TOWN OF WELLESLEY
WELLESLEY, MASSACHUSETTS 02481

DAVID J. HICKEY, JR, PE
TOWN ENGINEER

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ASSISTANT TOWN ENGINEER

20 MUNICIPAL WAY
781-235-7600
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DEPARTMENT OF PUBLIC WORKS
ENGINEERING DIVISION

September 28, 2020

Mrs. Glenda Velez
U. S. Environmental Protection Agency – Region 1
5 Post Office Square – OEP06-01
Boston, MA 02109-3912

Dr. Laura Schifman
Massachusetts Dept. of Environmental Protection
One Winter Street – 5th Floor
Boston, MA 02108

RE: NPDES Phase II Small MS4 General Permit
Annual Report – Year 2
Wellesley, Massachusetts
EPA NPDES Permit Number: MA 041067
MA DEPT Transmittal Number: W-036293

Dear Mrs. Velez and Mr. Civian:

Please find enclosed herewith a copy of our annual report, year 2, for the period July 1, 2019 to June 30, 2020 as required by our NPDES Phase II Small MS4 General Permit. The annual report highlights stormwater related activities and tasks performed during the past year.

Should you have any questions or if you require additional information, please feel free to contact me.

Sincerely,

George J. Saraceno
Certified Stormwater Manager

David J. Hickey, Jr., P.E.
Town Engineer

Cc: David Cohen, Director
Jeff Azano Brown, Assistant Director
Meghan Jop, Executive Director
Brandon Schmitt, Natural Resources Commission
Don McCauley, Planning Board

Year 2 Annual Report
Massachusetts Small MS4 General Permit
Reporting Period: July 1, 2019-June 30, 2020

Please DO NOT attach any documents to this form. Instead, attach all requested documents to an email when submitting the form

Unless otherwise noted, all fields are required to be filled out. If a field is left blank, it will be assumed the requirement or task has not been completed. Please ONLY report on activities between July 1, 2019 and June 30, 2020 unless otherwise requested.

Part I: Contact Information

Name of Municipality or Organization: Town of Wellesley

EPA NPDES Permit Number: MAR041067

Primary MS4 Program Manager Contact Information

Name: David J. Hickey, Jr. Title: Town Engineer

Street Address Line 1: 20 Municipal Way

Street Address Line 2: na

City: Wellesley State: MA Zip Code: 02481

Email: dhickey@wellesleyma.gov Phone Number: (781) 235-7600

Stormwater Management Program (SWMP) Information

SWMP Location (web address): https

https://www.wellesleyma.gov/319/stormwater-management

Date SWMP was Last Updated: Aug 17, 2020

If the SWMP is not available on the web please provide the physical address:

na

Part II: Self-Assessment

First, in the box below, select the impairment(s) and/or TMDL(s) that are applicable to your MS4. Make sure you are referring to the most recent EPA approved Section 303(d) Impaired Waters List which can be found here: https://www.epa.gov/tmdl/region-1-impaired-waters-and-303d-lists-state

Impairment(s)

☒ Bacteria/Pathogens ☐ Chloride ☐ Nitrogen ☐ Phosphorus
☐ Solids/ Oil/ Grease (Hydrocarbons)/ Metals

TMDL(s)

In State: ☐ Assabet River Phosphorus ☐ Bacteria and Pathogen ☐ Cape Cod Nitrogen
☒ Charles River Watershed Phosphorus ☐ Lake and Pond Phosphorus

Out of State: ☐ Bacteria/Pathogens ☐ Metals ☐ Nitrogen ☐ Phosphorus

Clear Impairments and TMDLs

Next, check off all requirements below that have been completed. ***By checking each box you are certifying that you have completed that permit requirement fully.*** *If you have not completed a requirement leave the box unchecked. Additional information will be requested in later sections.*

Year 2 Requirements

☒ Completed Phase I of system mapping

☒ Developed a written catchment investigation procedure and added the procedure to the SWMP

☒ Developed written procedures to require the submission of as-built drawings and ensure the long term operation and maintenance of completed construction sites and added these procedures to the SWMP

☒ Enclosed or covered storage piles of salt or piles containing salt used for deicing or other purposes

☒ Developed written operations and maintenance procedures for parks and open space, buildings and facilities, and vehicles and equipment and added these procedures to the SWMP

☒ Developed an inventory of all permittee owned facilities in the categories of parks and open space, buildings and facilities, and vehicles and equipment and added this inventory to the SWMP

☒ Completed a written program for MS4 infrastructure maintenance to reduce the discharge of pollutants

☒ Developed written SWPPPs, included in the SWMP, for all of the following permittee owned or operated facilities: maintenance garages, public works yards, transfer stations, and other waste handling facilities where pollutants are exposed to stormwater

Optional: If you would like to describe progress made on any incomplete requirements listed above, provide any additional information, and/or if any of the above year 2 requirements could not be completed due to the impacts of COVID-19, please identify the requirement that could not be completed, any actions taken to attempt to complete the requirement, and reason the requirement could not be completed below:

Annual Requirements

- ☒ Provided an opportunity for public participation in review and implementation of SWMP and complied with State Public Notice requirements
- ☒ Kept records relating to the permit available for 5 years and made available to the public
- ☒ The SSO inventory has been updated, including the status of mitigation and corrective measures implemented
  - ○ This is not applicable because we do not have sanitary sewer
  - ◉ This is not applicable because we did not find any new SSOs
  - ○ The updated SSO inventory is attached to the email submission
  - ○ The updated SSO inventory can be found at the following website:
- ☒ Properly stored and disposed of catch basin cleanings and street sweepings so they did not discharge to receiving waters
- ☒ Provided training to employees involved in IDDE program within the reporting period
- ☒ All curbed roadways were swept at least once within the reporting period
- ☒ Updated outfall and interconnection inventory and priority ranking as needed

Optional: If you would like to describe progress made on any incomplete requirements listed above, provide any additional information, and/or if any of the above annual requirements could not be completed due to the impacts of COVID-19, please identify the requirement that could not be completed, any actions taken to attempt to complete the requirement, and reason the requirement could not be completed below:

Bacteria/ Pathogens (Combination of Impaired Waters Requirements and TMDL Requirements as Applicable)

Annual Requirements

*Public Education and Outreach**

- ☒ Annual message was distributed encouraging the proper management of pet waste, including noting any existing ordinances where appropriate
- ☒ Permittee or its agents disseminated educational material to dog owners at the time of issuance or renewal of dog license, or other appropriate time
- ☐ Provided information to owners of septic systems about proper maintenance in any catchment that discharges to a water body impaired for bacteria

** Public education messages can be combined with other public education requirements as applicable (see Appendix H and F for more information)*

Optional: If you would like to describe progress made on any incomplete requirements listed above or provide any additional details, please use the box below:

Our messages for owners with septic systems was through the ThinkBlueMassachusetts campain on our

website. 98% of the Town is served by a Municipal sewer collection system.

Charles River Watershed Phosphorus TMDL

☐ Completed Legal Analysis

Optional: If you would like to describe progress made on any incomplete requirements listed above or provide any additional details, please use the box below:

The legal analysis was completed on 9/24/20 and has been attached to the SWMP.

Optional: Use the box below to provide any additional information you would like to share as part of your self-assessment:

This year, the Town best improvements have been expanding Stormwater Management content on the website and expanding information we provide to the public, businesses and institutions. The website added links to public information form regional and local sources such as ThinkBlue and Wellesley's Natural Resources Commission (NRC). With expanded on-line mapping residents can obtain geographical information and copies of our annual reports and Stormwater Management Program.

Wellesley continues to be invested in Pond Management Program to improve water quality. Key work includes active phosphorus removal program, weed harvesting and annual reporting of Morses Pond, as well focused shore side project that will improve sediment and erosion control at Morses Pond. The Town is also been sampling Fuller Brook and several other ponds to evaluate the impacts the conditions and plan for future projects, specifically we are interested in assessing the impact of the Fuller Brook Park Preservation Project on water quality in the brook. We hope that the sample results will show that the improvements to Fuller Brook Park show that Fuller Brook can be removed from the list of impaired waters.

The Town continues to actively review stormwater management and treatment in land development projects and this year as part of an initiative to improve the playing fields at Hunnewell Field, we constructed wetland including the installation of a sediment forebay and micropool with educaiton signs expalining the importance and function.

The DPWcontinues to work with the NRC, the State Stormwater Coalition and our local Charles River Stormwater Collaborative to discuss and implement stormwater campaigns in Massachusetts such as the ThinkBlueMassachusetts campaign, which is advancing public outreach and public participation initiatives to help advance the cause of improving stormwater quality, reduce sediment and erosion, eliminate IDDE and pesticides. We continue to attend educational seminars through Soak Up the Rain, MADEP, EPA and Southeast New England Network.

In the Public involvement realm we met with Sprague School fifth-graders to discuss pesticides elimination and nutrients reduction in the nearby Boulder Brook Conservation area and around Morses Pond. This presentation was also featured in the NRC newsletter. We also met with Schofield School second graders as they presented their experiments, results and recommendations related to improving an erosion problem near their school.

The Town purchased a 2020 RAVO 5i Series street sweeper with a high efficiency vacuum sweeping capability for filtering fine dust particles from vehicles and remove sediment, leaves, trash and debris from the roadway.

For large land development projects, we have included the practice of requiring Applicants to provide phosphorus removal calculations as part of our review process.

Part III: Receiving Waters/Impaired Waters/TMDL

Have you made any changes to your lists of receiving waters, outfalls, or impairments since the NOI was submitted?

- ○ Yes
- ◉ No

If yes, describe below, including any relevant impairments or TMDLs:

Part IV: Minimum Control Measures

Please fill out all of the metrics below. If applicable, include in the description who completed the task if completed by a third party.

MCM1: Public Education

Number of educational messages completed **during this reporting period**: 8

*Below, report on the educational messages completed **during this reporting period**. For the measurable goal(s) please describe the method/measures used to assess the overall effectiveness of the educational program.*

BMP:Pet Waste Management

Message Description and Distribution Method:

Added a pet waste message to the Dog License Form, which is distributed to each resident requesting a dog license.
NRC posted in their newsletter in July 2019 a message asking visitors of Perrin Park to cleanup after their dogs.
We have included pet waste as part of our Hashtag Photo Contest that began in year 2 of the permit and continues to year 3.

Targeted Audience: Residents

Responsible Department/Parties: Engineering/NRC

Measurable Goal(s):

We had 3,570 dog licenses issued, which included the pet waste message on each application.

Message Date(s): Fall 2019

Message Completed for: Appendix F Requirements ☒ Appendix H Requirements ☒

Was this message different than what was proposed in your NOI? Yes ○ No ◉

If yes, describe why the change was made:

BMP:Grass Clippings & Fertilizer Use

Message Description and Distribution Method:

The Town prepared a message on managing lawns and fertilizer usage. Good lawn management includes grasscycling or recycling the clippings by leaving them on the lawn. We also encourage phosphorus-free fertilizers. We reference the DEP "don't trash the grass" campaign and Sustainable Landscapes UMass extension, OrganicLandCare.net and ThinkBlueMassachusetts.org.

Targeted Audience: Residents, business, institutions and commercial facilities

Responsible Department/Parties: Engineering

Measurable Goal(s):

Added notice to the Town's Stormwater Management website. Included in the Town's newsletter, which is distributed to all the residence via mail.

Message Date(s): Fall 2019

Message Completed for: Appendix F Requirements ☐ Appendix H Requirements ☒

Was this message different than what was proposed in your NOI? Yes ○ No ◉

If yes, describe why the change was made:

BMP:Pesticide Awareness

Message Description and Distribution Method:

The DPW continues to work with the Wellesley NRC to promote a campaign to eliminate the use of pesticides. In their quarterly newsletter, the NRC posted a notice from the Bates Elementary School 5th Graders, to reduce chemical pesticides in the Boulder Brook Reservation, which is close to their elementary school.

Targeted Audience: Residence, business and commercial facilities

Responsible Department/Parties: Engineering/NRC

Measurable Goal(s):

Distribute quarterly email from the NRC called Insights from Outside, which highlighted a recent ban on Roundup at the Linden Square Townhomes in Wellesley. The DPW switched to Triclopyr Ester (formerly Turflon Ester Ultra herbicide) with less chemical concentration for the treatment of poison ivy and discussed the environmental benefits at the DPW Board Meeting.

