VILLAGE OF SOUTHAMPTON
LAKE AGAWAM ALGAE HARVESTING PHASE I
APPLICATION ATTACHMENTS

VILLAGE OF SOUTHAMPTON
LAKE AGAWAM ALGAE HARVESTING PHASE I

PROJECT SUMMARY

The Village of Southampton proposes an intact cellular microalgae harvesting system for Lake Agawam. The system involves the use of a Hydronucleation Flotation Treatment (HFT) Technology for algae harvesting developed by AECOM. This environmentally friendly algae harvesting process will involve deploying a moored barrier (boom) and weir skimmers across target areas of Lake Agawam. The collected water will be pumped to a land-based algae harvesting and nutrient removing system where the water will be conditioned, and intact cellular microalgae will be separated from the water column and the collected algae slurry (biomass) placed in algae biomass storage tanks prior to being hauled off-site for disposal. Clean clarified water will then be returned to the surface water from where it was removed.

The proposed project represents Phase I of a two-phase effort to install a system capable of treating three million gallons per day (3M GPD) of water from Lake Agawam. Phase I will support engineering design tasks, construction and implementation of a system capable of treating 2M GPD. During first year of operation, the Village and consulting engineer AECOM will monitor system performance and water quality of the lake. These efforts will inform engineering design and implementation for future system expansion to the full 3M GPD capacity. This grant request addresses Phase I costs only.

Use of the algae harvester will provide immediate benefits to Lake Agawam in that it will remove algae that causes harmful algae blooms. The project will also remove nutrients as well as other parameters of concern for water quality. For example, after 1 year of operation, the 2 MGD system is projected to exceed the nitrogen reduction levels anticipated from the Village's planned Sewage Treatment Plant, STP (30% reduction). A 2 MGD harvester is projected to reduce the total nitrogen load to the lake by 35%. In addition, 15% of the total phosphorus load will also be removed. The mass load of TN and TP removed annually is expected to decline as concentrations of these POCs are reduced in the lake and water quality improves with treatment over time.

The project is based on a successful demonstration project funded by New York State in 2020 and implements a recommendation of the Lake Agawam Harmful Algal Bloom Action Plan (NYSDEC, 2020).

3. PROJECT DESCRIPTION

3a. Existing conditions of applicable groundwater/sub-watershed/waterbody and most recent and relevant data available (provide sources).

Lake Agawam has routinely experienced blooms of cyanobacteria. Studies have shown that nitrogen loading to the lake from groundwater discharge, benthic flux and stormwater have contributed to these cyanobacteria blooms.[1]

Nitrogen loading from groundwater is primarily due to on-site wastewater disposal systems (septic and cesspool systems). The recently completed Suffolk County Subwatersheds Wastewater Plan (CDM Smith, 2020) indicates that on-site wastewater systems account for 87 percent of the total nitrogen load to groundwater while fertilizer only accounts for 8.5 percent of the groundwater nitrogen load in the Lake Agawam subwatershed.

Excess nutrients (typically nitrogen and phosphorous) have been causing algal blooms and depleted oxygen levels (hypoxia), which are deleterious to fish and other wildlife. Hypoxic conditions can also occur as a result of long periods of stagnation (lack of mixing) during warm weather, when the water does not readily retain oxygen. Lake Agawam appears on the NYS List of TMDL waters. Harmful Algal Blooms (HABs) with High Toxins have been confirmed by the NYS Department of Environmental Conservation every year from 2013-2021. Existing conditions are well documented, the most recent of include the following:

- Nelson, Pope & Voorhis, LLC (NP&V), Village of Southampton Water Quality Improvement Project Plan, Report prepared for Village of Southampton, Village Board of Trustees, April 2022.

- New York State Department of Environmental Conservation (NYSDEC). Harmful Algal Bloom Action Plan - Lake Agawam. April 2020.[1]

- Gobler, C.J., 2017. Quantifying Nitrogen Loading from Southampton Village to Surrounding Water Bodies and Their Mitigation by Creating a Sewer District, Stony Brook University, School of Marine and Atmospheric Sciences, February 2017.

- Nelson, Pope & Voorhis, LLC (NP&V), 2009. Comprehensive Management Plan for Lake Agawam. Report prepared for Village of Southampton, Village Board of Trustees, June 2009.

[1] https://www.dec.ny.gov/docs/water_pdf/habapagawam.pdf

3b. How the proposed solution addresses the issue in the context of Reduction, Remediation and/or Restoration as per the CPF Water Quality Project Plan. Note all remediation and restoration projects must assure that reduction measures are also addressed.

The Village will design and implement an innovative algae harvesting system to address the growing health risks from the continuous formation of Harmful Algal Blooms (HABs) in Lake Agawam. Algae harvesting is an emerging innovative technology that has been proven as a long-term solution to restore nutrient impacted waterbodies and prevent HABs development. The proposed process uses a Hydronucleation Flotation Technology (HFT) to physically separate the algae cells from the water column intact. By physically removing the algae cells intact, the key nutrients that fuel HAB growth are removed along with any cyanotoxins that are bound in the cells. In addition to exporting the excess nutrients from the lake, carbon, largely derived from atmospheric carbon dioxide, is also exported with the algae. Carbon is the main building block for algae production and comprises approximately 80% of the algae cell. While carbon sequestration is not the primary purpose for implementing this technology, it provides an added benefit in helping to decarbonize the harvesting plant. The clean clarified water from the harvesting operations is returned back to the lake. The clean clarified water will allow sunlight to penetrate deeper through the water column and will allow for growth of submerged aquatic vegetation (SAV). Once the SAV growth is established, the lake will start to show signs of recovery and the algae harvesting operations can be reduced and eventually removed once external sources of nutrients to the lake are controlled. The following tasks are proposed:

- Task 1 – Baseline Testing and Analysis
- Task 2 – Planning and Design Documents
- Task 3 - Algae Harvester System Installation
- Task 4 – Operation and Maintenance
- Task 5 – Monitoring and Reporting

The following conceptual design plans are attached:

- Site Plan (Area of Treatment equals entirety of Lake Agawam)
- Lake Agawam Skimmer and Diffuser Layout
  Figure reflects 3MGD system; layout similar for proposed 2MGD system
- Algae Harvester Treatment System Configuration – Plan View
- Plan View - Lake Agawam Algae Piping Layout
- Lake Agawam Algae Harvester inflow and outflow locations and layout

The attached PowerPoint presentation, entitled *Innovative Algae Harvesting Technology*, provides further information on the technology.

3c. Describe the proposed technology and its demonstrated efficacy in similar settings. May include published data.

The proposed project involves using the HFT process for algae harvesting developed by AECOM. This environmentally friendly algae harvesting process takes advantage of the characteristic of algae to float. Algae-laden water is withdrawn from the water body and conditioned by adding a small amount of commonly used potable water treatment chemicals to create an algae flocculant (floc). Microscopic air bubbles generated by the HFT process attach to algae floc, which imparts buoyancy. The algae floc then floats to the surface of the water in a flotation tank, where it can be skimmed, thereby effectively removing algae and associated nutrients contained within the harvested intact algae cells.

The application of algae removal measures has two major components: 1) algae interception and containment, and 2) physical removal of algae and the key nutrients (nitrogen and phosphorus) that fuel HAB growth from the Lake. The capture of algal biomass will be accomplished by deploying a moored barrier (boom) and six weir skimmers at the north end of the lake. The concentrated algae-rich surface water will then be pumped to the land-based algae harvesting and nutrient removal/treatment system, consisting of liquid/solids separation processes and solids handling process. The primary land-based unit process includes HFT and algae biomass storage tanks along with secondary equipment. Water that has gone through the HFT process (more details on the process below) will be returned to Lake Agawam through a 300-foot-long multiport diffuser system located at the south end of the lake. The diffuser system has been designed to allow discharge of up to 2 MGD of clean clarified water back into Lake Agawam.

Intact cellular algae that is collected/separated from the lake water in the treatment process (i.e. recovered biomass slurry), will be temporarily stored in a 20,000 gallon holding tank adjacent to HFT units. The slurry, which consists of 2% to 3% solids, will then be transported by subcontracted licensed transporters for disposal at a permitted facility such as a wastewater treatment plant (WWTP) or industrial wastewater treatment plant (IWTP), approved land application site, or converted into a feedstock suitable for use in sustainably generating biogas, biofuel, or potentially a soil amendment/fertilizer.

The operational period is anticipated to correlate with Lake Agawam's higher-yield algae production time range (typically from May to October) and is scoped to be 24 hours per day, seven days per week for 180 consecutive days unless otherwise approved by the Village of Southampton.

The purpose of this project is to remove algae from the surface waters of Lake Agawam through a land-based treatment system. The proposed land-based area for deployment of water treatment equipment will involve an approximately 10,000± square foot (SF) area that will include the following components:

- Up to two (2) 1 MGD HFT units (~55 ft x 10 ft each)
- One (1) twenty-thousand gallon holding tank for temporary biomass storage
- Up to four (4) lake water intake pumps (2 pumps for each HFT units)
- One (1) high-density polyethylene (HDPE) or polyvinyl chloride (PVC) intake piping system to provide raw lake water (influent) to HFT units.
- One (1) field trailer for on-site office
- One (1) covered chemical storage area with secondary containment

Proposed locations of the land-based treatment systems will utilize Village of Southampton property as depicted on the attached Figures 1 and 2 provided by AECOM. Inflow and outflow locations are shown in Figure 3.

AECOM's algae harvesting technology was successfully demonstrated in Lake Agawam in 2019. Please see the attached report, *Lake Agawam Innovative Algae Harvesting Demonstration Project* (February 2020), prepared for NYS Department of Environmental Conservation by AECOM. The same technology has been successfully demonstrated in other areas of New York and Florida.[2,3]

3d. How the project supports Town of Southampton, Suffolk County, NYSDEC, Long Island Nitrogen Action Plan (LINAP) or other adopted goals/policies (provide references with pages numbers).

Town of Southampton Water Quality Improvement Project Plan[4]
The plan indicates that aquatic habitat restoration and pollution prevention projects meet State Law Chapter 551 definition of "water quality improvement project." The proposed project addresses both aspects of water quality improvement by improving water quality in the lake. By removing algae from the lake, harmful algal blooms will be avoided. Improved water quality will result in a healthier ecosystem for wildlife and humans. Agawam Lake is shown in the Plan as being situated in a High Priority area. See attached map.

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[2] *Assessment of Nutrient Management Technology Submission: Algae Harvesting Hydronucleation Flotation Technology (HFT)*. H2Ohio Technology Assessment Program Final Report. TetraTech, January 2022.

[3] *Optimizing the Harmful Algal Bloom Interception, Treatment, and Transformation System (HABITATS).* Martin Page, Bruce MacAllister, Marissa Campobasso, Angela Urban, Catherine Thomas, Clinton Cender, Clint Arnett, Craig White, Edith Martinez-Guerra, Ashley Boyd, Elizabeth Gao, Al Kennedy, Tom Biber, Kaytee Pokrzywinski, Chris Grasso, Briana Fernando, Chris Veinotte, Jim Riley, Ashley Gonzalez, Jay Miller, Kathryn Gunderson, Lance Schideman, Yuanhui Zhang, B.K. Sharma, Dan Levy, Bill Colona, David Pinelli, Tammy Karst-Riddoch, and Will Lovins. Technical Report (Engineer Research and Development Center (U.S.)) ; no. ERDC TR-21-18. Available at: https://erdc-library.erdc.dren.mil/jspui/handle/11681/42223

[4] https://www.southamptontownny.gov/DocumentCenter/View/7318/Water-Quality-Improvement-Plan-CPF-Referendum-PDF?bidId=

Lake Agawam Harmful Algal Blooms Action Plan (2020)[5]

The proposed project is listed as a short-term priority project on page 33 under item 5, "Utilize emerging bloom reduction treatments, including hydrogen peroxide and ultrasonic technologies, as well as an algae harvester."

