | Remedy Sites QP-11 and QP-17. Widen vegetated buffer between agricultural fields and Sevenmile River. | | | | | | |
| QP-17 | Located on a tributary along Northwest Road in Spencer. Tributary flows to Sevenmile River through a culvert under Cooney Road near the intersection of Route 31. Surrounding features include the Spencer Greenhouse and a small farm near the tributary. Sampled tributary downstream of Cooney Road. | Low-density Residential | 2.5 | 0.004 | 2.0 | 246,375 | 2.71 | Infiltration Basin | Basin constructed over permable soils designed to store runoff until it exfiltrates through the soil. A forebay is to be constructed near the inlet of the basin to pretreat the runoff. | 80% | 65% | 1.76 | $9,000 | $14,000 | $12,000 - $16,000 |
| QP-18 | Located near a tributary in Spencer. Accessible from Wilson Street. Tributary discharges to Lake Whittemore downstream. Storm water sewer system and paved swales are located along Wilson Street. Sampled small outlet pipe near Wilson Street. | Medium-density Residential | 2.0 | 0.003 | 2.0 | 197,100 | 0.16 | No BMP Suggested | | | | | | | |

Location: G:/GIS-Projects/B365/AssessmentFieldMap.mxd

QP-17
2.5 ACRE

QP-11
2.0 ACRES

QP-15
3.0 ACRES

QP-18
2.0 ACRES

QP-9
0.5 ACRES

QP-6
2.0 ACRES

QP-10

QP-9A
1.0 ACRES

QP-2
2.0 ACRES

QP-5

QP-7
2.0 ACRES

1 0.5 0 1 Miles

ESS Group, Inc.
Engineers
Scientists
Consultants

TOWN OF BROOKFIELD
319 Grant QAPP
Brookfield, MA

Scale: 1:2,000'

Source: 1) USGS-DRG, 1982-1985
2) ESS Field Data, 2006

**DRAINAGE AREA MAP**

Legend

- Final Sampling Locations

**FIGURE 1**