Message Date(s): July 2019 and January 2020

Message Completed for: Appendix F Requirements ☐ Appendix H Requirements ☒

Was this message different than what was proposed in your NOI? Yes ○ No ◉

If yes, describe why the change was made:

BMP:Fowl Water Advertisement

Message Description and Distribution Method:

ThinkBlue Massachusetts ran an educational advertisement campaign "Fowl Water" to help viewers visualize how stormwater pollution from motor oil, pet waste, and trash become stormwater pollution. Video advertisement on Facebook and Youtube (https://www.thinkbluemassachusetts.org/).

Targeted Audience: Residents

Responsible Department/Parties: Engineering, Massachusetts Statewide Municipal Stormwater Coalition

Measurable Goal(s):

The "Fowl Water" video was placed in Facebook, Instagram and Youtube. The Facebook/Instagram impressions were 32,540 and Youtube impressions 32,356 for the Town of Wellesley.

Message Date(s): May 16, 2020 to June 5, 2020

Message Completed for: Appendix F Requirements ☐ Appendix H Requirements ☒

Was this message different than what was proposed in your NOI? Yes ◉ No ○

If yes, describe why the change was made:

This message was prepared with the assistance of the Charles River Stormwater Collaborative.

BMP:Annual Pet Waste Message - Scoop the Poop

Message Description and Distribution Method:

ThinkBlue Massachusetts shared posts on Facebook to encourage the proper management of pet waste.

Targeted Audience: Residents

Responsible Department/Parties: Engineering

Measurable Goal(s):

The Think Blue Massachusetts Facebook account has approximately 300 followers and averages approximately 3,000 reaches per month. The Town's website on the Stormwater web page has a link to Think Blue Massachusetts.
The DPW has an extensive pre-treatment procedure in-place, a copy of which is included in our SWMP, that includes a brine or pre-wetting chemicals. Our staff has presented the pre-treatment procedure we use at various Public Works events.

Message Date(s): July 17, 2019; August 14, 2019; April 9, 2020; May 13,18, 28 & 29, 2020; June 2, 2020

Message Completed for: Appendix F Requirements ☒ Appendix H Requirements ☒

Was this message different than what was proposed in your NOI? Yes ◉ No ○

If yes, describe why the change was made:

We are utilizing work from the Massachusetts State Stormwater Coalition in addition to our own materials.

BMP:Annual Septic Maintenance Message

Message Description and Distribution Method:

Think Blue Massachusetts shared posts on Facebook regarding Septic Smart week to provide information to owners on septic systems about proper maintenance. (https://www.facebook.com/ThinkBlueMassachusetts/posts/1281120368722966).

Targeted Audience: Residents

Responsible Department/Parties: Engineering, Board of Health

Measurable Goal(s):

The Think Blue Massachusetts Facebook account has approximately 300 followers and averages approximately 3,000 reaches per month. The Town's website on the Stormwater web page has a link to Think Blue Massachusetts.

Message Date(s): September 2019

Message Completed for: Appendix F Requirements ☒ Appendix H Requirements ☒

Was this message different than what was proposed in your NOI? Yes ◉ No ○

If yes, describe why the change was made:

We are utilizing work from the Massachusetts State Stormwater Coalition in addition to our own materials.

BMP:Annual Winter Deicing/salt Message

Message Description and Distribution Method:

Think Blue Massachusetts shared posts on Facebook regarding road salt application for residential, commercial & industrial site owners on the proper storage and application rates of winter deicing material. (https://www.facebook.com/ThinkBlueMassachusetts/posts/1281120368722966).

Targeted Audience: Residential, business, institutions, industrial and commercial facilities

Responsible Department/Parties: Engineering

Measurable Goal(s):

The Think Blue Massachusetts Facebook account has approximately 300 followers and averages approximately 3,000 reaches per month. The Town's website on the Stormwater web page has a link to Think Blue Massachusetts.

Message Date(s): Nov 14, 2019; Dec. 5, 9, 13, 16, 17, 18 & 24, 2019; Jan. 7, 2020

Message Completed for: Appendix F Requirements ☒ Appendix H Requirements ☒

Was this message different than what was proposed in your NOI? Yes ◉ No ○

If yes, describe why the change was made:

We are utilizing work from the Massachusetts State Stormwater Coalition in addition to our own materials.

BMP:Annual Message - Proper lawn maintenance

Message Description and Distribution Method:

Think Blue Massachusetts shared posts on Facebook in the spring on the proper use and disposal of grass clippings and encouraging the use of slow-release fertilizers. The DPW and NRC in the newsletter included messages on proper lawn maintenance, which is distributed both via mail, email and on the Town's website.

Targeted Audience: Residential, business, institutions, industrial and commercial facilities

Responsible Department/Parties: Engineering

Measurable Goal(s):

The Think Blue Massachusetts Facebook account has approximately 300 followers and averages approximately 3,000 reaches per month. The Town's website on the Stormwater web page has a link to Think Blue Massachusetts.

Message Date(s): Nov. 1, 2019; April 28 & 30, 2020; May 14 & 22, 2020

Message Completed for: Appendix F Requirements ☒ Appendix H Requirements ☒

Was this message different than what was proposed in your NOI? Yes ◉ No ○

If yes, describe why the change was made:

We are utilizing work from the Massachusetts State Stormwater Coalition in addition to our own materials.

BMP:[Message name here]

Message Description and Distribution Method:

Targeted Audience:

Responsible Department/Parties:

Measurable Goal(s):

Message Date(s):

Message Completed for: Appendix F Requirements ☐ Appendix H Requirements ☐

Was this message different than what was proposed in your NOI? Yes ○ No ○

If yes, describe why the change was made:

Add an Educational Message

MCM2: Public Participation

Describe the opportunity provided for public involvement in the development of the Stormwater Management Program (SWMP) **during this reporting period**:

A copy of the Town's Stormwater Management Program manual is now on the Town's website, which may be downloaded or read as Adobe PDF document. Many of our residences, contractors and business owners are becoming more aware of stormwater issues and are currently reviewing our stormwater initiatives through the NRC, as described above in the educational messages but also through our construction requirements. For example, through our site plan review process, Applicants must review the requirements to mitigate impervious area, reduce and eliminate sediment and erosion control and manage stormwater runoff. These review processes and questions brought to our attention have helped us to update our SWMP.

Was this opportunity different than what was proposed in your NOI? Yes ○ No ◉

Describe any other public involvement or participation opportunities conducted **during this reporting period**:

In the November 2019 Newsletter, the NRC noted that the Town's Sprague Elementary fifth-graders learned about watersheds and contaminants like fertilizer, pesticides and leaking car oil. They also saw real life point source pollution and shore lines around Morses Pond impacted by sediment and erosion control. Students are working on project, video and written pieces to share what they learned. They performed a PowerPoint presentation to show their work on this project with Town officials.

The NRC promotes a Rain Barrel Program to help manage stormwater runoff and manage water resources, including money saved by reducing water bills.

The Engineering Division is working with the State Stormwater Coalition to implement a Hashtag Photo Contest for the summer of 2020. The Hastag Photo Contest is designed to make our residences more aware of stormwater. Residents take pictures in Wellesley of stormwater related issues and post them to social media. The contest will award 20 participants with $100 gift cards to Amazon.

MCM3: Illicit Discharge Detection and Elimination (IDDE)

Sanitary Sewer Overflows (SSOs)

Check off the box below if the statement is true.

☐ This SSO section is NOT applicable because we DO NOT have sanitary sewer

*Below, report on the number of SSOs identified in the MS4 system and removed **during this reporting period**.*

Number of SSOs identified: 0

Number of SSOs removed: 0

MS4 System Mapping

Below, check all that apply.

The following elements of the Phase I map have been completed:

☒ Outfalls and receiving waters

☒ Open channel conveyances

☒ Interconnections

☒ Municipally-owned stormwater treatment structures

☒ Waterbodies identified by name and indication of all use impairments

☒ Initial catchment delineations

Optional: Describe any additional progress you made on your map during this reporting period or provide additional status information regarding your map:

We have completed the requirements of the Phase I map as described above. The Phase I map has been added to our Stormwater Management webpage for download. We continue to update the Phase I map as additional treatment structures are being added to our GIS system and updated on the Phase I map.

Screening of Outfalls/Interconnections

If conducted, please submit any outfall monitoring results from this reporting period. Outfall monitoring results should include the date, outfall/interconnection identifier, location, weather conditions at time of sampling, precipitation in previous 48 hours, field screening parameter results, and results from all analyses.

◉ The outfall screening data is attached to the email submission

○ The outfall screening data can be found at the following website:

*Below, report on the number of outfalls/interconnections screened **during this reporting period**.*

Number of outfalls screened: 18

Catchment Investigations

If conducted, please submit all data collected during this reporting period as part of the dry and wet weather investigations. Also include the presence or absence of System Vulnerability Factors for each catchment.

◉ The catchment investigation data is attached to the email submission

○ The catchment investigation data can be found at the following website:

*Below, report on the number of catchment investigations completed **during this reporting period**.*

Number of catchment investigations completed this reporting period: 72

*Below, report on the percent of catchments investigated **to date.***

Percent of total catchments investigated: 20

Optional: Provide any additional information for clarity regarding the catchment investigations below:

The catchment investigations have centered around areas of the Town with gas stations, fleet service areas, illicit discharges and cross connections such as sewer mains conflicting with drain manholes.

IDDE Progress

If illicit discharges were found, please submit a document describing work conducted over this reporting period, and cumulative to date, including location source; description of the discharge; method of discovery; date of discovery; and date of elimination, mitigation, or enforcement OR planned corrective measures and schedule of removal.

◉ The illicit discharge removal report is attached to the email submission

○ The illicit discharge removal report can be found at the following website:

*Below, report on the number of illicit discharges identified and removed, along with the volume of sewage removed **during this reporting period.***

Number of illicit discharges identified: 1

Number of illicit discharges removed: 1

Estimated volume of sewage removed: 0 gallons/day

*Below, report on the total number of illicit discharges identified and removed to date. At a minimum, report on the number of illicit discharges identified and removed **since the effective date of the permit (July 1, 2018).***

Total number of illicit discharges identified: 1

Total number of illicit discharges removed: 1

Optional: Provide any additional information for clarity regarding illicit discharges identified, removed, or planned to be removed below:

We assisted the Town of Newton in the investigation of an illicit discharge to the Charles River. The illicit discharge turned out to be from the installation of a geothermal well in Newton, which was identified, reported to DEP and overflow contained on the property. The illicit discharge was related to chemicals used for the installation of the geothermal well and not sewerage.

Employee Training

Describe the frequency and type of employee training conducted **during the reporting period**:

We perform IDDE training to every new employee as part of their orientation during the first week of employment. We also provide IDDE training for all employees as part of our Right-to-Know training that includes a Powerpoint presentation and explanation of IDDE and stormwater.

MCM4: Construction Site Stormwater Runoff Control

*Below, report on the construction site plan reviews, inspections, and enforcement actions completed **during this reporting period.***

Number of site plan reviews completed: 5

Number of inspections completed: 2

Number of enforcement actions taken: 1

Optional: Enter any additional information relevant to construction site plan reviews, inspections, and enforcement actions:

The number of inspections completed is lower than the number of site plan reviews because the some of the

projects have not commenced construction but are awaiting regulatory approval. Enforcement actions were taken on a few projects where the sediment and erosion controls were missing, ineffective or failed during a heavy rain event. This was a limited occurance and impacted mostly single family lot construction and one large subdivision. These smaller projects are generally not reviewed or conditioned by our various land development requirements so trtacing and oversight can be complicated, however the combined effort from the contractors and the DPW was quickly made to clean up the impact and the contractors were informed about the importance of controlling sediment.

MCM5: Post-Construction Stormwater Management in New Development and Redevelopment

Ordinance or Regulatory Mechanism

Below, select the option that describes your ordinance or regulatory mechanism progress.

- ○ Bylaw, ordinance, or regulations are updated and adopted consistent with permit requirements
- ◉ Bylaw, ordinance, or regulations are updated consistent with permit requirements but are not yet adopted
- ○ Bylaw, ordinance, or regulations have not been updated or adopted

As-built Drawings

Describe the measures the MS4 has utilized to require the submission of as-built drawings and ensure long term operation and maintenance of completed construction sites:

The Town requires through plan review a condition that Operation and Maintenance Plans be provided and annual inspection logs be submitted to the Town Engineer on an annual basis. As-built plans are required by the same mechanism as O&M Plans, with a stamped and signed plan prepared by a Professional Engineer or Land Surveyor in the Commonwealth of Massachusetts. The Town also provides inspection of the onsite drainage system, including measurements that provide ties to inspection ports and cleanouts. As-built plans submitted and approved by the Town of Wellesley Department of Public Works is updated in the Town's GIS system.