Long Island South Shore Estuary Reserve Comprehensive Management Plan (SSER CMP)[6]

The NYSDEC Priority Waterbodies List (PWL) indicates that the waterbody is adjacent to the South Shore Estuary Reserve (SSER). The SSER CMP is an element of the LI Nitrogen Action Plan. The project is aligned with the CMP because it will improve water quality across several parameters, including nitrogen reduction.

Long Island Nitrogen Action Plan[7]

The project aligns with Action Plan scope, which supports a myriad of nitrogen reduction strategies.

Suffolk County Subwatershed Plan[8]

Agawam Lake is discussed as a water body that has experienced freshwater Harmful Algal Blooms (HABs), and is indicated as a Priority 1 subwatershed for nitrogen reduction via wastewater management (p. 2-74). While the Village is actively planning a sewer system, algae harvesting is a near-term action that will improve water quality. Further, the system will treat legacy nitrogen inputs from groundwater that will continue to flow for a period of time after the sewer system is implemented.

Southampton Village Water Quality Improvement Project Plan (2022)

This plan was funded by Southampton Village and completed April 2022. Section 7.4 describes the project as a strategy for water quality improvement in Lake Agawam, and further notes that the project has been identified by the Village of Southampton Environmental Committee and Clean Water Task Force as a priority project for 2022-2023.

3e. If the project is for habitat restoration: The narrative must address how underlying causes are being ameliorated and expected outcomes for local species populations or other ecological considerations are given.

Studies have shown that nitrogen loading to the lake from groundwater discharge, benthic flux and stormwater have contributed to cyanobacteria blooms in Agawam Lake. External controls implemented to date encompass multiple stormwater management projects that utilize both conventional and green infrastructure practices that intercept and treat stormwater prior to discharge to the lake. Additional projects are planned to design and install yet more bioswales

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[5] https://www.dec.ny.gov/docs/water_pdf/habapagawam.pdf

[6] https://dos.ny.gov/system/files/documents/2021/10/draft-li-sser-cmp-update-2021.pdf

[7] https://www.dec.ny.gov/docs/water_pdf/linapscope.pdf

[8] https://suffolkcountyny.gov/Portals/0/formsdocs/planning/CEQ/2020/RevisedComplete%20SWP2-21-20.pdf

and raingardens in the watershed area to provide maximal diversion and treatment of stormwater. Community education campaigns on lawn maintenance are ongoing.

Southampton Village along with the Center for Clean Water Technology (Stony Brook University) have partnered with CDM Smith to design a permeable reactive barrier (PRB) at the northern portion of the lake, to reduce the nitrogen load from groundwater to the lake. The objective of the study is to pilot the effectiveness of PRBs to remove nitrate from groundwater prior to discharging into the lake. This project is currently in the process of completing its second design phase (collection and evaluation of data supporting design considerations), following which the project will proceed to full design.

The Village is currently planning a sewer system that will service the Village's downtown area. When complete, existing onsite wastewater treatment systems (OWTS) will be abandoned and sanitary wastewater will be conveyed to a sewage treatment plant. Sewering will eliminate a key source of nitrogen in groundwater discharge to the lake.

The proposed algae harvester will improve water quality in Agawam Lake in the near term, before the sewer system is constructed. In addition, it is estimated that residual nutrients will continue to flow into the lake via groundwater flows for a number of years after the sewer system is placed into operation. The clean clarified water that is returned to the lake after the algae is removed will allow sunlight to penetrate deeper through the water column and will allow for growth of submerged aquatic vegetation (SAV). Once the SAV growth is established, the lake will start to show signs of recovery and the algae harvesting operations can be reduced and eventually removed.

4. WATER QUALITY BENEFIT

4a. Identify Nitrogen, Pathogen or Pollutant of Concern (POC) including Existing Condition and Target Reduction.

Use of the algae harvester will provide immediate benefits to Lake Agawam. For example, after 1 year of operation, a 2 MGD system will exceed the nitrogen reduction levels anticipated from the proposed Sewage Treatment Plant, STP (30% reduction). A 2 MGD harvester is projected to reduce the total nitrogen load to the lake by 35%. In addition, 15% of the total phosphorus load will also be removed.

The existing and target reductions for total nitrogen (TN) and total phosphorus (TP) loads to Lake Agawam are summarized in the following table:

Parameter	TP	TN
Existing Condition (lbs/year)	2,276 (1)	25,450 (2)
Target Reduction (lbs/year) (3)	344	8,858
% Load Reduction	15%	35%

NOTES:

1 – from Gobler (2008) and modified to assume a shorter anoxic period of 90 days (instead of 365 days) for the internal TP load component

2 – from Gobler (2017)

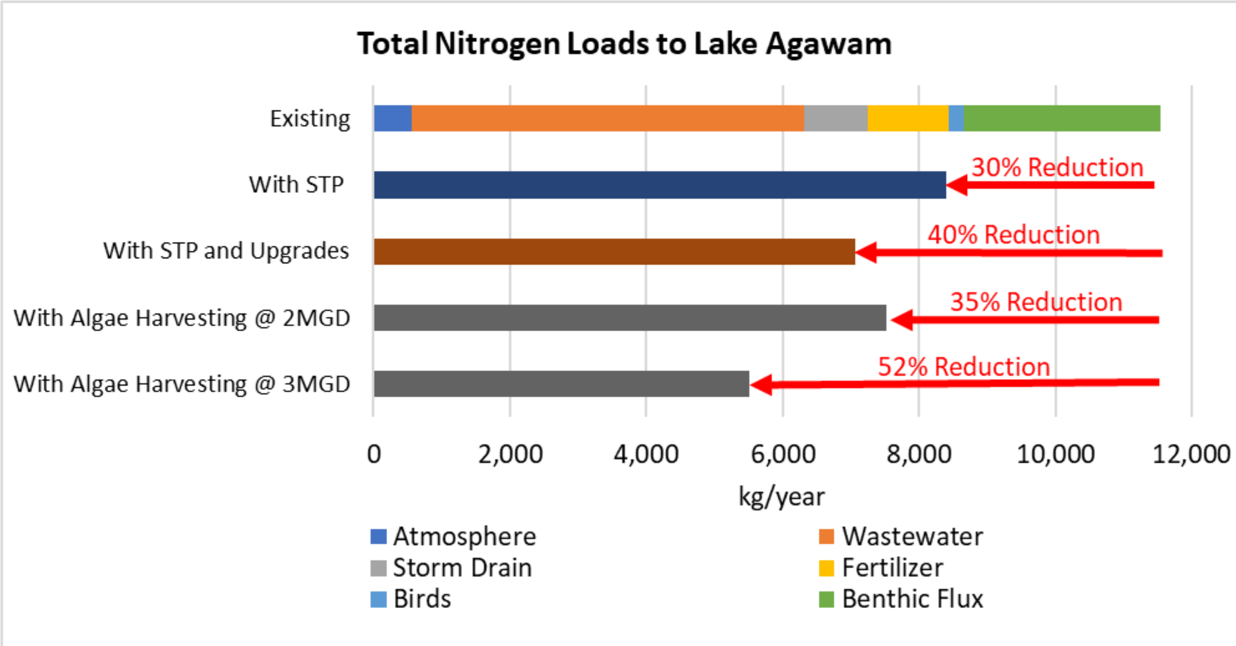
3 – calculated as:

- Concentration (mg/L) x Volume Treated (m^3/year) x % Removal x 2.205 lbs/kg
  And assuming:
  - Average surface water concentrations in Lake Agawam over the open water season of 120 mg/L for TP (Gobler 2017) and 3.64 mg/L for TN (AECOM 2019)
  - A treatment volume of 2 million gallons per day (MGD) and 180 days of treatment per year for a total treatment volume of 360 million gallons (1.4×10^6 m^3/year) (approximately two lake volumes)
  - % removal documented for TP (95%) and TN (82%) documented in the 2019 Lake Agawam Algae Harvesting Demonstration Project (AECOM 2020). These removal rates are consistent with results of multiple other field demonstration studies (USACE 2021, TetraTech 2022)

The mass load of TN and TP removed annually is expected to decline as concentrations of these POCs are reduced in the lake and water quality improves with treatment over time.

The mass load of TN and TP removed annually is expected to decline as concentrations of these POCs are reduced in the lake with treatment over time. Efficiency of the HFT to remove nutrients is expected to maintain effectiveness

The target reduction that can be achieved by algae harvesting is greater than what is estimated with a proposed sewage treatment plant to take Village septic systems offline as illustrated in the figure below.



HFT is anticipated to have multiple additional water quality benefits. In the 2019 Lake Agawam Algae Harvesting Demonstration Project, the process exceeded expectations to remove nutrients as well as other parameters of concern for water quality with average removal efficiencies of:

- >99% Chlorophyll *a* (an indicator of algae biomass)
- >80% Total suspended solids
- >90% Total microcystins and nodularins

The water returned to Lake Agawam following treatment had low algal biomass (average chlorophyll *a* = 0.501 µg/L), total suspended solids (8.5 mg/L) and nutrient levels (average total phosphorus = 0.01 mg/L; average total nitrogen = 0.55 mg/L) that are characteristic of low productivity (oligotrophic) to moderate productivity (mesotrophic) lakes with good water clarity to support aquatic life. DAF treatment also resulted in low concentrations of microcystins (average = 2.0 µg/L) that were below the US Environmental Protection Agency's Recommended Human Health Recreational Ambient Water Quality Criteria value (8 µg/L).

4b. Describe plans for collecting and reporting on water quality over time.

The Village will continue to work with AECOM and Dr. Gobler of the NYS Center for Clean Water Technology for ongoing water quality monitoring.

4c. Indicate useful life of proposed technology (must meet or exceed five years).

The algae harvesters are constructed of high grade stainless steel and have a life expectancy of over 20 years. The motors and other ancillary equipment will exceed 10 years.

5. COST FACTORS

5a. Explain how you have confirmed that the proposed budget is reasonable, appropriate and necessary. If available, provide third party estimates or other documentation of how costs were determined.

The Village has made best efforts to avoid potential cost overruns by engaging an engineering firm that specializes in algae harvesting technology. AECOM has prepared a conceptual design and detailed budget estimate that is based on professional engineering practices, experience designing similar projects, and knowledge of current market conditions. No extraneous or unnecessary costs are included in the budget. The budget estimate is presented in Table 1.

5b. Describe any matching funds to be provided.

The Village proposes 20% matching share, or $1,340,900 to offset Year 1 operating costs.

5c. Explain: i. Why project cannot proceed and intended benefits cannot be achieved without external funding. ii. if funds are awarded at a lower level than requested, or if there are cost overruns, explain how the project will proceed.

The Village has invested substantial funding to complete numerous stormwater remediation and other water quality improvement initiatives throughout the Village. It is also currently working toward design and engineering for a sewer district. Becase its funding needs far outweigh available local resources, the Village has attempted to leverage SCWQPRP, Community Preservation Fund (CPF), NYS, local, and other sources whenever possible. If funds are not awarded by CPF, or are awarded at a lower level than requested, the project may be delayed while funding for the balance of the project budget is identified.

The Village has made best efforts to avoid potential cost overruns by engaging an engineering firm that specializes in algae harvesting technology. AECOM has prepared a conceptual design and detailed budget estimate that is based on professional engineering practices, experience designing similar projects, and knowledge of current market conditions.

Lake Agawam Restoration				
Innovative Algae Harvesting Technology				
Grant Application Budgetary Cost Proposal				
				13-Apr-22
Scope of Work			2 MGD System	
1.0	Baseline Testing and Analysis			
	1.1	Sample Collection	$ 10,000.00	
	1.2	Testing	$ 35,000.00	
	1.3	Evaluation & Analysis	$ 15,000.00	$ 60,000.00
2.0	Planning and Design Documents			
	2.1	Process Design	$ 15,000.00	
	2.2	Electrical Design	$ 15,000.00	
	2.3	Collection & Conveyance System Design	$ 15,000.00	
	2.4	Health and Safety Plan	$ 5,000.00	
	2.5	O&M Plan	$ 10,000.00	
	2.6	Biological Impact Monitoring Plan	$ 15,000.00	$ 75,000.00
3.0	Harvester System Installation			
	3.1	Transportation / Mobization	$ 50,000.00	
	3.2	Electrical connection, service and Installation (allocation)	$ 120,000.00	
	3.3	Hydronucleation Flotation System 2 units (1MGD/ea) - Purchase Price	$ 2,400,000.00	
	3.4	Site Construction and equipment setup	$ 225,000.00	$ 2,795,000.00
4.0	Conveyance and Discharge Installaiton			
	4.1	Extraction System and piping	$ 440,000.00	
	4.2	Marine Installaiton (Diffuser System and piping)	$ 850,000.00	$ 1,290,000.00
5.0	Startup & Commissioning			
	6.1	System Commissioning	$ 40,000.00	
	6.2	Startup and Shakedown	$ 20,000.00	$ 60,000.00
6.0	Year 1 Operation			
	7.1	Year 1 System O&M	$ 1,080,000.00	
	7.2	Water Quality monitoring (laboratory)	$ 120,000.00	
	7.3	Electrical Usage (allocation)	$ 50,000.00	
	7.5	Off-site Disposal of Algae biomass (allocation)	$ 240,000.00	
	7.6	Winterization (allocation)	$ 60,000.00	$ 1,550,000.00
		Total		$ 5,830,000.00
		Contingency - 15%		$ 874,500.00
		Total		$ 6,704,500.00
	Notes			
	1	Permits not included		
	2	Land Based power supply capable of meeting project needs will be available		
	3	Algae recovered from the lake can be disposed locally		

Table 1. Engineer's cost estimate

6. MANAGEMENT, EXPERIENCE, ABILITY

6a. Describe applicant's experience in completing similar projects.

AECOM (NYSE: ACM) is the world's trusted infrastructure consulting firm, delivering professional services throughout the project lifecycle – from planning, design and engineering to program and construction management. On projects spanning transportation, buildings, water, new energy, and the environment, our public- and private-sector clients trust us to solve their most complex challenges. AECOM is a Fortune 500 firm and its Professional Services business had revenue of $13.3 billion in fiscal year 2021. An overview of the firm and biographical statements of key project personnel are attached.

Village Administrator Charlene Kagel-Betts, CPA has more than 20 years of experience in municipal finance, and before joining the Village in 2020, worked as Chief Internal Auditor for East Hampton Town, served as the Southampton Town comptroller, and was chief fiscal officer for the Town of Brookhaven. She began her career as an agent for the Internal Revenue Service in New York City, before going into public accounting and government auditing. Leveraging her depth of experience in municipal management and finance, Ms. Kagel-Betts will provide overight of the procurement process and payment applications submitted by consultants and contractors.

6b. Describe community support or opposition to project. If there is opposition, explain how this is to be addressed.

The Village community is supportive of projects that will improve the health of Lake Agawam and lead to HAB reduction. Please see attached letters of support.

6c. Describe any permits needed and time frame/status of approvals. If permits are approved, indicate same.

A New York State Department of Environmental Conservation (NYSDEC) Article 24 Freshwater Wetlands Permit application will be submitted April 2022. Expected timeframe for approval is 3-6 months. Please see attached project narrative which has been prepared for the permit application; while the permit application addresses the overall 3MGPD system, the information is relevant for the proposed Phase I project.

A wetlands permit from the Village of Southampton Trustees will be sought in coordination with the NYSDEC permit.

7. MAINTENANCE, MONITORING, EVALUATION

Estimate ongoing maintenance costs and explain how these will be supported. Explain stewardship and monitoring activities planned for ensuring sustainability of the project.

The HFT algae harvesters will be operated continuously during the active algae growing season for approximately 6 months (May – Oct). Each harvester will run up to 24 hours per day, 7 days per week during this period. The intent of this project is to physically remove as much of the algae (nutrients) as possible. Intake pumps and equipment will be continuously monitored and adjusted as necessary to maintain optimum efficiency. Biomass recovered from the harvesting operations will be temporarily stored on-site in a 20,000-gallon holding tank. The recovered algae biomass will be routinely hauled off-site for disposal at either a Municipal WWTP or Industrial Waste Treatment Plant. Conventional liquid waste transporter trucks (5,000 – 7,000 gallon capacity) will be used to transport the recovered biomass. Monthly Operating Reports (MORs) for each month of operation will be prepared to summarize the system operations and monitoring results.

8. DURATION OF PROJECT

8a. Provide a projected project timeline.

Please see schedule shown in Table 2.

8b. If project is multi-year or phased, provide a breakdown of budget and milestones for each year and phase.

N/A

Lake Agawam

Algae Harvester Installation and 1 Year O&M Schedule

Task		Scope of Work	NTP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
			Months from Notice to Proceed (NTP)																								
1.0	Baseline Testing and Analysis		3 months																								
	1.1	Sample Collection																									
	1.2	Testing																									
	1.3	Evaluation & Analysis																									
2.0	Planning and Design Documents		3 months																								
	2.1	Process Design																									
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5.0	Startup & Commissioning		2 months																								
	6.1	System Commissioning																									
	6.2	Startup and Shakedown																									
6.0	Year 1 Operation		12 months																								
	7.1	Year 1 System O&M																									
	7.2	Water Quality monitoring																									
	7.5	Off-site Disposal of Algae biomass																									
	7.6	Winterization																									

Table 2. Project Schedule

Village of Southampton

23 MAIN STREET
SOUTHAMPTON, NEW YORK 11968-4899

Phone: (631) 283-0247
Fax: (631) 283-4990
Website: www.southamptonvillage.org

Resolution
2022-824
4/12/2022

Information: RESOLVED, that the Village of Southampton hereby authorizes the Mayor or his designee to execute any and all documents pertaining to the 2022 Town of Southampton Community Preservation Fund Water Quality Improvement Program application to support estimated project costs associated with the following projects:

1. **West Main Street Bioswales - $246,729**
2. **Gin Lane Phase 2 Stormwater Mitigation**
3. **Old Town Pond dredging design/implementation 4,161,597**
4. **Lake Agawam Algae Harvesting**
5. **Old Town Pond Watershed Bioswales - $741,197**
6. **Wickapogue Watershed Bioswales - $361,405**
7. **Phillips Pond Watershed Bioswales - $282,040**

Department:	Village Hall	**Sponsors:**	
Category:	Resolutions	**Functions:**	

Financial Impact

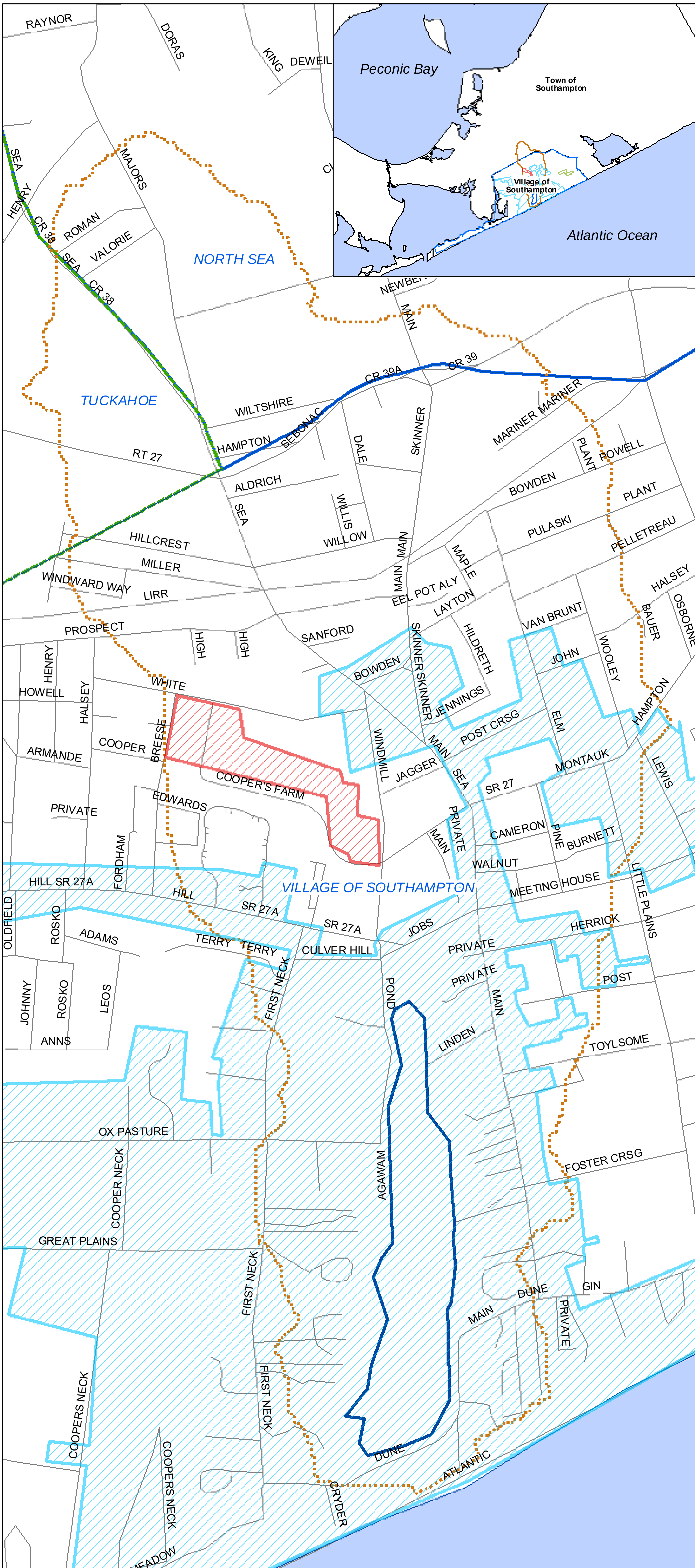
Body

Voting

Motioned: Jesse Warren
Seconded: Joseph McLoughlin
Y: Jesse Warren, Gina Arresta, Joseph McLoughlin, Robin Brown, Roy Stevenson
N: None
A: None
N/A:

Certified By:

Cathy M. Sweeney
Village Clerk
Incorporated Village of Southampton



Village of Southampton

LAKE AGAWAM COMPREHENSIVE MANAGEMENT PLAN

Location Map

SOURCE: NPV (drainage area generation)
SOURCE DATE: November 7, 2007
PRINT DATE: June 18, 2008

Legend

Historic Districts

- Cooper, Captain Mercator, House
- Southampton Village Historic District
- Wickapogue Road Historic District

Hamlets

- North Sea
- Tuckahoe
- Village of Southampton
- Agawam Lake
- Streets
- Agawam Drainage Area

1 inch equals 1,000 feet

NPV

Full Environmental Assessment Form
Part 1 - Project and Setting

Instructions for Completing Part 1

Part 1 is to be completed by the applicant or project sponsor. Responses become part of the application for approval or funding, are subject to public review, and may be subject to further verification.

Complete Part 1 based on information currently available. If additional research or investigation would be needed to fully respond to any item, please answer as thoroughly as possible based on current information; indicate whether missing information does not exist, or is not reasonably available to the sponsor; and, when possible, generally describe work or studies which would be necessary to update or fully develop that information.

Applicants/sponsors must complete all items in Sections A & B. In Sections C, D & E, most items contain an initial question that must be answered either "Yes" or "No". If the answer to the initial question is "Yes", complete the sub-questions that follow. If the answer to the initial question is "No", proceed to the next question. Section F allows the project sponsor to identify and attach any additional information. Section G requires the name and signature of the applicant or project sponsor to verify that the information contained in Part 1is accurate and complete.