Street Design and Parking Lots Report

Describe the status of the street design and parking lots assessment due in year 4 of the permit term, including any planned or completed changes to local regulations and guidelines:

The Town is currently reviewing several of our public parking lots for accessibility, parking spaces, sustainability, i.e., electric vehicle charging stations and interior traffic islands through the Town's Traffic Committee. The Traffic Committee is reviewing our current local regulations and guidelines to determine if addition changes are necessary. The Town has already adopted Complete Streets program that designs street for all users.

We are currently designing a roadway to create a road diet, reducing pavement width (eliminating impervious area), adding a drainage swale to improve flooding issues.

Green Infrastructure Report

Describe the status of the green infrastructure report due in year 4 of the permit term, including the findings and progress towards making the practice allowable:

Through the NRC, the Town offers rain barrels to residents and business owners. Education materials are provided on the Town's website and through NRC newsletters. For any new building projects, the Town considers green roofs and various infiltration practices such as rain gardens, drainage swales, etc. The Town is reconstructing a roundabout that includes the use of Flex MSE, a vegetated wall system and drainage swales. We have a proposed parking lot that will include two bioretention basins when constructed in year 3. We will continue to review green infrastructure in year 3 of the permit, possibly hiring a consultant to review with the Phosphorus Control Plan. The Town has adopted a sustainability campaign, see https://www.sustainablewellesley.com/.

Retrofit Properties Inventory

Describe the status of the inventory, due in year 4 of the permit term, of permittee-owned properties that could be modified or retrofitted with BMPs to mitigate impervious areas and report on any properties that have been modified or retrofitted:

The Town has a softball project that included the installion of a constructed wetland as a retrofit to mitigate stormwater runoff from an upstream residential neighborhood. The constructed wetland is designed to help reduce phosphorus and nitrogen from stormwater runoff. The constructed wetland will include an educational sign.

MCM6: Good Housekeeping

Catch Basin Cleaning

Below, report on the number of catch basins inspected and cleaned, along with the total volume of material removed from the catch basins ***during this reporting period****.*

Number of catch basins inspected: 1,225

Number of catch basins cleaned: 1,225

Total volume or mass of material removed from all catch basins: 237 cubic yards

Below, report on the total number of catch basins in the MS4 system.

Total number of catch basins: 5,192

If applicable:

Report on the actions taken if a catch basin sump is more than 50% full during two consecutive routine inspections/cleaning events:

The DPW cleans out problematic catch basins that typically have a high sediment load based on a cleaning history of the system, which is kept in a list and cleaned twice per year. COVID had an effect on this year's program but crews were able to cleaning a minimum of 25% where we are finding the average to be fairly low volumes in the basins, but we are also tracking areas with larger sediment load.

Street Sweeping

*Report on street sweeping completed **during this reporting period** using one of the three metrics below.*

- (•) Number of miles cleaned: 47
- ( ) Volume of material removed: 489 cubic yards
- ( ) Weight of material removed: 211 tons

O&M Procedures and Inventory of Permittee-Owned Properties

Below, check all that apply.

The following permittee-owned properties have been inventoried:

- ☒ Parks and open spaces
- ☒ Buildings and facilities
- ☒ Vehicles and equipment

The following O&M procedures for permittee-owned properties have been completed:

- ☒ Parks and open spaces
- ☒ Buildings and facilities
- ☒ Vehicles and equipment

Stormwater Pollution Prevention Plan (SWPPP)

*Below, report on the number of site inspections for facilities that require a SWPPP completed **during this reporting period**.*

Number of site inspections completed: 1

Describe any corrective actions taken at a facility with a SWPPP:

We report SWPPP site inspections for a new private subdivision that is currently under construction and will be through the third year of the permit.

Additional Information

Monitoring or Study Results

Results from any other stormwater or receiving water quality monitoring or studies conducted during the reporting period not otherwise mentioned above, where the data is being used to inform permit compliance or permit effectiveness must be attached.

- ( ) Not applicable
- (•) The results from additional reports or studies are attached to the email submission
- ( ) The results from additional reports or studies can be found at the following website(s):

If such monitoring or studies were conducted on your behalf or if monitoring or studies conducted by other entities were reported to you, a brief description of the type of information gathered or received shall be described below:

The DPW performed water quality monitoring on two vernal pools that receive stormwater runoff from a residential neighborhood upstream. The water was tested for E. coli, phosphorus and nitrogen. The water quality results showed that the receiving water in the vernal pools is typical of water that has water fowl and high organic decomposition. Nitrogen and phosphorus levels were low.

Through the NRC, the Town has completed a Comprehensive Pond Management Program that included an assessment of eight public ponds. The program includes watershed assessment, water quality improvements and plan summary for future work. We have included a copy of the Morses Pond Annual Report dated 2019, which includes the phosphorus inactivation work and results. The DPW continues to perform work on the Morses Pond erosion maintenance work.

Additional Information

Optional: Enter any additional information relevant to your stormwater management program implementation during the reporting period. Include any BMP modifications made by the MS4 if not already discussed above:

The DPW has spent much time retrofitting, upgrading and repairing the Town's drainage system. For example, we have expanded the number of deep sumps basins in the system and we continue to install and plan parking bio-basins and swales. We completed the installation of a constructed wetland that includes a sediment forebay and micropool to help reduce sediment, contaminants and remove phosphorus and nitrogen and are maintaining the bio swles and constructed wetlands constructed in previous years.

COVID-19 Impacts

Optional: If any of the above year 2 requirements could not be completed due to the impacts of COVID-19, please identify the requirement that could not be completed, any actions taken to attempt to complete the requirement, and reason the requirement could not be completed below:

We could not advance our outfall screening and inspections during the months of March, April and May when the office operations were scaled down. Other operations such as street sweeping, catch basin inspections and cleaning was also affected by Covid-19 reduced this year.

Activities Planned for Next Reporting Period

Please confirm that your SWMP has been, or will be, updated to comply with all applicable permit requirements including but not limited to the year 3 requirements summarized below. (Note: impaired waters and TMDL requirements are not listed below)

Yes, I agree ☒

- Inspect all outfalls/ interconnections (excluding Problem and Excluded outfalls) for the presence of dry weather flow
- Complete follow-up ranking as dry weather screening becomes available

Annual Requirements

- Annual report submitted and available to the public
- Annual opportunity for public participation in review and implementation of SWMP
- Keep records relating to the permit available for 5 years and make available to the public
- Properly store and dispose of catch basin cleanings and street sweepings so they do not discharge to receiving waters
- Annual training to employees involved in IDDE program
- Update inventory of all known locations where SSOs have discharged to the MS4
- Continue public education and outreach program
- Update outfall and interconnection inventory and priority ranking and include data collected in connection with the dry weather screening and other relevant inspections conducted
- Implement IDDE program
- Review site plans of construction sites as part of the construction stormwater runoff control program
- Conduct site inspection of construction sites as necessary
- Inspect and maintain stormwater treatment structures
- Log catch basins cleaned or inspected
- Sweep all uncurbed streets at least annually
- Continue investigations of catchments associated with Problem Outfalls
- Review inventory of all permittee owned facilities in the categories of parks and open space, buildings and facilities, and vehicles and equipment; update if necessary

Provide any additional details on activities planned for permit year 3 below:

Year 3 of the permit will include the construction of grass swales for a roadway project, including the use of Flex MSE retaining wall, which is a sustainable retaining wall, using composting and sand bags rather than concrete. additionally we intend to produce concepts for five pilot projects on Town owned sites and infrastructure for retrofitting.

Our public education goals will include messages about leaf litter and pesticides for the fall, and we plan o stay active in local and regional stormwater coalitions

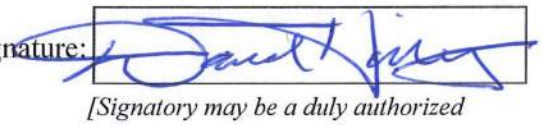
We continue to make progress on the catchment investigation by ranking, observing and inspecting outfalls and interconnections.

The Town will vote on a new drainage bylaw and we will work to straighten policies and utilize checklists that improve control for construction and post construction site inspections under the Town's drainage review bylaw. We also plan to hire a consultants to assist in the preparation of a Phosphorus Control Plan.

Part V: Certification of Small MS4 Annual Report 2020

40 CFR 144.32(d) Certification

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, I certify that the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Name:	David J. Hickey, Jr., P.E.	Title:	Town Engineer
Signature:		Date:	9-25-20

[Signatory may be a duly authorized representative]

MORSES POND ANNUAL REPORT: 2019

PREPARED FOR THE TOWN OF WELLESLEY

BY WATER RESOURCE SERVICES, INC.

JANUARY 2020

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This report documents the implementation of the 2005 Comprehensive Morses Pond Management Plan through 2019. Program elements have included: 1) phosphorus inactivation, 2) plant harvesting, 3) low impact development demonstration, 4) education, and 5) dredging. Dredging was completed in 2013 and low impact development demonstration was done earlier than dredging, and these elements have been covered in past reports to the extent that further inclusion is unnecessary. The history of the other elements has also been covered in a cumulative fashion is past reports, most recently December of 2017, so this report has been streamlined to cover just the actions of 2019 within the context of the overall management plan. Additionally, some of the approach applied to Morses Pond was extended to additional ponds within Wellesley as of 2018 and those efforts are included in this report for completeness.

Phosphorus Inactivation

Operational Background

Phosphorus entering through Bogle Brook and Boulder Brook was determined to be the primary driver of algae blooms in Morses Pond. Dry spring-summer periods fostered fewer blooms than wetter seasons in an analysis of over 20 years of data, although very wet conditions can flush the lake fast enough to also limit blooms. Work in the watershed to limit phosphorus inputs is a slow process and has limits related to urbanization that are very difficult to overcome. Reduction in the phosphorus content of lawn fertilizer is believed to be reducing inputs to the pond, but with so much developed land in the watershed, loading is still excessive. Inactivation of incoming phosphorus is possible, however, and has been used extensively and successfully in Florida to limit the impact of development on lakes there. The comprehensive plan called for a similar effort at Morses Pond.

A phosphorus inactivation system was established at Morses Pond in the spring of 2008. After testing and initial adjustment in 2008, the system has been operated in the late spring and part of summer in 2009 through 2019. The system has been modified over time, with simplification and a different aluminum chemical applied since 2014. The system has been automated since 2016, with control from a smart phone as needed. When a set amount of precipitation has occurred (normally 0.1 inch), the pumps turn on and polyaluminum chloride is fed into the Bogle Brook and Boulder Brook tributaries slightly upstream of the pond at rates of 40 to 80 gallons per hour. The tank serving Bogle Brook holds 2000 gallons, while the tank serving Boulder Brook holds 1000 gallons; Bogle Brook provides roughly twice the flow provided by Boulder Brook and is therefore treated at twice the rate. The system runs for 4 hours in response to a triggering precipitation event, although the duration is adjustable. The system is activated from the week before Memorial Day until about the week after 4th of July, although this is also adjustable as warranted. By treating incoming storm water during the late spring period, Morses Pond can achieve a low enough phosphorus concentration to avoid algae blooms for the summer. If there is enough inflow to raise the phosphorus level, this also translates into increased flushing that tends to minimize algae blooms as well.

A total of 5100 gallons of polyaluminum chloride were applied to Morses Pond in 2019 (Table 1). This is the lowest amount applied since the initial test year in 2008. Precipitation during the May-June 2019 period was 8.5 inches and for May-August it was 17.1 inches, both among the higher values observed

since 2008. The system performed reasonably well in 2019, but with less chemical and more precipitation the results were not quite as impressive as in recent years.

The record of phosphorus inactivation effort over the duration of this project is summarized in Table 1. As the chemicals used have changed, the most relevant measure of application is the pounds of aluminum applied, which has varied between 3009 (2019) to 6720 (2012) lbs. per treatment season, except for the lower value for the initial testing year (2008). The amount of aluminum needed is largely a function of precipitation, particularly in May and June under the operational scenario applied. Yet even with wetter 2017 through 2019 treatment seasons, less chemical was used than earlier in the program, owing mainly to automation and efficiency.