A. Project and Applicant/Sponsor Information.

Name of Action or Project: Lake Agawan Algae Skimmer		
Project Location (describe, and attach a general location map): Lake Agawan, Village of Southampton, NY (see attached location map)		
Brief Description of Proposed Action (include purpose or need): The Village is seeking permits for the installation and application of an algae skimmer system to Lake Agawam. The proposed technique involves Hydronucleation Floatation Treatment (HFT) Technology for algae harvesting developed by AECOM. The harvesting process will involve deploying a moored barrier (boom) and a weir skimmer across target areas of Lake Agawam to collect water. The collected water will be pumped to a land-based algae harvesting and nutrient removal system, where the water will be treated, and algae will be separated and placed in algae biomass storage tanks. Treated water will then be returned to the surface water from where it was removed and the separated algae biomass will be properly disposed of. The proposed project is a recommendation of the 2020 NYSDEC Harmful Algal Bloom (HAB) Action Plan. The proposed project will help to improve water quality in the lake and habitat for aquatic life.		
Name of Applicant/Sponsor: Village of Southampton c/o Jesse Warren, Mayor	Telephone: 631-283-0247 E-Mail: jwarren@southamptonvillage.org	
Address: 23 Main Street		
City/PO: Southampton	State: NY	Zip Code: 11968
Project Contact (if not same as sponsor; give name and title/role): Nelson Pope Voorhis, LLC. c/o Charles J. Voorhis, CEP, AICP	Telephone: 631-427-5665 E-Mail: cvoorhis@nelsonpope.com	
Address: 70 Maxess Road		
City/PO: Melville	State: NY	Zip Code: 11747
Property Owner (if not same as sponsor): Same	Telephone: E-Mail:	
Address:		
City/PO:	State:	Zip Code:

B. Government Approvals

B. Government Approvals, Funding, or Sponsorship. ("Funding" includes grants, loans, tax relief, and any other forms of financial assistance.)

Government Entity		If Yes: Identify Agency and Approval(s) Required	Application Date (Actual or projected)
a. City Counsel, Town Board, or Village Board of Trustees	☑Yes☐No	Village of Southampton Trustees; wetlands permit; installation of project	Pending
b. City, Town or Village Planning Board or Commission	☐Yes☑No		
c. City, Town or Village Zoning Board of Appeals	☐Yes☑No		
d. Other local agencies	☐Yes☑No		
e. County agencies	☐Yes☑No		
f. Regional agencies	☐Yes☑No		
g. State agencies	☑Yes☐No	NYSDEC Article 24; Water Quality Certification	Pending
h. Federal agencies	☐Yes☑No		

i. Coastal Resources.

i. Is the project site within a Coastal Area, or the waterfront area of a Designated Inland Waterway? ☑Yes☐No

ii. Is the project site located in a community with an approved Local Waterfront Revitalization Program? ☐Yes☑No

iii. Is the project site within a Coastal Erosion Hazard Area? ☐Yes☑No

C. Planning and Zoning

C.1. Planning and zoning actions.

Will administrative or legislative adoption, or amendment of a plan, local law, ordinance, rule or regulation be the only approval(s) which must be granted to enable the proposed action to proceed? ☐Yes☑No

- **If Yes,** complete sections C, F and G.
- **If No,** proceed to question C.2 and complete all remaining sections and questions in Part 1

C.2. Adopted land use plans.

a. Do any municipally- adopted (city, town, village or county) comprehensive land use plan(s) include the site where the proposed action would be located? ☑Yes☐No

If Yes, does the comprehensive plan include specific recommendations for the site where the proposed action would be located? ☑Yes☐No **Lake Agawam Comprehensive Watershed Management Plan; NPV, 2009

b. Is the site of the proposed action within any local or regional special planning district (for example: Greenway; Brownfield Opportunity Area (BOA); designated State or Federal heritage area; watershed management plan; or other?) ☐Yes☑No

If Yes, identify the plan(s):

c. Is the proposed action located wholly or partially within an area listed in an adopted municipal open space plan, or an adopted municipal farmland protection plan? ☐Yes☑No

If Yes, identify the plan(s):

C.3. Zoning

a. Is the site of the proposed action located in a municipality with an adopted zoning law or ordinance. ☑Yes☐No
If Yes, what is the zoning classification(s) including any applicable overlay district?
n/a; surface water body

b. Is the use permitted or allowed by a special or conditional use permit? n/a; surface water body ☐Yes☑No

c. Is a zoning change requested as part of the proposed action? n/a; surface water body ☐Yes☑No
If Yes,
i. What is the proposed new zoning for the site? ______

C.4. Existing community services.

a. In what school district is the project site located? Southampton Union Free School District (School District ID: 473606)

b. What police or other public protection forces serve the project site?
Southampton Village Police Department

c. Which fire protection and emergency medical services serve the project site?
Southampton Fire Department and Southampton Village Volunteer Ambulance

d. What parks serve the project site?
Agawam Park - Parks Department of the Village of Southampton

D. Project Details

D.1. Proposed and Potential Development

a. What is the general nature of the proposed action (e.g., residential, industrial, commercial, recreational; if mixed, include all components)? mixed: residential and recreational

b. a. Total acreage of the site of the proposed action? 66.4 Lake acres
b. Total acreage to be physically disturbed? 0.5 acres
c. Total acreage (project site and any contiguous properties) owned or controlled by the applicant or project sponsor? 73.9 acres

c. Is the proposed action an expansion of an existing project or use? ☐Yes☑No
i. If Yes, what is the approximate percentage of the proposed expansion and identify the units (e.g., acres, miles, housing units, square feet)? % ______ Units: ______

d. Is the proposed action a subdivision, or does it include a subdivision? ☐Yes☑No
If Yes,
i. Purpose or type of subdivision? (e.g., residential, industrial, commercial; if mixed, specify types)

ii. Is a cluster/conservation layout proposed? ☐Yes☑No
iii. Number of lots proposed? ______
iv. Minimum and maximum proposed lot sizes? Minimum ______ Maximum ______

e. Will the proposed action be constructed in multiple phases? ☐Yes☑No
i. If No, anticipated period of construction: 60 months
ii. If Yes:
- Total number of phases anticipated ______
- Anticipated commencement date of phase 1 (including demolition) ______ month ______ year
- Anticipated completion date of final phase ______ month ______ year
- Generally describe connections or relationships among phases, including any contingencies where progress of one phase may determine timing or duration of future phases: ______

The operational period is anticipated to correlate with Lake Agawam's higher-yield algae production time range (typically from May to October) in the scope of five years, Monday through Friday, during normal business hours unless otherwise approved by the Village of Southampton.

f. Does the project include new residential uses? ☐Yes ☑No
If Yes, show numbers of units proposed.

	One Family	Two Family	Three Family	Multiple Family (four or more)
Initial Phase				
At completion of all phases				

g. Does the proposed action include new non-residential construction (including expansions)? ☐Yes ☑No
If Yes,
i. Total number of structures ___________
ii. Dimensions (in feet) of largest proposed structure: ________height; ________width; and _______ length
iii. Approximate extent of building space to be heated or cooled: ____________________ square feet

h. Does the proposed action include construction or other activities that will result in the impoundment of any liquids, such as creation of a water supply, reservoir, pond, lake, waste lagoon or other storage? ☐Yes ☑No
If Yes,
i. Purpose of the impoundment: ____________________
ii. If a water impoundment, the principal source of the water: ☐ Ground water ☐ Surface water streams ☐Other specify: ____________________
iii. If other than water, identify the type of impounded/contained liquids and their source. ____________________
iv. Approximate size of the proposed impoundment. Volume: ___________ million gallons; surface area: ___________ acres
v. Dimensions of the proposed dam or impounding structure: ________ height; _______ length
vi. Construction method/materials for the proposed dam or impounding structure (e.g., earth fill, rock, wood, concrete): ____________________

D.2. Project Operations

a. Does the proposed action include any excavation, mining, or dredging, during construction, operations, or both? ☐Yes ☑No
(Not including general site preparation, grading or installation of utilities or foundations where all excavated materials will remain onsite)
If Yes:
i. What is the purpose of the excavation or dredging? ____________________
ii. How much material (including rock, earth, sediments, etc.) is proposed to be removed from the site?
- Volume (specify tons or cubic yards): ____________________
- Over what duration of time? ____________________

iii. Describe nature and characteristics of materials to be excavated or dredged, and plans to use, manage or dispose of them. ____________________

iv. Will there be onsite dewatering or processing of excavated materials? ☐Yes ☑No
If yes, describe. ____________________

v. What is the total area to be dredged or excavated? ____________________ acres
vi. What is the maximum area to be worked at any one time? ____________________ acres
vii. What would be the maximum depth of excavation or dredging? ____________________ feet
viii. Will the excavation require blasting? ☐Yes ☐No
ix. Summarize site reclamation goals and plan: ____________________

b. Would the proposed action cause or result in alteration of, increase or decrease in size of, or encroachment into any existing wetland, waterbody, shoreline, beach or adjacent area? ☑Yes ☐No
If Yes:
i. Identify the wetland or waterbody which would be affected (by name, water index number, wetland map number or geographic description): Lake Agawam in the Village of Southampton, NY; Wetland ID: SH-6; Wetland Class: 3; Wetland Size (Acres) - 68.4; installation and operation of surface water treatment facility

ii. Describe how the proposed action would affect that waterbody or wetland, e.g. excavation, fill, placement of structures, or alteration of channels, banks and shorelines. Indicate extent of activities, alterations and additions in square feet or acres:
Proposed project will involve an algae harvesting process deploying a moored barrier (boom) and a weir skimmer across target areas of Lake Agawam. Weir skimmer will be secured to post driven in the lake bottom. Water will only be collected from the top 12 inches of water column. The collected water will be pumped to a land-based algae harvesting and nutrient removing system, where the water will be treated (±3 million gallons per day), and algae will be separated. Treated water will then be returned to the surface waters of Lake Agawam. Algae biomass will be disposed of at an approved upland facility.

iii. Will the proposed action cause or result in disturbance to bottom sediments? ☑Yes ☐No
If Yes, describe: Post driven to lake bottom to secure weir skimmer

iv. Will the proposed action cause or result in the destruction or removal of aquatic vegetation? ☐Yes ☑No
If Yes: **Treatment and removal of algae, only.

- acres of aquatic vegetation proposed to be removed: ____
- expected acreage of aquatic vegetation remaining after project completion: ____
- purpose of proposed removal (e.g. beach clearing, invasive species control, boat access): ____
- proposed method of plant removal: ____
- if chemical/herbicide treatment will be used, specify product(s): ____

v. Describe any proposed reclamation/mitigation following disturbance: ____

c. Will the proposed action use, or create a new demand for water? ☐Yes ☑No
If Yes:
i. Total anticipated water usage/demand per day: ____ gallons/day
ii. Will the proposed action obtain water from an existing public water supply? ☐Yes ☑No
If Yes:

- Name of district or service area: ____
- Does the existing public water supply have capacity to serve the proposal? ☐Yes ☐No
- Is the project site in the existing district? ☐Yes ☐No
- Is expansion of the district needed? ☐Yes ☐No
- Do existing lines serve the project site? ☐Yes ☐No

iii. Will line extension within an existing district be necessary to supply the project? ☐Yes ☑No
If Yes:

- Describe extensions or capacity expansions proposed to serve this project: ____
- Source(s) of supply for the district: ____

iv. Is a new water supply district or service area proposed to be formed to serve the project site? ☐Yes ☑No
If, Yes:

- Applicant/sponsor for new district: ____
- Date application submitted or anticipated: ____
- Proposed source(s) of supply for new district: ____

v. If a public water supply will not be used, describe plans to provide water supply for the project: ____

vi. If water supply will be from wells (public or private), what is the maximum pumping capacity: ____ gallons/minute.

d. Will the proposed action generate liquid wastes? ☐Yes ☑No
If Yes:
i. Total anticipated liquid waste generation per day: ____ gallons/day
ii. Nature of liquid wastes to be generated (e.g., sanitary wastewater, industrial; if combination, describe all components and approximate volumes or proportions of each): ____

iii. Will the proposed action use any existing public wastewater treatment facilities? ☑Yes ☐No
If Yes:

- Name of wastewater treatment plant to be used: Potentially Bergen Point Suffolk County Southwest Sewer District No. 3
- Name of district: Southwest Sewer District; disposal of algae biomass only
- Does the existing wastewater treatment plant have capacity to serve the project? ☑Yes ☐No
- Is the project site in the existing district? ☐Yes ☑No
- Is expansion of the district needed? ☐Yes ☑No

- Do existing sewer lines serve the project site? ☐Yes ☑No
- Will a line extension within an existing district be necessary to serve the project? ☐Yes ☑No

  If Yes:
  - Describe extensions or capacity expansions proposed to serve this project: ____________

iv. Will a new wastewater (sewage) treatment district be formed to serve the project site? ☐Yes ☑No

If Yes:
- Applicant/sponsor for new district: ____________
- Date application submitted or anticipated: ____________
- What is the receiving water for the wastewater discharge? ____________

v. If public facilities will not be used, describe plans to provide wastewater treatment for the project, including specifying proposed receiving water (name and classification if surface discharge or describe subsurface disposal plans): ____________

vi. Describe any plans or designs to capture, recycle or reuse liquid waste: ____________

e. Will the proposed action disturb more than one acre and create stormwater runoff, either from new point sources (i.e. ditches, pipes, swales, curbs, gutters or other concentrated flows of stormwater) or non-point source (i.e. sheet flow) during construction or post construction? ☐Yes ☑No

If Yes:

i. How much impervious surface will the project create in relation to total size of project parcel?

_____ Square feet or _____ acres (impervious surface)

_____ Square feet or _____ acres (parcel size)

ii. Describe types of new point sources. ____________

iii. Where will the stormwater runoff be directed (i.e. on-site stormwater management facility/structures, adjacent properties, groundwater, on-site surface water or off-site surface waters)? ____________

- If to surface waters, identify receiving water bodies or wetlands: ____________
- Will stormwater runoff flow to adjacent properties? ☐Yes ☑No

iv. Does the proposed plan minimize impervious surfaces, use pervious materials or collect and re-use stormwater? ☐Yes ☑No

f. Does the proposed action include, or will it use on-site, one or more sources of air emissions, including fuel combustion, waste incineration, or other processes or operations? ☐Yes ☑No

If Yes, identify:

i. Mobile sources during project operations (e.g., heavy equipment, fleet or delivery vehicles) ____________

ii. Stationary sources during construction (e.g., power generation, structural heating, batch plant, crushers) ____________

iii. Stationary sources during operations (e.g., process emissions, large boilers, electric generation) ____________

g. Will any air emission sources named in D.2.f (above), require a NY State Air Registration, Air Facility Permit, or Federal Clean Air Act Title IV or Title V Permit? ☐Yes ☑No

If Yes:

i. Is the project site located in an Air quality non-attainment area? (Area routinely or periodically fails to meet ambient air quality standards for all or some parts of the year) ☐Yes ☐No

ii. In addition to emissions as calculated in the application, the project will generate:
- ___________Tons/year (short tons) of Carbon Dioxide (CO_2)
- ___________Tons/year (short tons) of Nitrous Oxide (N_2O)
- ___________Tons/year (short tons) of Perfluorocarbons (PFCs)
- ___________Tons/year (short tons) of Sulfur Hexafluoride (SF_6)
- ___________Tons/year (short tons) of Carbon Dioxide equivalent of Hydroflourocarbons (HFCs)
- ___________Tons/year (short tons) of Hazardous Air Pollutants (HAPs)

h. Will the proposed action generate or emit methane (including, but not limited to, sewage treatment plants, landfills, composting facilities)? ☐ Yes ☑ No

If Yes:

i. Estimate methane generation in tons/year (metric): ____________

ii. Describe any methane capture, control or elimination measures included in project design (e.g., combustion to generate heat or electricity, flaring): ____________

i. Will the proposed action result in the release of air pollutants from open-air operations or processes, such as quarry or landfill operations? ☐ Yes ☑ No

If Yes: Describe operations and nature of emissions (e.g., diesel exhaust, rock particulates/dust):

j. Will the proposed action result in a substantial increase in traffic above present levels or generate substantial new demand for transportation facilities or services? ☐ Yes ☑ No

If Yes:

i. When is the peak traffic expected (Check all that apply): ☐ Morning ☐ Evening ☐ Weekend
☐ Randomly between hours of ________ to ________.

ii. For commercial activities only, projected number of truck trips/day and type (e.g., semi trailers and dump trucks): ____________

iii. Parking spaces: Existing ________ Proposed ________ Net increase/decrease ________

iv. Does the proposed action include any shared use parking? ☐ Yes ☐ No

v. If the proposed action includes any modification of existing roads, creation of new roads or change in existing access, describe:

vi. Are public/private transportation service(s) or facilities available within ½ mile of the proposed site? ☐ Yes ☐ No

vii Will the proposed action include access to public transportation or accommodations for use of hybrid, electric or other alternative fueled vehicles? ☐ Yes ☐ No

viii. Will the proposed action include plans for pedestrian or bicycle accommodations for connections to existing pedestrian or bicycle routes? ☐ Yes ☐ No

k. Will the proposed action (for commercial or industrial projects only) generate new or additional demand for energy? ☑ Yes ☐ No

If Yes:

i. Estimate annual electricity demand during operation of the proposed action:
Power consumption of about 61.83 kilowatts (kw) per hour with an average current draw of 23.39 amperes

ii. Anticipated sources/suppliers of electricity for the project (e.g., on-site combustion, on-site renewable, via grid/local utility, or other):
Units will be powered from the local utility (Public Service Electric & Gas Long Island) from a temporary power pole drop

iii. Will the proposed action require a new, or an upgrade, to an existing substation? ☐ Yes ☑ No

l. Hours of operation. Answer all items which apply.

i. During Construction:

- Monday - Friday: Restricted to 8:00 AM thru 6:00 PM
- Saturday: Restricted to 9:00 AM thru 5:00 PM
- Sunday: —
- Holidays: —

ii. During Operations:

- Monday - Friday: normal business hours
- Saturday: ________
- Sunday: ________
- Holidays: ________

m. Will the proposed action produce noise that will exceed existing ambient noise levels during construction, operation, or both? ☑ Yes ☐ No

If yes:

i. Provide details including sources, time of day and duration:

Noise levels are not expected to exceed 60 decibels (dB) at a distance of 20 feet from the HFT unit(s) during normal business hours Monday-Friday 8:00 AM thru 6:00 PM, unless otherwise approved by the Village of Southampton

ii. Will the proposed action remove existing natural barriers that could act as a noise barrier or screen? ☐ Yes ☑ No

Describe: ______

n. Will the proposed action have outdoor lighting? ☐ Yes ☑ No

If yes:

i. Describe source(s), location(s), height of fixture(s), direction/aim, and proximity to nearest occupied structures:

______

ii. Will proposed action remove existing natural barriers that could act as a light barrier or screen? ☐ Yes ☑ No

Describe: ______

o. Does the proposed action have the potential to produce odors for more than one hour per day? ☐ Yes ☑ No

If Yes, describe possible sources, potential frequency and duration of odor emissions, and proximity to nearest occupied structures: ______

p. Will the proposed action include any bulk storage of petroleum (combined capacity of over 1,100 gallons) or chemical products 185 gallons in above ground storage or any amount in underground storage? ☐ Yes ☑ No

If Yes:

i. Product(s) to be stored ______

ii. Volume(s) ______ per unit time ______ (e.g., month, year)

iii. Generally, describe the proposed storage facilities: ______

q. Will the proposed action (commercial, industrial and recreational projects only) use pesticides (i.e., herbicides, insecticides) during construction or operation? ☑ Yes ☐ No

If Yes:

i. Describe proposed treatment(s):

The proposed project involves Hydronucleation Floatation Treatment (HFT) Technology for algae harvesting developed by AECOM. The HFT process starts with conditioning the algae in the water column for removal by introducing low dosages of National Sanitation Foundation (NSF) international approved chemicals commonly used in the potable and wastewater treatment industry. As the water flows through a series of treatment mixing tanks, the chemicals cause the algae biomass to coagulate in a large mass which it floats to the top of the tank and is separated from the water. Information on specific chemicals to be used is provided in an attached project narrative.

ii. Will the proposed action use Integrated Pest Management Practices? ☑ Yes ☐ No

r. Will the proposed action (commercial or industrial projects only) involve or require the management or disposal of solid waste (excluding hazardous materials)? ☑ Yes ☐ No

If Yes:

i. Describe any solid waste(s) to be generated during construction or operation of the facility: See attached project narrative

- Construction: ______ tons per ______ (unit of time)
- Operation : ______ tons per ______ (unit of time) Algae biomass; quantity based on bloom/treatment

ii. Describe any proposals for on-site minimization, recycling or reuse of materials to avoid disposal as solid waste:

- Construction: ______
- Operation: ______

iii. Proposed disposal methods/facilities for solid waste generated on-site:

- Construction: ______
- Operation: Potentially Bergen Point Suffolk County Southwest Sewer District No. 3

s. Does the proposed action include construction or modification of a solid waste management facility? ☐ Yes ☑ No

If Yes:

i. Type of management or handling of waste proposed for the site (e.g., recycling or transfer station, composting, landfill, or other disposal activities): ______

ii. Anticipated rate of disposal/processing:

- ________ Tons/month, if transfer or other non-combustion/thermal treatment, or
- ________ Tons/hour, if combustion or thermal treatment

iii. If landfill, anticipated site life: ______________ years

t. Will the proposed action at the site involve the commercial generation, treatment, storage, or disposal of hazardous waste? ☐ Yes ☑ No

If Yes:

i. Name(s) of all hazardous wastes or constituents to be generated, handled or managed at facility: ______

ii. Generally describe processes or activities involving hazardous wastes or constituents: ______

iii. Specify amount to be handled or generated _____ tons/month

iv. Describe any proposals for on-site minimization, recycling or reuse of hazardous constituents: ______

v. Will any hazardous wastes be disposed at an existing offsite hazardous waste facility? ☐ Yes ☐ No

If Yes: provide name and location of facility: ______

If No: describe proposed management of any hazardous wastes which will not be sent to a hazardous waste facility: ______

E. Site and Setting of Proposed Action

E.1. Land uses on and surrounding the project site

a. Existing land uses.

i. Check all uses that occur on, adjoining and near the project site.

☐ Urban ☐ Industrial ☐ Commercial ☑ Residential (suburban) ☐ Rural (non-farm)
☐ Forest ☐ Agriculture ☑ Aquatic ☑ Other (specify): Recreational

ii. If mix of uses, generally describe:

Project site is mainly Lake Agawam (aquatic). Many residential properties border Lake Agawam as well as several public access areas including Agawam Park

b. Land uses and covertypes on the project site.

Land use or Covertype	Current Acreage	Acreage After Project Completion	Change (Acres +/-)
• Roads, buildings, and other paved or impervious surfaces			
• Forested			
• Meadows, grasslands or brushlands (non-agricultural, including abandoned agricultural)			
• Agricultural (includes active orchards, field, greenhouse etc.)			
• Surface water features (lakes, ponds, streams, rivers, etc.)	64.73	64.73	0
• Wetlands (freshwater or tidal)			
• Non-vegetated (bare rock, earth or fill)			
• Other Describe: ______			

c. Is the project site presently used by members of the community for public recreation? ☐Yes ☑No

i. If Yes: explain: Lake Agawam is not actively used due to the microcystin toxin presence in blue green algae; was previously used for recreational fishing; adjacent to Agawam Park

d. Are there any facilities serving children, the elderly, people with disabilities (e.g., schools, hospitals, licensed day care centers, or group homes) within 1500 feet of the project site? ☐Yes ☑No

If Yes,

i. Identify Facilities: ____________________

e. Does the project site contain an existing dam? ☐Yes ☑No

If Yes:

i. Dimensions of the dam and impoundment:

- Dam height: ____________ feet
- Dam length: ____________ feet
- Surface area: ____________ acres
- Volume impounded: ____________ gallons OR acre-feet

ii. Dam's existing hazard classification: ____________

iii. Provide date and summarize results of last inspection: ____________

f. Has the project site ever been used as a municipal, commercial or industrial solid waste management facility, or does the project site adjoin property which is now, or was at one time, used as a solid waste management facility? ☐Yes ☑No

If Yes:

i. Has the facility been formally closed? ☐Yes ☐ No

- If yes, cite sources/documentation: ____________

ii. Describe the location of the project site relative to the boundaries of the solid waste management facility: ____________

iii. Describe any development constraints due to the prior solid waste activities: ____________

g. Have hazardous wastes been generated, treated and/or disposed of at the site, or does the project site adjoin property which is now or was at one time used to commercially treat, store and/or dispose of hazardous waste? ☐Yes ☑No