Table 1. Summary of Phosphorus Inactivation Effort, 2008-2019

Year	Applied Alum (gal)	Applied Aluminate (gal)	Aluminum Mass (lbs)	# of Treatment Days	May-June Precipitation (in)	May-August Precipitation (in)	Notes
2008	2000	1000	2240	5	6.2	16.7	Testing and adjustment phase, most treatment in July
2009	6002	2900	6595	16	5.9	16.1	Some elevated storm flow untreated
2010	4100	2080	4630	13	6.1	14.5	Additional chemical applied after early July
2011	5000	2475	5569	14	8.0	17.8	Some equipment failures. Additional chemical applied in August in response to bloom
2012	6000	3000	6720	19	6.9	14.4	Equipment problems hampered dosing during treatment
2013	6055	2785	6476	20	13.7	19.1	Very wet June (26.7 cm), unable to treat all storm flows; continued treatment through July
	Polyaluminum chloride						
2014	5985		3531	12	5.5	11.8	No treatment after 1st week of July, first year using polyaluminum chloride
2015	7900		4661	14	6.2	10.5	Leftover chemical used in summer, but little treatment after first week of July
2016	5800		3422	13	4.7	7.3	Only a little over half of the chemical was used by early July, remainder by August 15th
2017	6000		3540	17	8.3	13.9	Two deliveries of chemical were made and all was used by early July
2018	5400		3186	11	4.9	14.1	Two deliveries of chemical were made and all was used by the end of July
2019	5100		3009	14	8.5	17.8	Three deliveries (the 1st was a half load and portions of loads 2 and 3 were used on other ponds) of chemical were made and all was used by the mid-July

Analysis of Program Results

Water quality is assessed prior to the start of treatment, normally in May, again in early summer, and yet again at least once later in the summer in up to three areas: the north basin, the transition zone to the south basin just south of the islands, and near the town beach at the south end of the pond (Figure 1). Visual and water quality checks are made on an as needed basis, as part of normal operations or in response to complaints, major storms, or town needs. The water quality record for 2019 (Table 2) incorporates field and laboratory tests at multiple sites. A summary of phosphorus data for key periods since 2008 is provided (Table 3) to put the treatments and results in perspective. It is intended that total phosphorus will decrease through the treatment, such that values in the south basin, assessed in the swimming area near the outlet of the pond, will be lower than in the north basin, with the transition zone exhibiting intermediate values. Based on data collected since the early 1980s, total phosphorus in the south basin in excess of 20 µg/L tends to lead to algal blooms, while values <20 µg/L minimize blooms and values near 10 µg/L lead to highly desirable conditions (Figure 3).

Total phosphorus concentrations were higher in 2019 than in recent years. The relatively wet spring and summer seasons combined with lower overall application of aluminum resulted in phosphorus concentrations in the south basin of 15-20 ug/L at the start of treatment, 14-17 µg/L in late June and 16-20 µg/L in July and August after treatment has ceased. Phosphorus was maintained at <20 µg/L but did not approach the more desirable 10 µg/L at the start of summer. Conditions remained acceptable in the pond into September, but without any margin for error. It appears that we have defined the lower limit of successful treatment in 2019.

Total Kjeldahl nitrogen values were generally moderate to high in 2019, ranging from about 0.35-0.53 mg/L in early May and increasing through summer to values of about 0.53-0.89 mg/L in August as available nitrate was converted to organic nitrogen in surface waters, mainly by algae uptake. Nitrate was moderate to high in early May at 0.33-0.54 mg/L but declined to <0.05 mg/L at most stations by August. Loss of nitrate can be a concern, as low ratios of available N to available P favor cyanobacteria, and a shift toward cyanobacteria by early September was observed.

There are usually summer oxygen deficiencies in the deep hole area (MP-1) with depressed or depleted oxygen by early September in many years. However, in 2019 oxygen was low at 4 m by late June and at 3 m by mid-July. Inputs of organic matter with spring and early summer storms and stronger stratification based on weather pattern may be responsible, but these were the worst deep water oxygen conditions in many years. Fortunately, internal loading of phosphorus under low oxygen conditions, a problem in many lakes, was only a minor influence in Morses Pond; maximum deep water phosphorus concentration was 35 µg/L, elevated but not extreme.

Conductivity is high in surface waters of Morses Pond and very high in deeper water, indicating large amounts of dissolved solids in the water, although conductivity does not reveal the nature of those solids. Salts from road management are a likely source. The pH is slightly elevated near the surface and declines with depth, as decomposition adds acids at deeper locations. The pH also tends to increase as water moves through the pond, with photosynthesis by algae and rooted plants removing carbon dioxide and raising the pH. Turbidity is moderate in most of the water column, decreasing with distance from inlets

Figure 1. Current system layout and water quality sampling sites in Morses Pond.

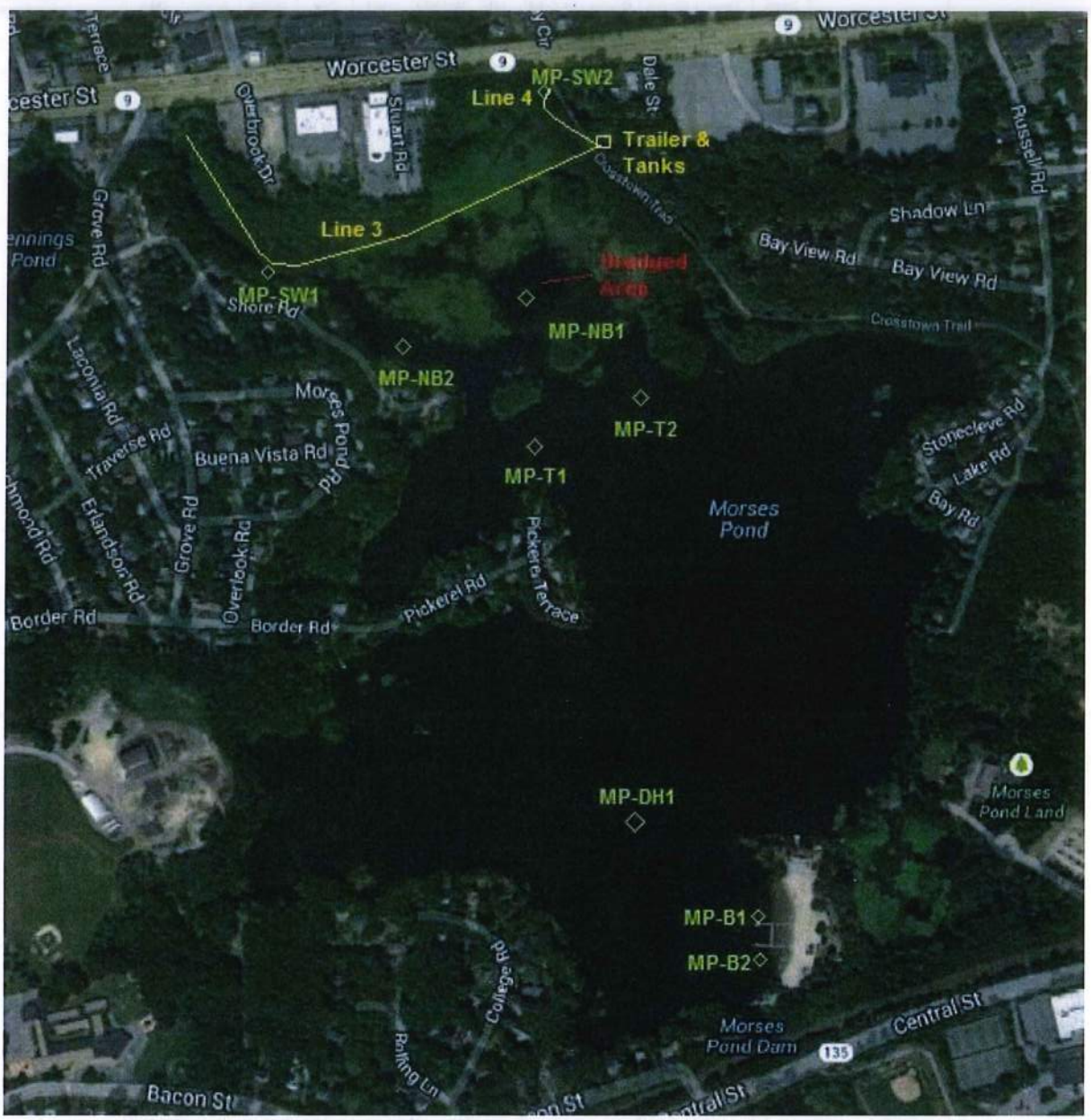


Table 2. Water quality record for Morses Pond in 2019

Station	Depth meters	Temp °C	Oxygen mg/l	Oxygen % Sat	Sp. Cond µS/cm	pH Units	Turbidity NTU	Total P mg/L	TKN mg/L	NO3-N mg/L	Secchi meters	Chl-a µg/L
Stream Inlets												
MP-SW-1 Bogle												
5/1/2019 Post-storm	0.1							0.023	0.465	0.431		
MP-SW-2 Boulder												
5/1/2019 Post-storm	0.1							0.021	0.352	1.440		
5/1/2019												
North Basin												
MP-NB-1 (dredged)	0.1							0.021	0.393	0.493		
MP-NB-2	0.1											
Transition Zone												
MP-T-1	0.1							0.021	0.437	0.333		
MP-T-2	0.1							0.018	0.387	0.535		
South Basin												
MP-B-1								0.015	0.532	0.364		
MP-B-2												
MP-1 (MP -DH1)	0.2	12.9	9.3	89.2	424	7.2	3.4	0.020	0.364	0.376	2.2	6.1
	1.0	12.7	9.2	87.8	423	7.3	3.3					5.7
	2.0	12.5	8.7	82.9	421	7.3	3.4					4.0
	3.0	12.2	8.3	78.3	424	7.3	3.4					3.7
	4.0	12.1	7.8	73.7	424	7.3	3.7					3.3
	5.0	11.6	6.9	64.6	426	7.3	3.7					3.2
	6.1	11.1	5.3	49.2	523	7.3	3.5	0.021	0.313	0.326		2.8
6/27/2019												
North Basin												
MP-NB-1 (dredged)								0.028	0.509	0.191		
MP-NB-2								0.032	0.534	0.188		
Transition Zone												
MP-T-1								0.035	0.559	0.159		
MP-T-2								0.032	0.504	0.173		
South Basin												
MP-B-1								0.017	0.430	0.142		
MP-B-2												
MP-1 (MP -DH1)	0.2	24.8	8.1	98.5	444	7.1	3.3	0.014	0.435	0.149	4.0	2.0
	1.0	24.2	7.5	90.7	443	7.1	3.3					2.9
	2.0	23.6	7.3	86.9	445	7.1	3.3					3.3
	3.0	21.1	4.6	52.6	441	7.0	3.2					3.1
	4.0	16.3	1.4	14.0	416	7.1	4.0					4.0
	5.0	12.1	0.2	1.8	439	7.2	6.5					8.5
	6.0	11.3	0.2	1.6	453	7.2	18.0					3.8
	6.5	11.0	0.2	1.8	467	7.3	22.3	0.032	0.662	0.051		5.3
Station												
7/16/2019												
North Basin												
MP-1 (MP -DH1)	0.1	27.3	7.6	97.3	421	7.1	4.5	0.016	0.516	0.050	3.4	3.2
	1.0	27.2	7.6	96.9	421	7.1	5.2					3.0
	2.0	26.9	7.5	95.6	419	7.0	5.4					4.2
	2.5	26.4	4.1	52.2	404	6.9	5.7					4.7
	3.0	24.7	1.2	14.1	427	6.8	6.7					5.6
	4.0	20.2	0.6	6.2	437	6.8	7.7					7.5
	5.0	14.1	0.7	6.8	442	6.9	9.8					7.5
	6.2	12.0	0.2	2.0	468	7.0	12.0	0.031	0.825	0.055		6.9
Station												
8/16/2019												
North Basin												
MP-NB-1 (dredged)								0.023	0.881	0.056		
MP-NB-2								0.033	0.679	0.069		
Transition Zone												
MP-T-1								0.024	0.766	0.061		
MP-T-2								0.019	0.890	0.050		
South Basin												
MP-B-1								0.020	0.584	0.050		
MP-B-2												
MP-1 (MP -DH1)	0.3	25.7	7.2	89.6	384	7.2	3.3	0.016	0.528	0.050	2.8	4.4
	1.0	25.4	7.3	89.6	385	7.2	5.0					4.5
	2.0	25.0	6.9	85.2	384	7.2	4.6					6.4
	3.0	24.3	4.1	49.3	383	7.2	4.6					4.2
	4.0	22.6	0.6	6.4	394	7.2	4.4					6.0
	5.0	16.1	0.4	4.5	454	7.1	8.8					11.9
	6.0	13.0	0.2	1.8	488	7.0	9.9					4.1
	6.3	12.7	0.2	1.6	492	7.0	9.9	0.035	1.250	0.050		4.2
Station												
9/5/2019												
North Basin												
MP-1 (MP -DH1)	1.0	24.0	8.0	96.5	394	7.0	4.4				4.0	3.4
	2.0	23.5	8.0	94.9	393	7.0	4.0					3.6
	3.0	23.1	7.8	92.3	397	7.1	3.9					4.0
	4.0	22.1	1.7	20.0	408	7.0	4.0					3.0
	5.0	18.0	0.7	7.7	451	7.0	6.9					14.4
	6.0	14.1	0.1	1.1	498	6.8	11.3					5.2