If Yes:

i. Describe waste(s) handled and waste management activities, including approximate time when activities occurred: ____________

h. Potential contamination history. Has there been a reported spill at the proposed project site, or have any remedial actions been conducted at or adjacent to the proposed site? ☐Yes ☑ No

If Yes:

i. Is any portion of the site listed on the NYSDEC Spills Incidents database or Environmental Site Remediation database? Check all that apply: ☐Yes ☑No

☐ Yes – Spills Incidents database Provide DEC ID number(s): ____________

☐ Yes – Environmental Site Remediation database Provide DEC ID number(s): ____________

☐ Neither database

ii. If site has been subject of RCRA corrective activities, describe control measures: ____________

iii. Is the project within 2000 feet of any site in the NYSDEC Environmental Site Remediation database? ☐Yes ☑No

If yes, provide DEC ID number(s): ____________

iv. If yes to (i), (ii) or (iii) above, describe current status of site(s): ____________

v. Is the project site subject to an institutional control limiting property uses? • If yes, DEC site ID number: _____ • Describe the type of institutional control (e.g., deed restriction or easement): _____ • Describe any use limitations: _____ • Describe any engineering controls: _____ • Will the project affect the institutional or engineering controls in place? • Explain: _____	☐Yes ☑No ☐Yes ☐No
E.2. Natural Resources On or Near Project Site	
a. What is the average depth to bedrock on the project site? ± 1500 feet	
b. Are there bedrock outcroppings on the project site? If Yes, what proportion of the site is comprised of bedrock outcroppings? _____ %	☐Yes ☑No
c. Predominant soil type(s) present on project site: N/A Lake Agawam, disturbance to bottom sediments very small for skimmer stabilization ___ % ___ % ___ %	
d. What is the average depth to the water table on the project site? Average: _____ feet	
e. Drainage status of project site soils: ☐ Well Drained: N/A % of site ☐ Moderately Well Drained: ___ % of site ☐ Poorly Drained ___ % of site	
f. Approximate proportion of proposed action site with slopes: ☑ 0-10%: 100 % of site ☐ 10-15%: ___ % of site ☐ 15% or greater: ___ % of site	
g. Are there any unique geologic features on the project site? If Yes, describe: _____	☐Yes ☑No
h. Surface water features. *i.* Does any portion of the project site contain wetlands or other waterbodies (including streams, rivers, ponds or lakes)? *ii.* Do any wetlands or other waterbodies adjoin the project site? If Yes to either *i* or *ii*, continue. If No, skip to E.2.i. *iii.* Are any of the wetlands or waterbodies within or adjoining the project site regulated by any federal, state or local agency? *iv.* For each identified regulated wetland and waterbody on the project site, provide the following information: • Streams: Name _____ Classification _____ • Lakes or Ponds: Name 923-25 Classification C • Wetlands: Name Federal Waters, NYS Wetland, Federal Waters, Fe... Approximate Size NYS Wetland (in a... • Wetland No. (if regulated by DEC) SH-6 *v.* Are any of the above water bodies listed in the most recent compilation of NYS water quality-impaired waterbodies? If yes, name of impaired water body/bodies and basis for listing as impaired: _____	 ☑Yes ☐No ☑Yes ☐No ☑Yes ☐No ☐Yes ☑No
i. Is the project site in a designated Floodway?	☐Yes ☑No
j. Is the project site in the 100-year Floodplain?	☑Yes ☐No
k. Is the project site in the 500-year Floodplain?	☐Yes ☑No
l. Is the project site located over, or immediately adjoining, a primary, principal or sole source aquifer? If Yes: *i.* Name of aquifer: Sole Source Aquifer Names:Nassau-Suffolk SSA	☑Yes ☐No

m. Identify the predominant wildlife species that occupy or use the project site:

Largemouth Bass	White Perch	Mallard Ducks
Bluegill	Carp	
Pumpkinseed	Brown Bullhead	

n. Does the project site contain a designated significant natural community? ☑ Yes ☐ No

If Yes:

i. Describe the habitat/community (composition, function, and basis for designation): Marine Intertidal Gravel/Sand Beach, Maritime Beach

ii. Source(s) of description or evaluation: ____________

iii. Extent of community/habitat:

- Currently: 529.63, 293.64 acres
- Following completion of project as proposed: ____________ acres
- Gain or loss (indicate + or -): ____________ acres

o. Does project site contain any species of plant or animal that is listed by the federal government or NYS as endangered or threatened, or does it contain any areas identified as habitat for an endangered or threatened species? ☑ Yes ☐ No

If Yes:

i. Species and listing (endangered or threatened): Piping Plover, Least Tern, Northern Long-eared Bat

p. Does the project site contain any species of plant or animal that is listed by NYS as rare, or as a species of special concern? ☐ Yes ☑ No

If Yes:

i. Species and listing: ____________

q. Is the project site or adjoining area currently used for hunting, trapping, fishing or shell fishing? ☐ Yes ☑ No

If yes, give a brief description of how the proposed action may affect that use: ____________

E.3. Designated Public Resources On or Near Project Site

a. Is the project site, or any portion of it, located in a designated agricultural district certified pursuant to Agriculture and Markets Law, Article 25-AA, Section 303 and 304? ☐ Yes ☑ No

If Yes, provide county plus district name/number: ____________

b. Are agricultural lands consisting of highly productive soils present? ☐ Yes ☑ No

i. If Yes: acreage(s) on project site? ____________

ii. Source(s) of soil rating(s): ____________

c. Does the project site contain all or part of, or is it substantially contiguous to, a registered National Natural Landmark? ☐ Yes ☑ No

If Yes:

i. Nature of the natural landmark: ☐ Biological Community ☐ Geological Feature

ii. Provide brief description of landmark, including values behind designation and approximate size/extent: ____________

d. Is the project site located in or does it adjoin a state listed Critical Environmental Area? ☐ Yes ☑ No

If Yes:

i. CEA name: ____________

ii. Basis for designation: ____________

iii. Designating agency and date: ____________

e. Does the project site contain, or is it substantially contiguous to, a building, archaeological site, or district which is listed on the National or State Register of Historic Places, or that has been determined by the Commissioner of the NYS Office of Parks, Recreation and Historic Preservation to be eligible for listing on the State Register of Historic Places? ☑ Yes ☐ No

If Yes:

i. Nature of historic/archaeological resource: ☐ Archaeological Site ☑ Historic Building or District

ii. Name: Southampton Village Historic District

iii. Brief description of attributes on which listing is based:

f. Is the project site, or any portion of it, located in or adjacent to an area designated as sensitive for archaeological sites on the NY State Historic Preservation Office (SHPO) archaeological site inventory? ☑ Yes ☐ No

g. Have additional archaeological or historic site(s) or resources been identified on the project site? ☑ Yes ☐ No

If Yes:

i. Describe possible resource(s): World War Memorial at Agawam Park adjacent to site; partially within an area of archaeological sensitivity

ii. Basis for identification: OPRHP Cultural Resources Information System

h. Is the project site within fives miles of any officially designated and publicly accessible federal, state, or local scenic or aesthetic resource? ☐ Yes ☑ No

If Yes:

i. Identify resource: __________

ii. Nature of, or basis for, designation (e.g., established highway overlook, state or local park, state historic trail or scenic byway, etc.): __________

iii. Distance between project and resource: __________ miles.

i. Is the project site located within a designated river corridor under the Wild, Scenic and Recreational Rivers Program 6 NYCRR 666? ☐ Yes ☑ No

If Yes:

i. Identify the name of the river and its designation: __________

ii. Is the activity consistent with development restrictions contained in 6NYCRR Part 666? ☐ Yes ☐ No

F. Additional Information

Attach any additional information which may be needed to clarify your project.

If you have identified any adverse impacts which could be associated with your proposal, please describe those impacts plus any measures which you propose to avoid or minimize them.

G. Verification

I certify that the information provided is true to the best of my knowledge.

Applicant/Sponsor Name Jesse M. Warren Date 4.14.2022

Signature [signature] Title Mayor

PRINT FORM

Disclaimer: The EAF Mapper is a screening tool intended to assist project sponsors and reviewing agencies in preparing an environmental assessment form (EAF). Not all questions asked in the EAF are answered by the EAF Mapper. Additional information on any EAF question can be obtained by consulting the EAF Workbooks. Although the EAF Mapper provides the most up-to-date digital data available to DEC, you may also need to contact local or other data sources in order to obtain data not provided by the Mapper. Digital data is not a substitute for agency determinations.

B.i.i [Coastal or Waterfront Area]	Yes
B.i.ii [Local Waterfront Revitalization Area]	No
C.2.b. [Special Planning District]	Digital mapping data are not available or are incomplete. Refer to EAF Workbook.
E.1.h [DEC Spills or Remediation Site - Potential Contamination History]	Digital mapping data are not available or are incomplete. Refer to EAF Workbook.
E.1.h.i [DEC Spills or Remediation Site - Listed]	Digital mapping data are not available or are incomplete. Refer to EAF Workbook.
E.1.h.i [DEC Spills or Remediation Site - Environmental Site Remediation Database]	Digital mapping data are not available or are incomplete. Refer to EAF Workbook.
E.1.h.iii [Within 2,000' of DEC Remediation Site]	No
E.2.g [Unique Geologic Features]	No
E.2.h.i [Surface Water Features]	Yes
E.2.h.ii [Surface Water Features]	Yes
E.2.h.iii [Surface Water Features]	Yes - Digital mapping information on local and federal wetlands and waterbodies is known to be incomplete. Refer to EAF Workbook.
E.2.h.iv [Surface Water Features - Lake/Pond Name]	923-25
E.2.h.iv [Surface Water Features - Lake/Pond Classification]	C
E.2.h.iv [Surface Water Features - Wetlands Name]	Federal Waters, NYS Wetland
E.2.h.iv [Surface Water Features - Wetlands Size]	NYS Wetland (in acres):68.4
E.2.h.iv [Surface Water Features - DEC Wetlands Number]	SH-6
E.2.h.v [Impaired Water Bodies]	No

E.2.i. [Floodway]	No
E.2.j. [100 Year Floodplain]	Yes
E.2.k. [500 Year Floodplain]	No
E.2.l. [Aquifers]	Yes
E.2.l. [Aquifer Names]	Sole Source Aquifer Names:Nassau-Suffolk SSA
E.2.n. [Natural Communities]	Yes
E.2.n.i [Natural Communities - Name]	Marine Intertidal Gravel/Sand Beach, Maritime Beach
E.2.n.i [Natural Communities - Acres]	529.63, 293.64
E.2.o. [Endangered or Threatened Species]	Yes
E.2.o. [Endangered or Threatened Species - Name]	Piping Plover, Least Tern, Northern Long-eared Bat (does not apply to location where they are installing algae skimmer).
E.2.p. [Rare Plants or Animals]	No
E.3.a. [Agricultural District]	No
E.3.c. [National Natural Landmark]	No
E.3.d [Critical Environmental Area]	No
E.3.e. [National or State Register of Historic Places or State Eligible Sites]	Yes - Digital mapping data for archaeological site boundaries are not available. Refer to EAF Workbook.
E.3.e.ii [National or State Register of Historic Places or State Eligible Sites - Name]	Southampton Village Historic District
E.3.f. [Archeological Sites]	Yes
E.3.i. [Designated River Corridor]	No

Project Narrative

Lake Agawam Algae Harvester Project
Village of Southampton, Suffolk County, NY

Prepared by: AECOM
Nelson Pope Voorhis

Prepared for: New York State Dept. of Environmental Conservation
Village of Southampton

Date: April 12, 2022

1.0 Overview and Summary Project Description

The Village of Southampton seeks regulatory approval for the installation and operation of an intact cellular microalgae harvesting system for Lake Agawam. The proposed project involves the use of a Hydronucleation Floatation Treatment (HFT) Technology for algae harvesting developed by AECOM. This environmentally friendly algae harvesting process will involve deploying a moored barrier (boom) and weir skimmers across target areas of Lake Agawam. The collected water will be pumped to a land-based algae harvesting and nutrient removing system where the water will be conditioned, and intact cellular microalgae will be separated from the water column and the collected algae slurry (biomass) placed in algae biomass storage tanks prior to being hauled off-site for disposal. Clean clarified water will then be returned to the surface water from where it was removed. Since work will involve taking water from Lake Agawam (and returning that same clarified water to the lake), the Village of Southampton will obtain a New York State Department of Environmental Conservation (NYSDEC) Article 24 Freshwater Wetlands Permit.