Table 3. Water quality testing results relative to the phosphorus inactivation system

Year	Location	Pre-Application TP (ug/L)	Early Summer TP (ug/L)	Late Summer TP (ug/L)	Observations
2008	North Basin	28	18	13	Mats observed, some cloudiness
	Transition	31	22	14	Some cloudiness, brownish color
	Swimming	21	12	12	No blooms reported, first year without copper treatment in some time
2009	North Basin	35	40	63	Cloudy, some green algae mats
	Transition	35	39	45	Cloudy
	Swimming	15	10	27	Generally clear, no blooms reported
2010	North Basin	26	46	53	Cloudy, green algae mats evident
	Transition	28	21	32	Brownish color, minimally cloudy
	Swimming	19	15	43	Generally clear, no blooms until late August (Dolichospermum)
2011	North Basin	53	33	130	Cloudy, green algae mats evident
	Transition	48	29	95	Slightly brownish
	Swimming	30	29	60	Cyanobloom in early August (Dolichospermum), dissipated after just a few days without treatment
2012	North Basin	32	24	48	Very dense plant growth, associated green algae mats
	Transition	28	37	28	Brownish most of summer
	Swimming	20	27	24	Had bloom in mid-July (Dolichospermum), treated with copper
2013	North Basin	36	47	30	Water brownish, but little visible algae; first year with newly dredged area within north basin
	Transition	No Data	78	32	Generally elevated turbidity, but much of it is not living algae
	Swimming	24	33	28	Continued treatment kept TP down, but not to target level; June flushing minimized algae biomass
2014	North Basin	30	22	20	Dense plant growths outside dredged area, some green algae mats, but water fairly clear
	Transition	21	20	18	Dense plant growths, some mats, water fairly clear
	Swimming	12	13	17	Water clear; Secchi to bottom in swimming area, no blooms reported
2015	North Basin	12	17	23	Dense plant growths outside dredged area, abundant green algae mats, but water fairly clear
	Transition	8	15	14	Dense plant growths, but water fairly clear
	Swimming	5	5	14	Water clear; Secchi to bottom in swimming area, no blooms reported
2016	North Basin	12	9	5	A few mats but much less than in recent years
	Transition	19	16	5	Dense plant growths but few mats, high water clarity
	Swimming	14	5	5	Water clear all summer
2017	North Basin	30.5	30.5	13	Dense rooted plants, some algae mats
	Transition	26.5	34	14	Dense rooted plants, few algae mats
	Swimming	17	18	15	Some cloudiness, but no visible algae blooms
2018	North Basin	30	18	16	Dense rooted plants, some algae mats
	Transition	31	15	16	Some cyanobacteria in June, less in August
	Swimming	17	12	11	Some cyanobacteria in June, less in August, but water green at 20 ft of depth in early Sept
2019	North Basin	24.5	29.8	28.2	Water turbid with suspended sediment on most visits
	Transition	19.7	33.5	21.8	Water turbid but on obvious cyanobacteria or algae mats
	Swimming	18.8	15.4	18.1	No cyanobacteria and few green algae mats observed in May-Aug, some cyanobacteria in Sept

but increasing right at the bottom in the deep hole location; accumulation of very light solids is suggested at the deep hole station and explains most other water quality variation. Alkalinity tends to be moderate at the deep hole location.

Average summer water clarity was slightly lower in 2019 than in 2018, which was lower than in 2017, which was lower than the record-breaking high of 2016, but clarity was still acceptable for contact recreation in all years since aluminum treatment commenced. However, the amount of aluminum delivered in each year has decreased each year since 2017 and the amount of aluminum per inch of May-June precipitation in 2019 was barely half to less than 22% of the amounts added in recent years. Experimentation with the timing and amount of aluminum added appears to now be sufficient to set a lower limit of about 3500 lbs per May-June application period or about 400 lbs per inch of precipitation,

whichever is higher. Having some aluminum available for application later in July or early August is advisable in wet summers, but the primary goal is to go into July with the southern basin phosphorus close to 10 µg/L, allowing maintenance of acceptable conditions through August with the normal range of summer conditions.

Bogle and Boulder Brooks were sampled only once in 2019 (Table 2). Phosphorus concentrations in a post-storm period were not especially high, compared to historical inlet concentrations averaging 130 µg/L for both Bogle and Boulder Brooks. TKN values were moderate and nitrate concentrations were elevated. Some additional inlet sampling should be conducted in 2020 to evaluate if there is a declining trend in phosphorus inputs as a consequence of reduced phosphorus in lawn fertilizer and if the elevated nitrate concentrations sometimes observed warrant upstream investigation.

The 12-year phosphorus inactivation history can be functionally divided into 3 periods: 2008-2010, 2011-2013, and 2014-2019, both in terms of system function and average summer water clarity data (Figure 2). While treatment in 2008 started late and was largely experimental, results for total phosphorus for 2008 were <20 µg/L. Similar results were achieved in 2009 and 2010; throughout these three years average summer phosphorus was 10-25 µg/L and average summer water clarity was about 3 m (10 ft). Equipment worked well and the operations team was effective in responding to storms.

Total phosphorus was somewhat elevated in 2011-2013, with summer averages of 22-45 µg/L. 2011 and 2013 were the rainy periods and equipment problems became more frequent. Timely repairs kept the treatments going, but they were not as efficient and apparently not as effective as in the previous three years. Detention capacity of the north basin was limited by shallow depth resulting from years of sediment deposition; dredging was planned for fall 2012 but not completed until 2013, and June 2013 set records for precipitation and flows. Water clarity averaged slightly more than 2 m (about 7 ft), not appreciably better than pre-treatment years, although it should be kept in mind that clarity would have been lower in the pre-treatment period if not for copper treatments.

After system modification in 2014 and 2016, clarity reached new highs. Outstanding conditions in 2014-2016 were a product of dry weather, effective treatment, and improved detention in the north basin. Phosphorus was low and water clarity was the highest it has been since implementation of the comprehensive plan (and indeed going back almost 30 years). No serious problems were encountered in application, chemical costs were not elevated, and labor costs were reduced by the automated application system in 2016. Wetter conditions in 2017 through 2019 and experimentation with lowering the amount of aluminum applied led to slightly higher phosphorus concentrations in those summers. Desirable conditions were achieved, but not quite at the levels observed in 2014-2016.

Only one algae bloom has occurred during the swimming season since P inactivation commenced. The combination of treatment and detention was insufficient to prevent a cyanobacteria bloom from forming in mid-July 2012. The only copper treatment since phosphorus inactivation started was conducted in the swimming area to reduce algae and increase clarity in mid-July, but a major storm within a few days resulted in a major flushing of the lake. The storm inputs were treated with aluminum, and no further algal blooms occurred. Cyanobacteria were observed in a deep water sample in late August

of 2018 and in the surface water in September 2019, but no surface blooms developed and the beach season had ended by the time of each cyanobacteria detection.

The higher clarity is related to lower algae abundance, which is in turn related to lower phosphorus levels. The relationship between clarity as Secchi transparency and total phosphorus (Figure 3) is fairly tight for Morses Pond. The early program (2008-2010) results were among the best observed to that time, while the middle program (2011-2013) results were not obviously better than the pre-treatment record. The next three years (2014-2016) are the best on record, and the most recent three years (2017-2019) have been at least acceptable despite experimentation with dosing conducted to determine the most efficient approach.

Algal data for 1996-2019 illustrate processes in Morses Pond over the summer (Figure 4). Algae biomass and composition can be very variable, depending on combinations of nutrient levels, light, temperature and flushing. Morses Pond phytoplankton biomass was frequently elevated prior to spring phosphorus inactivation, but since then biomass values have not exceeded the general threshold of 3 mg/L that signals low clarity (note that there is no official threshold for algae, but the red line in Figure 4 is a useful guide). Phytoplankton biomass as an annual spring/summer average has been below the 1 mg/L threshold indicative of low biomass since the system adjustments of 2014 and cyanobacteria have represented only a small amount of biomass each year. There have been small peaks in biomass at times, but no blooms that would prompt beach closure or other recreational impairment since improved operation of the phosphorus inactivation system in 2014. In September of 2018 and 2019 some cyanobacteria of the problem genus Aphanizomenon were present, but no surface blooms developed.

This portion of the Morses Pond comprehensive plan aimed at controlling algae blooms, including watershed loading reductions (reduced P in fertilizer), dredging for increased detention in the north basin, and P inactivation at inlets during storms in late spring and early summer, has achieved its goals.

Zooplankton have also been sampled, and while not as tightly linked to nutrients, provide important information on the link between algae and fish (Figures 5 and 6). Zooplankton biomass varies strongly between and within years. Values <25 ug/L are low and values higher than 100 ug/L are high as rough thresholds, with high values desired for both algae grazing and fish food; Morses Pond values span that range and more. Values in later summer are expected to be lower than in late spring or early summer, as fish predation by young-of-the-year fish (those hatching that year) reduces populations of zooplankters. Spring levels will depend on water quality, predation by adult fish, and available algae, which are food for zooplankton. The dominant zooplankton tends to be cladocerans and copepods, both groups of micro-crustaceans. *Daphnia*, among the larger cladocerans, filters the water to accumulate algae as food, and can increase water clarity markedly.

Daphnia were present in Morses Pond in all monitored years, a good sign, and abundance was elevated many samples. The late summer zooplankton population was sometimes low but overall the zooplankton community has adequate biomass to support the food web and provide substantial grazing capacity for algae consumption, which helps maintain water clarity. There is no indication of any aluminum toxicity to zooplankton; the treatment protocols minimize this probability.

Figure 2. Average summer water clarity and total phosphorus in Morses Pond, 1994-2019.

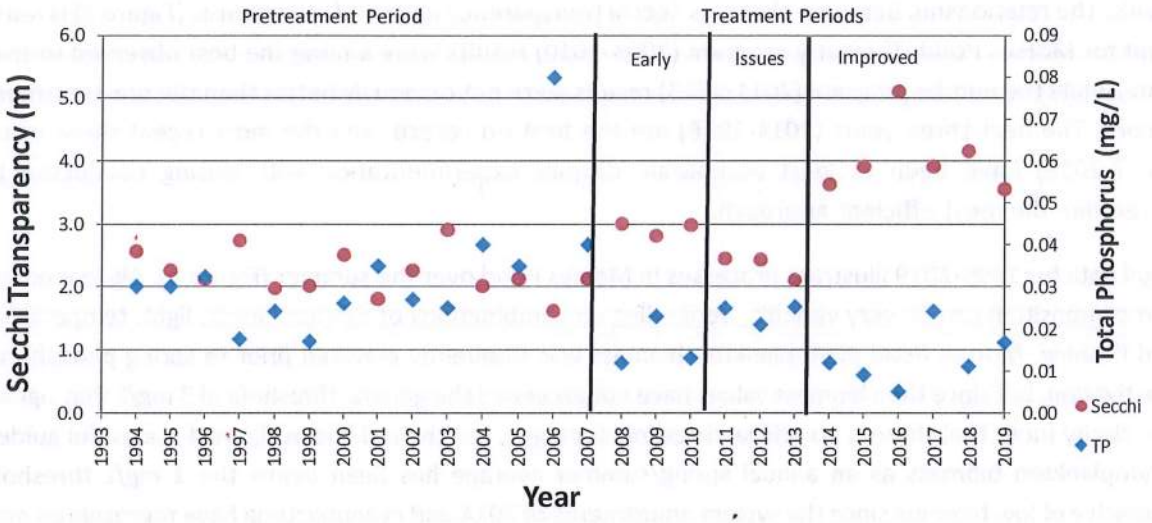


Figure 3. Relationship between summer water clarity and total phosphorus in Morses Pond.