2.0 Site Location, Existing Conditions, Background & Need

Lake Agawam has an average depth of 6.5 feet, and the volume is approximately 208 million gallons. The surrounding watershed encompasses approximately 1,145 acres in the Village of Southampton [Nelson, Pope & Voorhis, LLC (NPV), 2009]. The shoreline length of Lake Agawam is approximately 1.92 miles long and there is a fetch across the lake of approximately 4,265 feet (ft), or 0.81 miles. The depth remains relatively constant at the midsections of the lake, with shallow areas near the shoreline.

According to the Lake Agawam Conservancy (LAC), pollutants from roadways, lawn chemicals, and impacts from old septic systems throughout the watershed are negatively impacting Lake Agawam, causing harmful algal blooms that devastate the ecosystem and can potentially cause serious health problems for people and pets. Currently, Lake Agawam is not used for recreational purposes due to harmful algal blooms (NYSDEC, 2016). Since 2014, the lake has experienced periodic closures for recreation and fishing during the summer months (Gobler, 2017). Given the impaired water quality conditions and presence of harmful algae, the NYSDEC prepared a Harmful Algal Bloom (HAB) Action Plan for Lake Agawam in April 2020. This plan seeks priority short-term, mid-term and long-term projects to improve water quality in the lake. Section 11.4 (Research Activities) of this report provided information on a pilot program to remove harmful algae from the lake. The HAB Action plan provides the following summary of these activities:

> "As stated previously, SUNY Stony Brook's monitoring comprises much of the research on Lake Agawam to date. HAB monitoring and reporting through DEC has also been performed by SUNY Stony Brook since 2012. Under Governor Cuomo's HABs Initiative, an innovative new project to combat harmful algal blooms (HABs) was piloted in Lake Agawam. The algae harvester successfully removed cyanobacteria and toxins during the 10-day pilot. DEC is continuing to review and evaluate the results. DEC, Southampton Village, and Lake Agawam stakeholders continue to work together to identify solutions to address the long-term health of Lake Agawam."

Section 12.3 (Lake Agawam Priority Projects) lists the recommendations for water quality improvement and control of HABs. Under Priority Projects 1, Short-term (0-3 year), recommendation 5 is as follows:

> 5. Utilize emerging bloom reduction treatments, including hydrogen peroxide and ultrasonic technologies, as well as an algae harvester.

This project is in direct response to this recommendation as outlined in the NYSDEC HAB Action Plan. Use of an algae harvester is one of many projects that are being pursued by the Village of Southampton, the Town of Southampton and the LAC as well as other levels of government, toward water quality improvement in Lake Agawam.

3.0 Detailed Project Description

The proposed project involves using the HFT process for algae harvesting developed by AECOM. This environmentally friendly algae harvesting process takes advantage of the characteristic of algae to float. Algae-laden water is withdrawn from the water body and conditioned by adding a small amount of commonly used potable water treatment chemicals to create an algae flocculant (floc). Microscopic air bubbles generated by the HFT process attach to algae floc, which imparts buoyancy. The algae floc then floats to the surface of the water in a flotation tank, where it can be skimmed, thereby effectively removing algae and associated nutrients contained within the harvested intact algae cells.

The application of algae removal measures has two major components: 1) algae interception and containment, and 2) physical removal of algae and the key nutrients (nitrogen and phosphorus) that fuel HAB growth from the Lake. The capture of algal biomass will be accomplished by deploying a moored barrier (boom) and six weir skimmers at the north end of the lake. The concentrated algae-rich surface water will then be pumped to the land-based algae harvesting and nutrient removal/treatment system, consisting of liquid/solids separation processes and solids handling process. The primary land-based unit process includes HFT and algae biomass storage tanks along with secondary equipment. Water that has gone through the HFT process (more details on the process below) will be returned to Lake Agawam through a 300-foot-long multiport diffuser system located at the south end of the lake. The diffuser system has been designed to allow discharge of up to 3 MGD of clean clarified water back into Lake Agawam.

Intact cellular algae that is collected/separated from the lake water in the treatment process (i.e. recovered biomass slurry), will be temporarily stored in a 20,000 holding tank adjacent to HFT units. The slurry, which consists of 2% to 3% solids, will then be transported by subcontracted licensed transporters for disposal at a permitted facility such as a wastewater treatment plant (WWTP) or industrial wastewater treatment plant (IWTP), approved land application site, or converted into a feedstock suitable for use in sustainably generating biogas, biofuel, or potentially a soil amendment/fertilizer.

The operational period is anticipated to correlate with Lake Agawam's higher-yield algae production time range (typically from May to October) and is scoped to be 24 hours per day, seven days per week for 180 consecutive days unless otherwise approved by the Village of Southampton.

4.0 Project Equipment

The purpose of this project is to remove algae from the surface waters of Lake Agawam through a land-based treatment system. The proposed land-based area for deployment of water treatment equipment will involve an approximately 10,000± square foot (SF) area that will include the following components:

- Up to three (3) 1 MGD HFT units (~55 ft x 10 ft each)
- One (1) twenty-thousand gallon holding tank for temporary biomass storage
- Up to six (6) lake water intake pumps (2 pumps for each HFT units)
- One (1) high-density polyethylene (HDPE) or polyvinyl chloride (PVC) intake piping system to provide raw lake water (influent) to HFT units.
- One (1) field trailer for on-site office
- One (1) covered chemical storage area with secondary containment

Proposed locations of the land-based treatment systems will utilize Village of Southampton property as depicted on the attached illustration provided by AECOM (**Attachment A)**. The final location will be confirmed by the Village of Southampton.

Units will be powered from the local utility (Public Service Electric & Gas Long Island) from a temporary power pole drop. HFT system noise levels are not expected to exceed 60 decibels (dB) at a distance of 20 feet.

Water-based equipment will include:

- Intake Structures:
  - Up to six weir skimmers approximately 50 ft apart (3 MGD total inflow) are to be used as a water intake structures. The skimmers will be fitted with several smaller mesh size strainers to help prevent clogging. Each skimmer will be attached to an 8-inch flexible suction hose deployed in the water, anywhere from 10-100 feet from the shoreline, possibly farther, depending on water depth. A suction hose then runs to the shore where it is attached to hard piping leading to the intake pump, then discharged from the pump through hard piping to the harvester. A skimmer can be replaced with a foot valve positioned just below the water's surface. The skimmers and foot valves will be anchored in place using a poles driven into the lake bottom and marked with flagging (and possibly lighting) to alert of its location. Skimmers will be placed at the north end of the lake at a water depth of about 4.5 ft. It is possible that a V-Boom with an 18-inch curtain to help gather floating algae will also be utilized.

- Outflow Structure:
  - A 300 ft long Multiport Diffuser System (MDS) capable of discharging up to 3 MGD of clean clarified water back into the lake will be at located at the south end of the lake at water depth of about 10 ft. The MDS will be anchored on the lake bottom using concrete mats.

During the off season, the intake and outflow structures/piping will remain in place. The piping in the lake will be anchored on the lake bottom using sandbags and/or concrete mats and marked with floating surface buoys to identify location.

5.0 Hydronucleation Flotation Treatment Technology for Algae Harvesting

HFT involves liquid/solid separation of intact cellular algae which is an effective method and solution to restoring nutrient impaired waterbodies. By physically removing the intact cellular algae from the water, the nutrients contained within the cell wall of the algae are also removed, eliminating the sources (nitrogen and phosphorous) of harmful algal blooms. The work proposed herein is a scaled-up version of a 2019 Pilot Project completed at Lake Agawam in 2019 by AECOM under an OGS/NYSDEC Quality Assurance Project Plan (QAPP) executed on September 30, 2019 and later amended on October 16, 2019 following the requirements set forth in the US Environmental Protection Agency (EPA) Requirements for Quality Assurance Project Plans (QA/R-

5) - March 2001 (Reissued May 2006), EPA/240/B-01/003, and other applicable guidance provided on USEPA's Quality Assurance website (www.epa.gov/quality/qapps.html).
The HFT process starts with conditioning the algae in the water column for removal by introducing low dosages of National Sanitation Foundation (NSF) internationally approved chemicals commonly used in the potable and wastewater treatment industry. As the water flows through a series of treatment mixing tanks, the chemicals cause the algae biomass to coagulate, or "clump" together in a large mass to create a flocculant. Microscopic air bubbles, generated by the process, attach to the algae floc, which makes it buoyant. The algae floc then floats to the surface of the water, where it forms a dense mat layer, which is then separated from the water by a chain and flight collector or skimmer that moves across the top of the flotation tank and into an algae slurry holding tank. The chemicals are largely contained in the dense slurry that is produced by the algae harvester with very small (de-minimis) concentrations in the discharged water returned back to the lake.

Chemicals that will be used for the coagulation and flocculation treatment processes will be determined based on results from a screening process using water samples from Lake Agawam. Conditioned lake water samples exhibiting favorable characteristics will be floated using a bench-scale flotation testing technique and further assessed. *Specific chemicals that will undergo this screening process are listed in* ***Figure 1*** *below*. Benchwork will use 300 milliliter (mL) sample aliquots and a precise amount of diluted treatment chemical will be added using 1 mL syringes. Mixing will be done manually using a stainless-steel spatula. Selected chemically treated samples will then be floated in a bench-scale flotation test apparatus comprising a 500 mL graduated separatory funnel as the flotation vessel and a 0.5 L, handheld, aluminum pressure vessel for simulation of the treatment process. This testing technique will generate valuable information about the full-scale treatment performance including air bubble stability, air bubble/solids agglomerate rise rate, air/solids bond strength, wet consolidated solids (float) volume, and general effectiveness of treatment (water clarity). Bench testing will be conducted as needed. Specific coagulant and flocculant usage and concentration will depend on numerous factors such as current water chemistry, algae concentrations in the water, algae characteristics, and intake flow.

In similar projects, Aluminum chlorohydrate (ACH) coagulant is dosed at 30-50 ppm depending on the algae concentrations in the lake. The coagulant attached itself to the algae cells with very little remaining in the effluent water. The following calculations below assume 700 gpm (1MGD) operating for 24 hours:

- 30 ppm- pumped at 80 mL/min equating to 30.2 gal/day.
- 40 ppm- pumped at 108 mL/min equating to 40.3 gal/day.
- 50 ppm- pumped at 133 mL/min equating to 50.4 gal/day.

The flocculant polymer consists of an organic dry powder that is mixed into clean water in a conical mixing tank to form the polymer solution. The polymer is usually mixed as a 0.5%

concentration and dosed at 1-2 ppm depending on the current algae concentrations in the lake. For a dose of 2 ppm, 7630 grams of dry polymer would be mixed into 403 gallons of clean water and pumped into the harvester at rate of 1060 mL/min. The 403 gallons of polymer solution would last 24 hours.