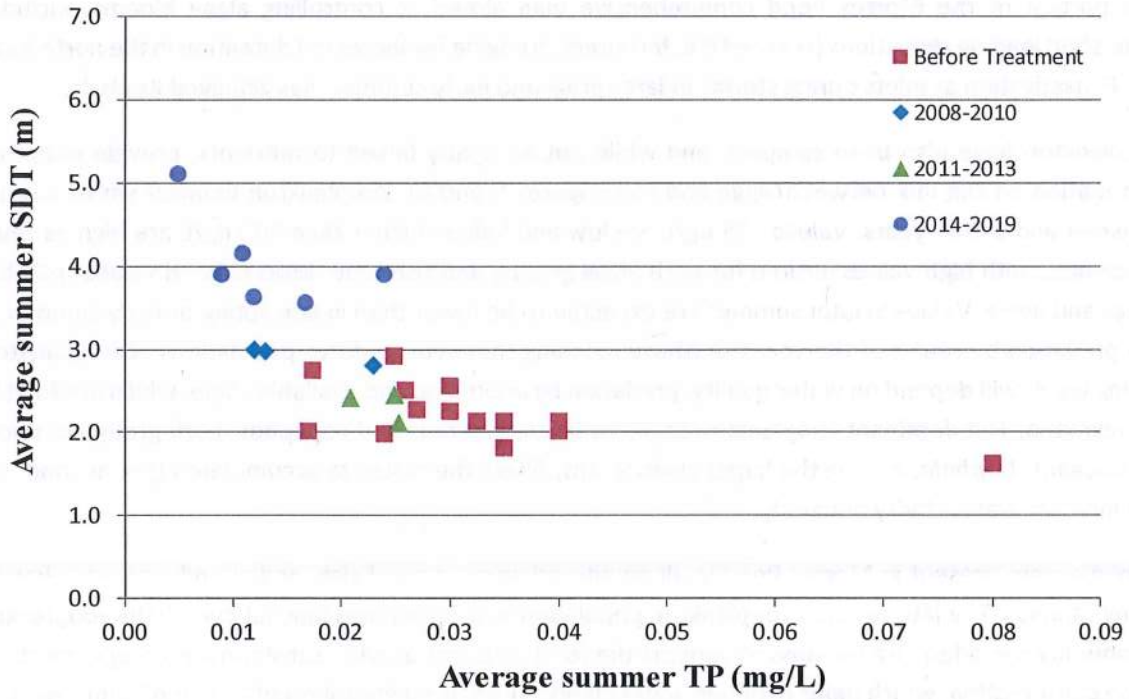
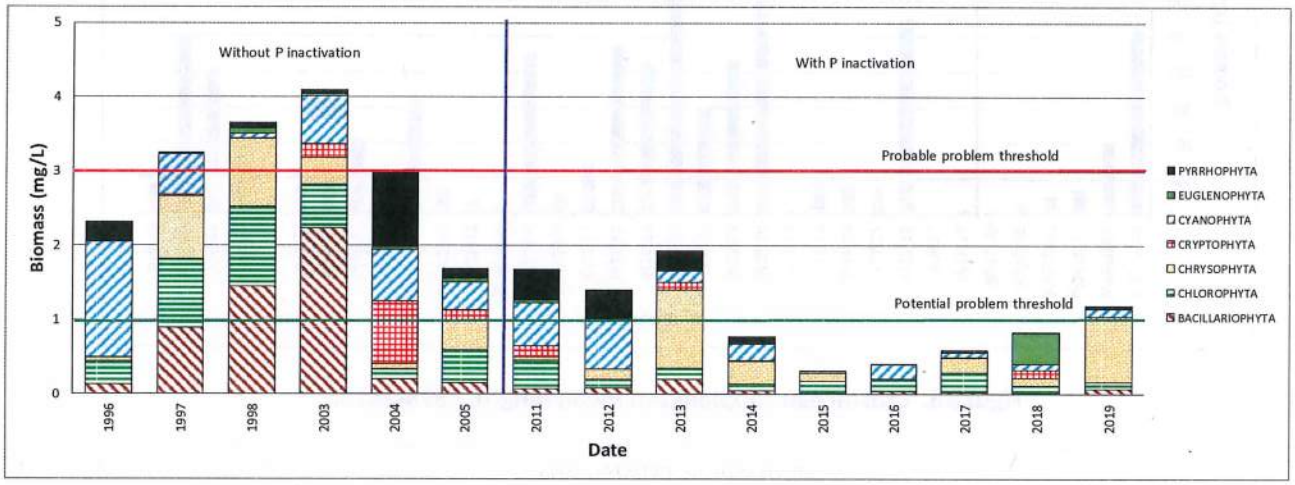


Figure 4. Summer average algae biomass divided into major algae groups for 1996-2019.



The size distribution of zooplankton (Figure 6) is important, as larger individuals are more effective grazers and represent better food for small fish. Mean lengths for at least crustacean zooplankton exceed the minimum desirable threshold (0.4 mm) in all samples and approach or slightly exceed the preferred upper threshold (0.8 mm) in many samples. If there are too many very large zooplankton, it may indicate a lack of small fish that are needed to feed the larger fish, which could be a problem over a period of years. The high mean length data are indicative of high game fish abundance and suggest good fishing. This is consistent with angler observations. As it is now, the biological structure of Morses Pond is almost ideal from a human use perspective, featuring lots of game fish for anglers and clear water for swimmers.

Figure 5. Zooplankton abundance for 1996-2019.

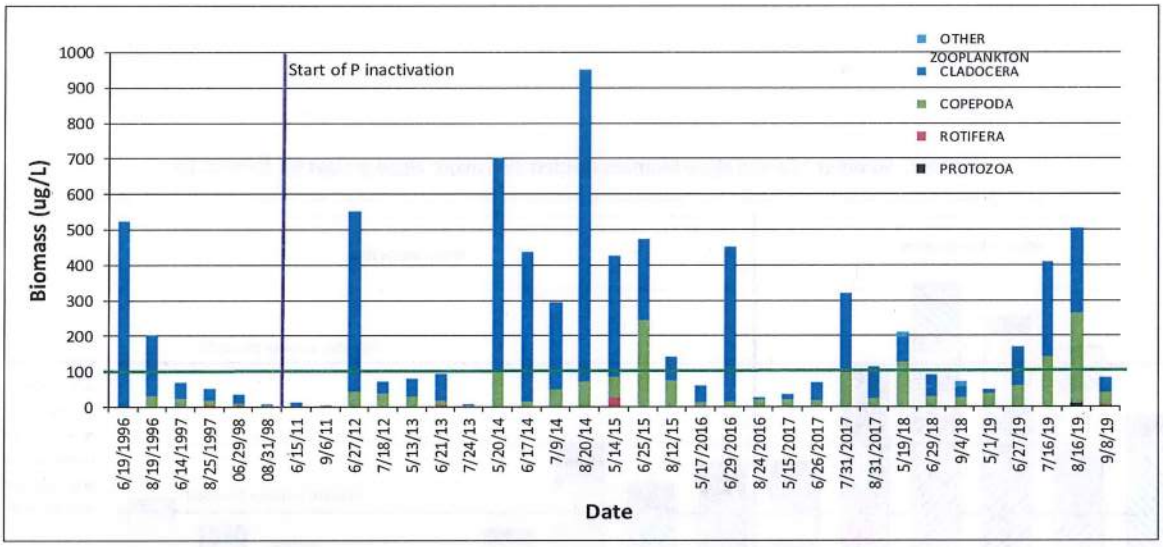
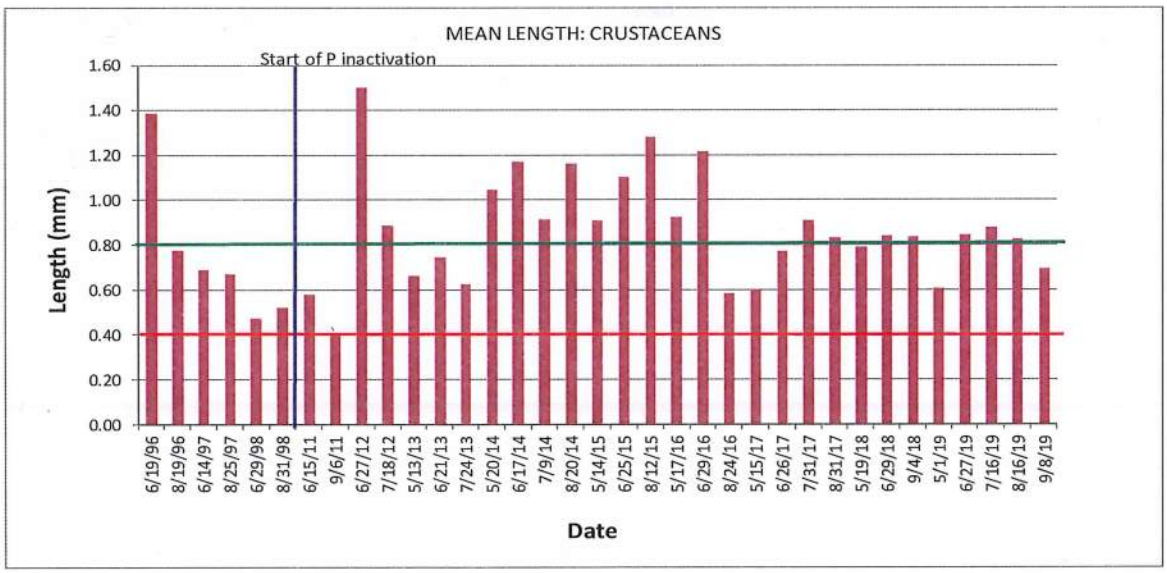
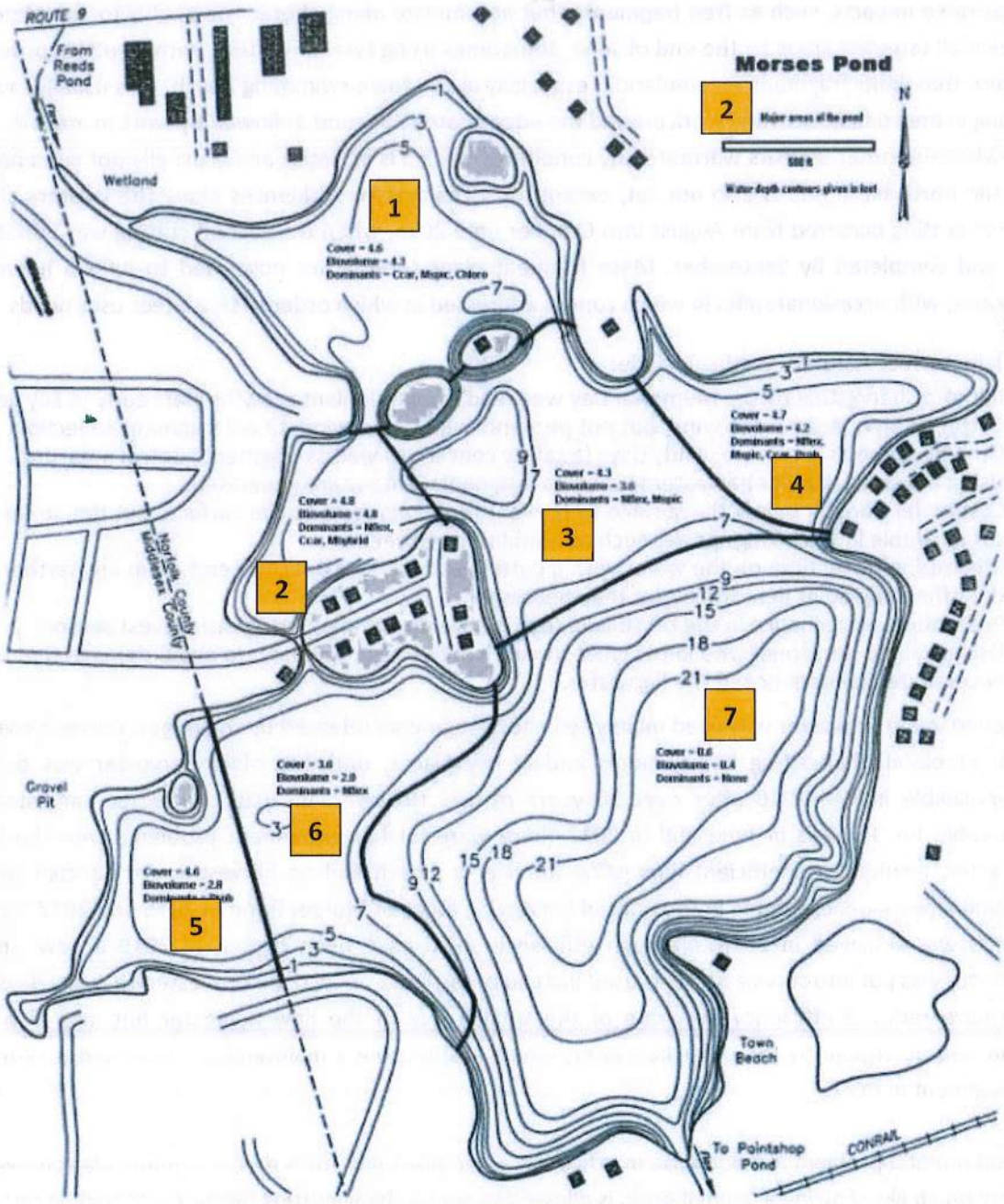


Figure 6. Crustacean zooplankton mean length, 1996-2019.



clogging is an issue, and more frequent unloading of the grass catcher is needed. In the aquatic environment this problem can be magnified, as travel time to dump each load can be substantial. It is therefore important to stay ahead of plant growth when harvesting, maintaining maximum cutting rate and minimizing travel time. Equipment issues that reduce cutting time and allow plants to grow high and dense can prevent achievement of goals even after the equipment is fixed.

Figure 7. Plant Management Zones for Morses Pond.



Mechanical Plant Harvesting

Harvesting Strategy

The Town of Wellesley initiated the enhanced Morses Pond vegetation harvesting program in 2007. The zoned vegetation harvesting strategy originates from the 2005 pilot program and comprehensive management plan written that year. For the pilot program, Morses Pond was divided into seven zones in order to better track the harvesting process. Figure 7 shows these zones and Morses Pond bathymetry. Harvesting protocols have been adjusted through experience to maximize effectiveness and minimize undesirable impacts, such as free fragments that accumulate along shore. The goal is to complete one harvest all targeted areas by the end of June, sometimes using two harvesters, with a cutting order and pattern that limits fragment accumulation, especially at the town swimming beach. This usually involves cutting in area 6 first, with any work around the edge of area 7 second, followed by work in areas 2, 3 and 4 in whatever order appears warranted by conditions. Area 5 is in Natick and is usually not cut, and area 1 is the north basin and is also not cut, except for a channel for residences along the western side. A second cutting occurred from August into October until 2015, when the second cutting was initiated in July and completed by September. More frequent plant surveys are now used to inform harvesting priorities, with occasional shifts in which zone is addressed in which order to best meet user needs.

The keys to successful harvesting include:

- Initiating harvesting by the Memorial Day weekend, sooner if plant growths start early in any year.
- Cutting with or against the wind, but not perpendicular to the wind, to aid fragment collection.
- Limiting harvesting on very windy days (a safety concern as well as fragment control measure).
- Using a second, smaller harvester to pick up fragments if many are generated.
- Cutting far enough below the surface to prevent rapid regrowth to the surface, but not so far as to cut desirable low growing species such as Robbins' pondweed.
- Minimizing travel time on the water with a cutting pattern that does not end a run any farther from the offloading point near the outlet than necessary.
- Preventive maintenance in the off season to minimize down time during the harvest season.
- Using trained personnel who know what to cut, where to cut, and how to avoid damage that would necessitate maintenance of the harvester.

A second, older harvester was used mainly to collect fragments released by the larger, newer harvester, or to accelerate harvesting at key times and in key places, until the older harvester was deemed unserviceable in late 2016 after over 30 years of use. However, in 2016 the larger harvester was inoperable for 3 weeks in June and in 2017 there were further equipment problems with the larger harvester, resulting in inefficient harvesting for over a month and no harvesting for another month; conditions were unacceptable in the normal harvesting areas of Morses Pond in 2016 and 2017. Greater success was achieved in 2018, although efficiency could have been higher. In 2019 a new, smaller harvester was put into service and was used instead of the larger, now older harvester on many days. This may have reduced efficiency by virtue of the smaller size of the new harvester but may also have minimized downtime by the older harvester, which has become a maintenance issue and is slated for replacement in FY22.

A fundamental problem is a decrease in efficiency when plant growth is dense. Aquatic plant harvesting is very much like mowing a lawn; if grass is allowed to get too high, cutting becomes difficult in one pass,

Harvesting Record

Records provided by the Town of Wellesley document the harvesting effort expended on Morses Pond (Table 4). Although the record is not always complete, records have been kept since 2007. Between late May and late October, from 2007 through 2019, harvesting was conducted on a range of 43 to 76 days. This represents a range of 303 to 537 total hours devoted to some aspect of the harvesting program, and 184 to 335 hours of actual harvesting time. In 2019 harvesting occurred on 62 days for a total of 472 hours with 278 hours actually spent cutting. Total loads of aquatic plants harvested have ranged from 54 to 127 per harvesting season, with 2019 very near the upper end of that range at 126 loads. Total weight of plants harvested, as measured upon entry to the composting facility (so some draining of water, but not a dry weight) has ranged from 224,000 to 808,000 lbs. The 2019 biomass total was estimated at about 344,700 lbs., but the record was incomplete and extrapolation from only about 40% of the harvesting dates was necessary. While as much time was spent and more loads were harvested as usual, the weight per load was lower than average and undesirable conditions were reported at times in Morses Pond.

An increasing number of non-cutting hours was observed from 2009 until 2015 (Figure 8) and appeared related to increases in time for maintenance and travel. From 2014 through 2017, records were kept for non-cutting hours in categories including transport time on the water, transport time on land, and maintenance. With a renewed emphasis on efficiency, the 2015 record indicates that non-cutting time was roughly cut in half. Non-cutting time increased very slightly in 2016 but was still far less than in 2014. Non-cutting time increased markedly in 2017, as the large harvester was working but not properly, resulting in low efficiency and an eventual breakdown. Note that this harvester experienced considerable downtime in 2016, but time not in use awaiting parts is not counted in the harvesting program. Non-cutting time was not tracked by task in 2018 or 2019, but was reduced from 2017; however, it was still higher than most other years, amounting to just over 40% of total program time in 2019.

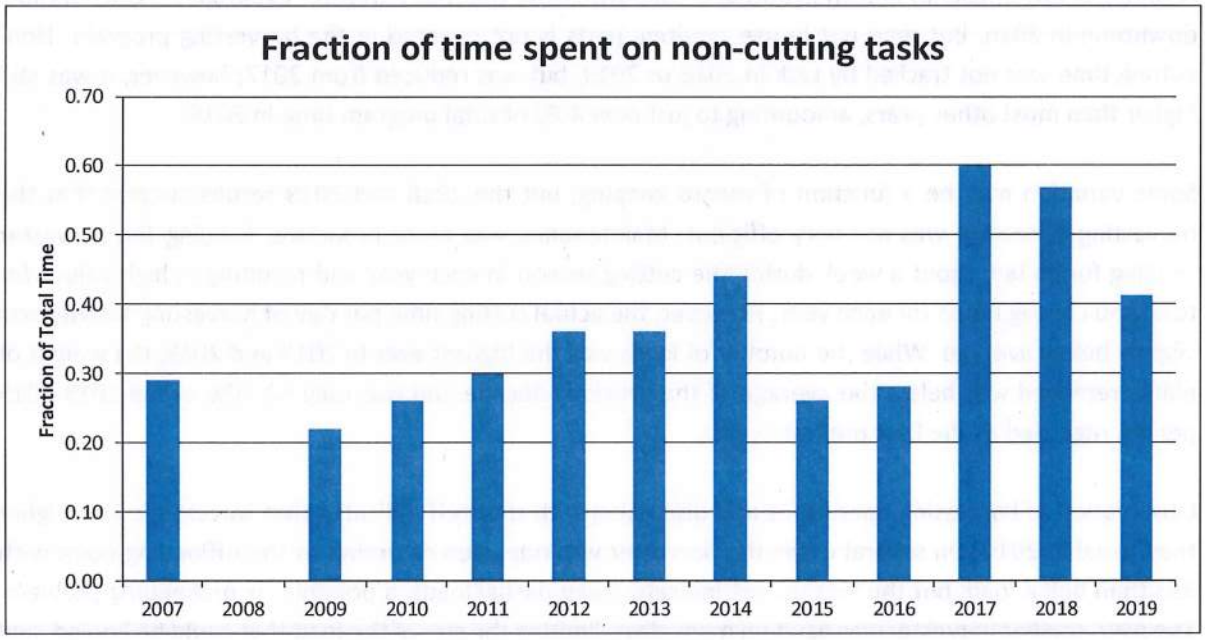
Some variation may be a function of record keeping, but the 2018 and 2019 results suggest that the harvesting operation was not very efficient. Maintenance was more proactive, keeping the harvester running for all but about a week during the cutting season in each year and resulting in high values for total and cutting hours for each year. However, the actual cutting time per day of harvesting activity was slightly below average. While the number of loads was the highest ever in 2018 and 2019, the weight of plants removed was below the average of the previous decade and was only 62-70% of the 2013-2015 period, regarded as the best program years.

Observation of harvesting operations and discussion with the staff indicates that travel time was higher than usual in 2019. On several dates the harvester was observed returning to the offloading point with less than half a load, but the logs do not indicate many partial loads, a possible recordkeeping problem. The new, smaller harvester was used on many days, limiting the size of the load that could be hauled, and this may account for smaller harvested plant weights despite log records of "full" loads. The logs do indicate substantial time spent on non-harvesting tasks by harvester personnel, including working on the beach and associated building and restoring the launch area after a storm caused considerable erosion. But it appears that the travel time issue, involving more trips back and forth to the launch with smaller

Table 4. Harvesting record summary for Morses Pond

Year	Days of Harvesting per Year	Total Hours per Year	Cutting Hours per Year	Total Hr/Day	Cutting Hr/Day	Total Loads	Total Weight	Weight/ Day	Weight/ Load	Weight/ Total Hr	Weight/ Cutting Hr
	(Days)	(Hr)	(Hr)	(Hr)	(Hr)	(Load)	(Pounds)	(Pounds)	(Pounds)	(Pounds)	(Pounds)
2007	49	359	255	7.3	5.2	109	NA	NA	NA	NA	NA
2008	43	NA	NA	NA	NA	NA	270320	6287	NA	NA	NA
2009	57	390	304	6.8	5.3	78	224060	3931	2891	575	738
2010	44	303	223	6.9	5.1	78	226960	5278	2900	749	1017
2011	54	414	291	7.7	5.4	102	292000	5407	2863	706	1003
2012	70	460	296	6.6	4.2	124.5	807760	11539	6488	1756	2729
2013	76	519.5	335	6.8	4.4	119.5	595277	7833	4981	1146	1777
2014	75	476.5	265.5	6.4	3.5	110	455220	6070	4138	955	1715
2015	57	363	268	6.4	4.7	90	607710	10662	6752	1674	2268
2016	48	350	252	7.3	5.3	85	521000	10854	6129	1489	2067
2017	43	454.5	183.5	10.6	4.3	54	348200	8098	6448	766	1898
2018	66	537	232	8.1	3.5	126.5	390185	5912	3084	727	1682
2019	62	472	277.5	7.6	4.5	126	344708	5560	2736	730	1242
For 2009 total hours, assumes 1.5 hr/harvesting day of non-cutting time, based on values for those days with total and cutting hours.											
For 2010 total weight, assumes 202,000 pounds resulting from hydroraking, based on values for days when hydroraking occurred.											
For 2012 and 2013, harvesting includes Area 1, which had very dense plant growths and accounts for additional weight removed.											

Figure 8. Non-cutting hours associated with the harvesting program.



loads, is the biggest issue. Three different staff members provided harvester time, and at least two have considerable experience, but the target average cutting time per day was not achieved.

Beyond the efficiency issue, there is a problem with the distribution of cutting days. The logs show that harvesting started on May 21, 2019 and continued on 61 days out of the next 85 days; with weekends, holidays, weather issues and occasional need for staff effort to be diverted elsewhere, this is a reasonably continuous program of harvesting that started on time in 2019. However, there was only 1 day of harvesting after August 13th, and by the end of August the plant growths were very dense in several areas, most notably in the northwest and northeast coves (areas 2 and 4). While as much time was devoted to the harvesting program as usual, it did not cover the entire period where effort was needed. The lower weight per load offset the higher than usual number of loads and the program could not afford to cease in mid-August with any expectation of maintaining desirable conditions through September. It is possible that cutting in July was less efficient as a function of lower density of aquatic plants, leading to less weight being harvested per hour and the observed lower than full loads being hauled. Ideally, an effective first cut by late June negates the need for cutting in the first half of July.

We need to improve efficiency and effectiveness in the mechanical harvesting program if goals are to be met. This need is somewhat constrained by the condition of the older, larger harvester, which is not scheduled for replacement until FY22. In 2019 the primary problems were electrical and hydraulic, all functions of equipment age and difficult to manage proactively. Use of the smaller harvester limited breakdowns but decreased load capacity, increasing travel time per unit of plant biomass hauled. There was also a problem with the shore conveyor that resulted in the need to swap conveyors at one point, another loss of harvesting time. Beyond equipment limitations, we need to find ways to maximize staff efficiency within the program and to provide the most effective cutting possible, maximizing the duration of benefits from each cut and delaying the need to cut any area again to avoid plant problems.

For 2020, it is recommended that a pre-harvesting season meeting be held with all involved personnel to consider options for improved efficiency within the constraints of equipment, staff time and budgets. Operationally, it is recommended that harvesting cut slower and deeper and focus on bringing back full loads, using the older, larger harvester as much as possible. This should result in slightly more than 5 hr. of cutting per day; the 2019 average was 4.5 hours of actual cutting per day, up from the 2018 average of 3.5 hours per day but still below the target. An effective first cutting completed by the end of June should allow a couple of weeks without harvesting on Morses Pond, a time when Longfellow and Rockridge Ponds are often harvested. Resumption of harvesting at Morses Pond should resume in mid-July and continue through August. If the harvesting program can start a week early, this might allow for harvesting in Rockridge Pond before the end of June, a recommendation for that pond covered later in this report. Alternatively, since the smaller harvester is used in Rockridge while the larger harvester is preferred for Morses, both ponds could but harvested simultaneously if staff are available. There may be other options for improvement and a meeting with all involved parties may provide insights.

Plant Surveys

Plant surveys are conducted to support harvesting operations, assessing where the need is greatest and evaluating success. The timing of surveys has varied, sometimes before harvesting, sometimes after, and comparisons have been useful but not always consistent. A point-intercept methodology was applied to document the spatial distribution and percent cover and biovolume of aquatic plants at specific re-locatable sites. At each point the following information is recorded:

- The GPS waypoint.
- Water depth using a metal graduated rod or a mechanical depth finder.
- Plant cover and biovolume ratings using a standardized system.
- Relative abundance of plant species.

For each plant species, staff recorded whether the species was present at trace (one or two sprigs), sparse (a handful of the plant), moderate (a few handfuls of the plant), or dense (many handfuls of the plant) levels at each site. Plant cover represents the total surface area covered in plants (2 dimensions). For cover, areas with no plants were assigned a "0," areas with approximately 1-25% cover were assigned a "1," a "2" for 26-50%, a "3" for 51-75%, a "4" for 76-99%, and a "5" for 100% cover. Like plant cover, a quartile scale was used to express plant biovolume, defined as the estimated volume of living plant material filling the water column (3 dimensions). For biovolume, 0= no plants, 1= 1-25%, 2=26-50%, 3=51-75%, 4=76-100%, and 5= 100% of plants filling the water column.

After 2017 we adjusted this approach to be more responsive to management needs, focusing on a smaller number of points in each designated zone of the pond and surveying three times, allowing for evaluation of conditions before cutting, after the first cut, and after the second cut. The target condition, based on the assessment methodology above, is to have each targeted harvesting area exhibit an average biovolume of about 2 (25-50% of the water column filled with plants, mainly the bottom quarter to half) but not to restrict the coverage except in key access areas like the public beach, such that sediment is stabilized and habitat is maximized.

2019 Results

A total of 37 species are known from Morses Pond, with 27 plant species detected 2019 (Table 5), the highest number of species ever, but with 3 separate surveys this might be expected. Even then, only 6 species were common or abundant, and 3 of those were invasive species. Oscillations in species richness are largely a function of less common species being found or not found in any given year and date of the survey. The shift to 3 surveys since 2018 has increased species detection. The dominant suite of species remains the same, with the four invasive submerged aquatic plant species encountered including:

- *Cabomba caroliniana* (Fanwort) – dominant in 2019
- *Myriophyllum spicatum* (Eurasian watermilfoil) – common in 2019
- *Myriophyllum heterophyllum* (Variable watermilfoil) – dominant in 2019
- *Potamogeton crispus* (Curlyleaf pondweed) – present in 2019

Note that *Trapa natans*, water chestnut, is also known from Morses Pond, but owing to the efforts of volunteer water chestnut pullers, it has never been found in the standard survey. Also note that *Lythrum salicaria* (purple loosestrife) is a peripheral invasive species that can be abundant but rarely picked up by our aquatic surveys.

Table 5. Aquatic plants in Morses Pond

		Plant Rating for Year												
Scientific Name	**Common Name**	**2005**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Brasenia schreberi	Watershield							P	P					P
Callitriche sp.	Water starwort	P		P										
Cabomba caroliniana	Fanwort	A	A	A	A	A	A	A	A	A	A	A	A	A
Ceratophyllum demersum	Coontail	C	C	C	A	C	C	C	C	C	C	C	C	C
Chlorophyta	Green algae	C	C	C	A		P	C	P	P	A	A	P	P
Cyanobacteria	Blue green algae		P		C	P	P		P	P	P			P
Decodon verticillatus	Swamp loosestrife	C	P		P	P								P
Elodea canadensis	Waterweed	C	C	C	C	C	C	C	C	A	A	A	C	P
Lemna Minor	Duckweed	P	P	P	P	P	P	P		P		P	P	P
Lythrum salicaria	Purple loosestrife	P	P	P	P	P	P			P				P
Myriophyllum heterophyllum	Variable watermilfoil	P	C	C	A	A	A	C	C	C	A	A	A	A
Myriophyllum spicatum	Eurasian watermilfoil	A	A	A	A	C	C	A	A	C	A	A	C	C
Najas flexilis	Common naiad	C	C	C	C	P	P	P	P	P	P		P	P
Nymphaea odorata	White water lily	C	C	C	C	C	C	C	P	P	P	P	P	P
Nuphar variegatum	Yellow water lily	C	P	P	P	P	P	P	P	P	P	A	C	C
Polygonum amphibium	Smartweed	P	P	P	P	P	P	P	P	P		P	P	P
Pontederia cordata	Pickerelweed	P		P	P			P		P			P	P
Potamogeton amplifolius	Broadleaf pondweed	C	C	C	C	C	C		C	C	C	C	P	C
Potamogeton crispus	Crispy pondweed		C	C	C	P	P	P	C	C	A	A	P	P
Potamogeton epihydrus	Ribbonleaf pondweed		P	P	P	P	P	P	C	P		P	P	P
Potamogeton perfoliatus	Claspingleaf pondweed					P	P		P	P			P	P
Potamogeton pulcher	Spotted pondweed	P			P	P	P	P	P	P	P		P	P
Potamogeton robbinsii	Fern-leaf pondweed	C	C	C	C	P	P	P	C	A	C	A	C	P
Potamogeton spirillus	Spiral seed pondweed					P	P	P	P	P	P			P
Potamogeton zosteriformis	Flatstem pondweed						P	P			P		P	P
Ranunculus sp.	Water crowfoot										P			
Salix sp.	Willow				P									
Sagittaria gramineus	Submerged arrowhead	P	P	P		P	P			P			P	
Sparganium sp.	Burreed													
Spirodela polyrhiza	Big duckweed	P				P		P						
Typha latifolia	Cattail			P										P
Trapa natans	Water chestnut													
Utricularia geminiscapa	Bladderwort	P	P		P		P	P		P	P		P	P
Utricularia gibba	Bladderwort	C				P				P			P	P
Valisneria americana	Water celery				P	P	P			P		P	P	P
Wolffia columbiana	Watermeal	P			P		P							
	# of Species	23	20	20	24	24	25	20	18	25	18	15	23	27
	P=Present, C=Common, A=Abundant													

Biovolume is a function of ice out date, the rate of plant growth, the date of the survey and any harvesting effort. The three survey per year approach allows tracking of conditions and progress of harvesting in target zones of the pond. Morses Pond exhibited moderate to high vegetation biovolume in the spring 2019 pre-harvest survey (Figure 9), suggesting rapid spring growth. Biovolume increased to dense levels in unharvested areas over the summer. Conditions were slightly worse in zones 2-4 than in zone 6 in mid-May 2019. With the beach opening a week later than usual in 2019, priority was given to zones 2 and 4 for the first cut in 2019, with the intent of maintaining lower plant density while still cutting zone 6 before the beach opened. Overall biovolume decreased in areas that were harvested, achieving the target rating of 2 after the first cut was completed in late June. Yet biovolume increased and the target of an overall rating of 2 was not observed in the early September survey, after the second cut. The harvesting effort in July and August of 2019 did not keep pace with plant growth, probably because there was very little harvesting after mid-August. Analysis of individual zones suggests that all four of the major target zones for harvesting (#2, 3, 4 and 6) exhibited plant biomass higher than desirable about 3 weeks after the second cut was completed in 2019 (Figure 10). Visual inspection indicated that invasive plants dominated.

Figure 9. Biovolume comparison in areas with and without harvesting over time in 2019

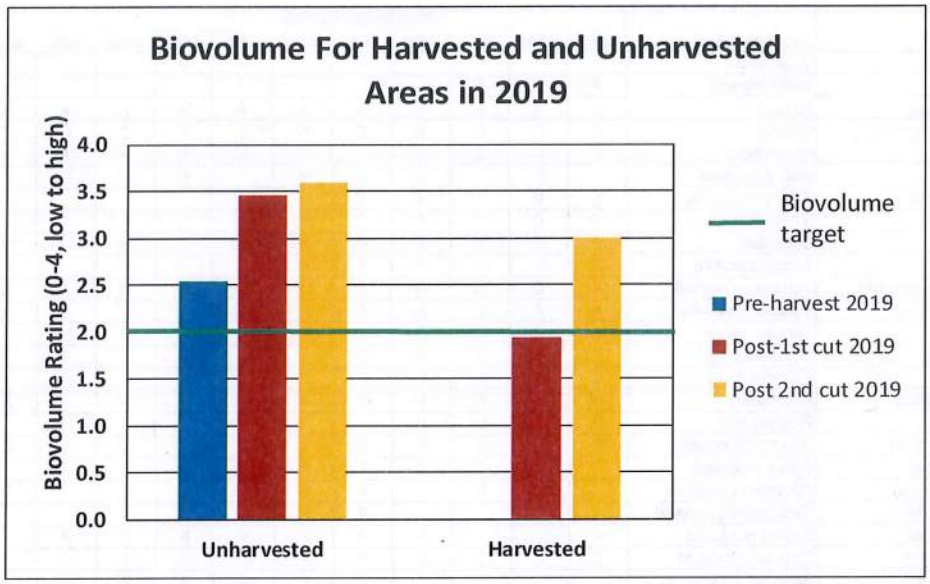
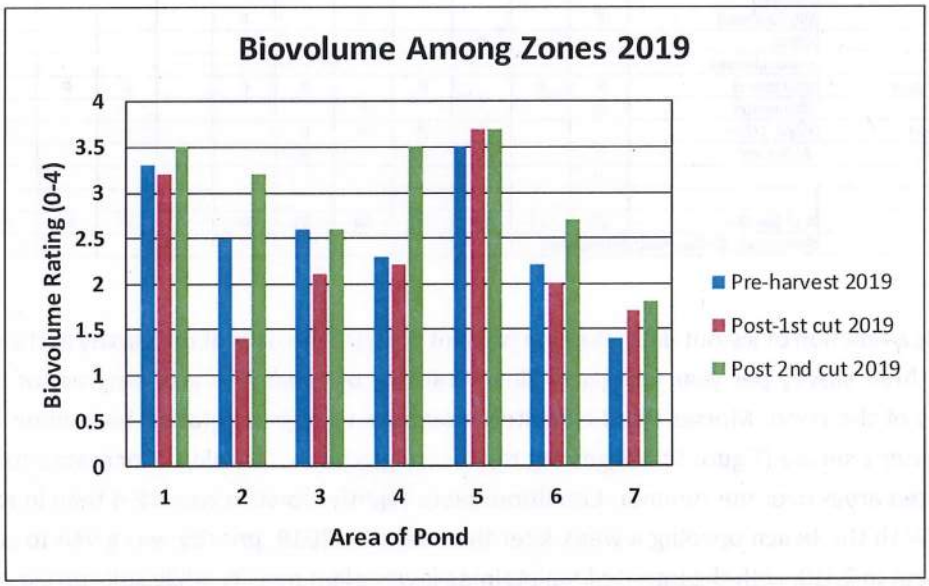


Figure 10. Biovolume comparison over time for each zone in 2019



Dominant plants include fanwort (*Cabomba caroliniana*), variable watermilfoil (*Myriophyllum heterophyllum*) and Eurasian watermilfoil (*M. spicatum*), all invasive species. Other species are locally abundant, but these three invasive species represent most of the submergent plant biomass and are the targets of harvesting. The primary goal of harvesting is to keep these species at low enough biovolume (portion of the water column filled) to minimize interference with recreation and to maximize habitat for