All chemicals will be stored in the container in which they were purchased or in containers approved for storage of the chemical. Additionally, chemicals will be stored in a covered area with secondary containment. Additional details on chemical storage are available in **Attachment B.**

Coagulent			
Chemical Family	**Product Name**	**NSF Product Spcific Maximum Use Limit**	**NSF Certified Drinking Water Treatment Chemical Typical Maximum Use Limit Range**
Aluminum Chlorohydrate	H-PAC 8323	250 mg/L	100 mg/L to 250 mg/L
Ferric Chloride	Kemira PIX-311	250 mg/L	100 mg/L to 250 mg/L
Polyaluminum Chloride	Kemira PAX-18	200 mg/L	100 mg/L to 250 mg/L
Starch based Cationic Coagulant	GreenFloc GFT 5100	NA	NA
	National 54-3418	NA	NA
	RediPRO 7300	NA	NA
	TOPCAT L98	NA	NA
Floculant			
Chemical Family	**Product Name**	**NSF Product Spcific Maximum Use Limit**	**NSF Certified Drinking Water Treatment Chemical Typical Maximum Use Limit Range**
Cationic Water-soluble Polyacrylamide Polymers	Tram Floc 222	NA	TramFloc 500-series 80 to 250 mg/L
	Polytec PT2160	NA	PolyTec-series 1 mg/L to 3.0 mg/L
	AFCO RS-630 (AFCO 8761)	NA	NA
	Flo-Pam FO 4290 SH	1 mg/L	1 mg/L to 3.5 mg/L
	Flo-Pam 934 SH	1 mg/L	1 mg/L to 3.5 mg/L

Figure 1: Candidate Products for Lake Agawam algae water treatment

6.0 Assessment & Mitigation of Potential Environmental Impacts

This proposed project serves to improve the water quality of Lake Agawam through the removal of algae that causes harmful algae blooms. Improved water quality will result in a healthier ecosystem for wildlife and humans. The use of this technology has been specifically piloted on Lake Agawam with demonstrated effectiveness. The deployment of an algae harvester is recommended in the NYSDEC HAB Action Plan.

The HFT process is a "flow-through" process. That is, if 3 MGD is pumped into the treatment units than 3 MGD of clean clarified water will be simultaneously returned to the lake. Based on the description of the material associated with HFT Technology, it is expected that no significant chemical or water volume change will occur, and therefore the project is not expected to cause a significant adverse impact on benthic, wetland, and vertebrate wildlife communities in Lake Agawam.

The proposed project includes the following mitigation factors that will ensure that no adverse environmental impacts will occur:

- All material collection (biomass), transport, and disposal will be conducted in conformance with all state and local permits issued for the project. Licensed transporters and disposal entities will be subcontracted to provide services, as required.

- Recovered algae biomass can be solidified and sent to a permitted landfill for disposal or transported to a WWTP, IWTP or other permitted facility for disposal. AECOM is also collaborating with two U.S. Department of Energy research laboratories (Pacific Northwest National Laboratory and National Research Energy Laboratory) in the use of hydrothermal liquefaction (HTL) and moderate oxidation treatment to transform algae biomass into a drop-in-place form of biocrude.

- Previous noise studies conducted at other similar sites suggest that noise attenuation efforts will not be required. The location of the equipment placement is not expected to be sufficiently near residential areas to create perceptible noise increases. In the unlikely event that sound level changes are perceived as a result of equipment operation, aesthetically pleasing measures such as decorative fencing and/or landscaping can be installed to provide noise attenuation.

- No sediment will be dredged as part of the HFT operations. Water withdrawal will only occur within the approximate top 12 inches of the water column.

- No adverse odors or odor impacts are anticipated. In the unlikely event of perceived odors from equipment operation, an air monitoring network can be designed, and the HFT can be enclosed to allow use of a vapor vacuum system fitted with granular activated carbon or similar substrate to mitigate any odors. The most conservative measure would be to place the entire HFT treatment system in a temporary structure such as a metal building or tent; however, this is not anticipated to be necessary.

- No chemical impacts are anticipated. Please note that the previous AECOM pilot study at Lake Agawam in 2019 included the implementation of a comprehensive monitoring program approved by the NYSDEC and the laboratory analyses performed documented no chemical impacts.

- Habitat clearing is expected to be less than 0.5 acres and units will be placed in non-sensitive areas as depicted on project plans. Noise and vibration from the structures during operation are expected to be below impact thresholds for both aquatic and terrestrial species.

- The lake and adjacent shore are listed as NYSDEC-regulated freshwater wetlands. No endangered species are believed to directly utilize the lake habitat, though bats, including the Northern long-eared bat (*Myotis septentrionalis*) (Threatened), may occur in the area during warmer months, and may roost in adjacent forests and forage over water. Monarch butterfly (*Danaus plexippus*) may occur in grassland areas proximate to the lake in the summer months. Neither of these species are expected to be impacted by the proposed operation as there will be no tree clearing or loss of suitable meadow habitat.

- The HFT process is expected to impact the plankton community, which may include other (non-target) algae species, planktonic invertebrates, and any planktonic eggs or larvae of fish or terrestrial invertebrates. The changes implemented by the water treatment process will result in increased light penetration and dissolved oxygen from the reduction in harmful algal blooms, which will ultimately benefit the plankton community.

- A monitoring plan has been developed in parallel with the project design and impact assessment herein. Baseline measurements of potentially impacted communities (including planktonic, benthic, and fish communities) will be made before treatment. A regular sampling schedule for each community will be arranged in consultation with regulatory authorities to meet regulatory requirements.

7.0 Monitoring Plan

As part of the monitoring for Lake Agawam, AECOM will perform pre- and post-monitoring of benthic invertebrates, ichthyoplankton, and fish. The monitoring will occur in both the spring and summer seasons to collect the highest biomass. A brief description of the monitoring events is provided below.

- **Water Quality Parameters** - During each survey, standard water quality measurements for temp, pH, conductivity, Dissolved Oxygen, and turbidity will be collected.

- **Benthic Invertebrates –** In order to determine the composition of benthic invertebrates in Lake Agawam, at up to five locations in the lake, triplicate samples of benthos will be collected. The samples will quantify the habitat type and abundance and diversity of benthic species. The samples will be collected in roughly equally spaced sampling locations from north to south to characterize the benthic communities throughout the lake.

  Benthic samples will be collected with a grab sampler (e.g., Ponar or similar device), the samples will be brought to the surface and the sediments characterized. The samples will then be rinsed though a 500-micron screen and the remaining organisms will be affixed with a biological stain (i.e., Rose Bengal) and placed in a jar with a biological preservative. Later, in a laboratory setting, the species will be enumerated.

- **Ichthyoplankton** - using 505-µm plankton nets AECOM will sample ichthyoplankton in two locations in the lake (i.e., northern half and southern half). The net will be set at mid-depth and pulled by a small boat for two hours. Velocity measurements recorded in ft per second (fps) to estimate filtered volume of the sample. Each sample will be preserved in a solution of formalin (final concentration of 5%), stored, and analyzed separately. Fish eggs and larva will be identified to the lowest distinguishable taxonomic category and counted. Counts were expressed as #/ 1 m^3 of water.

- **Fish** – In the northern (one location) and southern half (one location) of the lake, fish sampling will occur over a two-day period each season. At each location, a 125-ft long, multi-paneled gill nets will be deployed. The gill nets will soak for at least four hours each day. The net will be deployed starting two hours before sunrise and continue soaking through the morning. After each hour of soak time, the nets will be retrieved and captured fish identified by taxa, measured and enumerated. The captured fish will be returned to the lake. The fish populations will be identified by species and catch per unit effort.

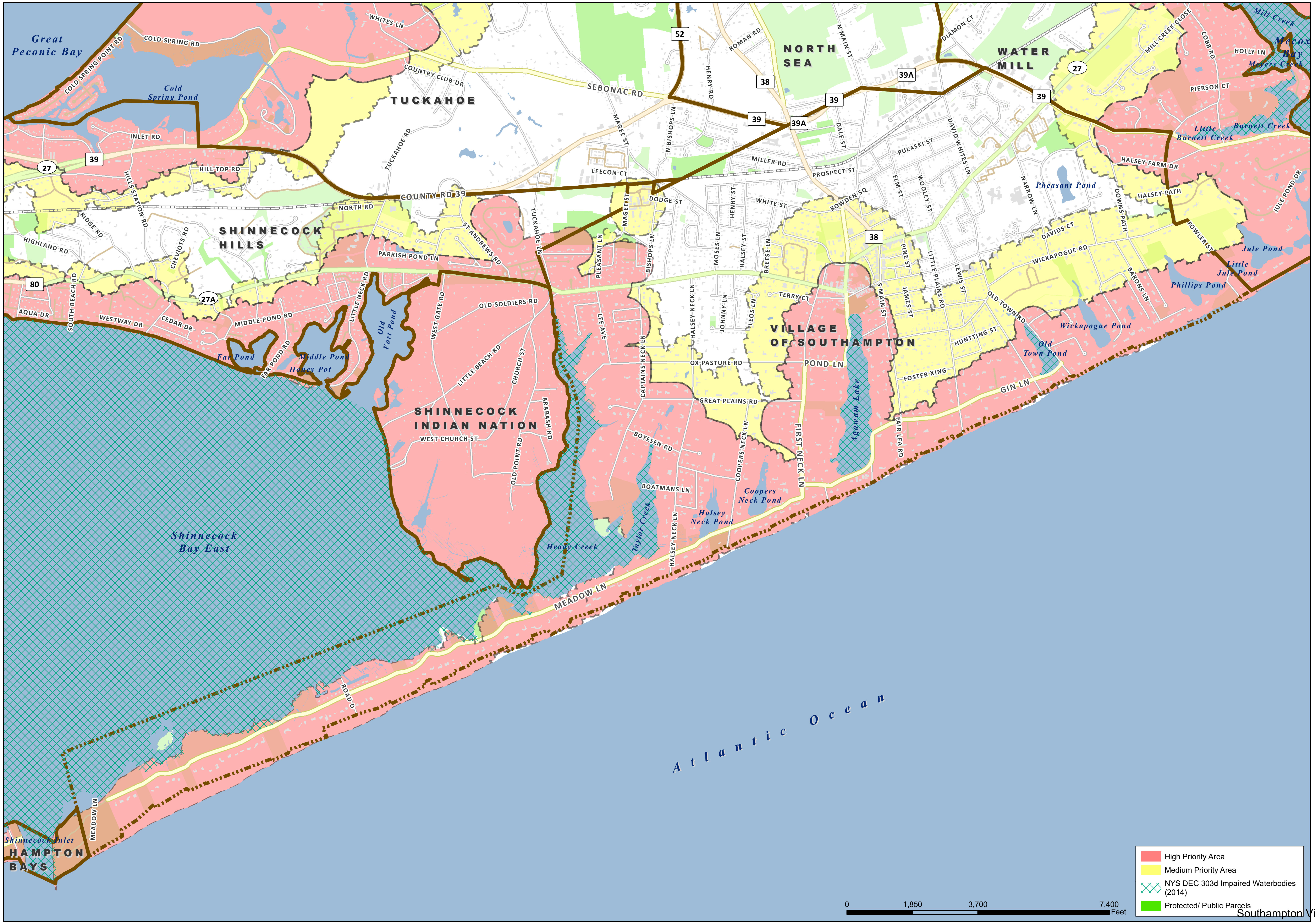
8.0 References

Gobler, C.J., 2017. Quantifying Nitrogen Loading from Southampton Village to Surrounding Water Bodies and Their Mitigation by Creating a Sewer District, Stony Brook University, School of Marine and Atmospheric Sciences, February 2017.

Nelson, Pope & Voorhis, LLC (NP&V), 2009. Comprehensive Management Plan for Lake Agawam. Report prepared for Village of Southampton, Village Board of Trustees, June 2009.

"Lake Agawam Conservancy - Lake Agawam Conservancy." Lake Agawam Conservancy - Saving Our Lake. Preserving Our Village., 2 Feb. 2022, https://lakeagawam.org/.

New York State Department of Environmental Conservation (NYSDEC). Harmful Algal Bloom Action Plan - Lake Agawam . Apr. 2020, https://www.dec.ny.gov/docs/water_pdf/habapagawam.pdf.



Town of Southampton CPF Water Quality Improvement Project Plan

VILLAGE OF SOUTHAMPTON

Prepared By: The Town of Southampton Dept of Geographic Information Systems Date: 7/5/2016 - MAP ID: 2514

Suffolk County Real Property Tax Service
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Suffolk County Real Property Tax Service Agency (R.P.T.S.A.)

Photo 1. Looking north.

Photo 2. Looking northeast.

Photos taken by Chic Voorhis on 7/21/2020

Photo 3. Looking west.

Photo 4. Looking north.

Photos taken by Chic Voorhis on 7/21/2020

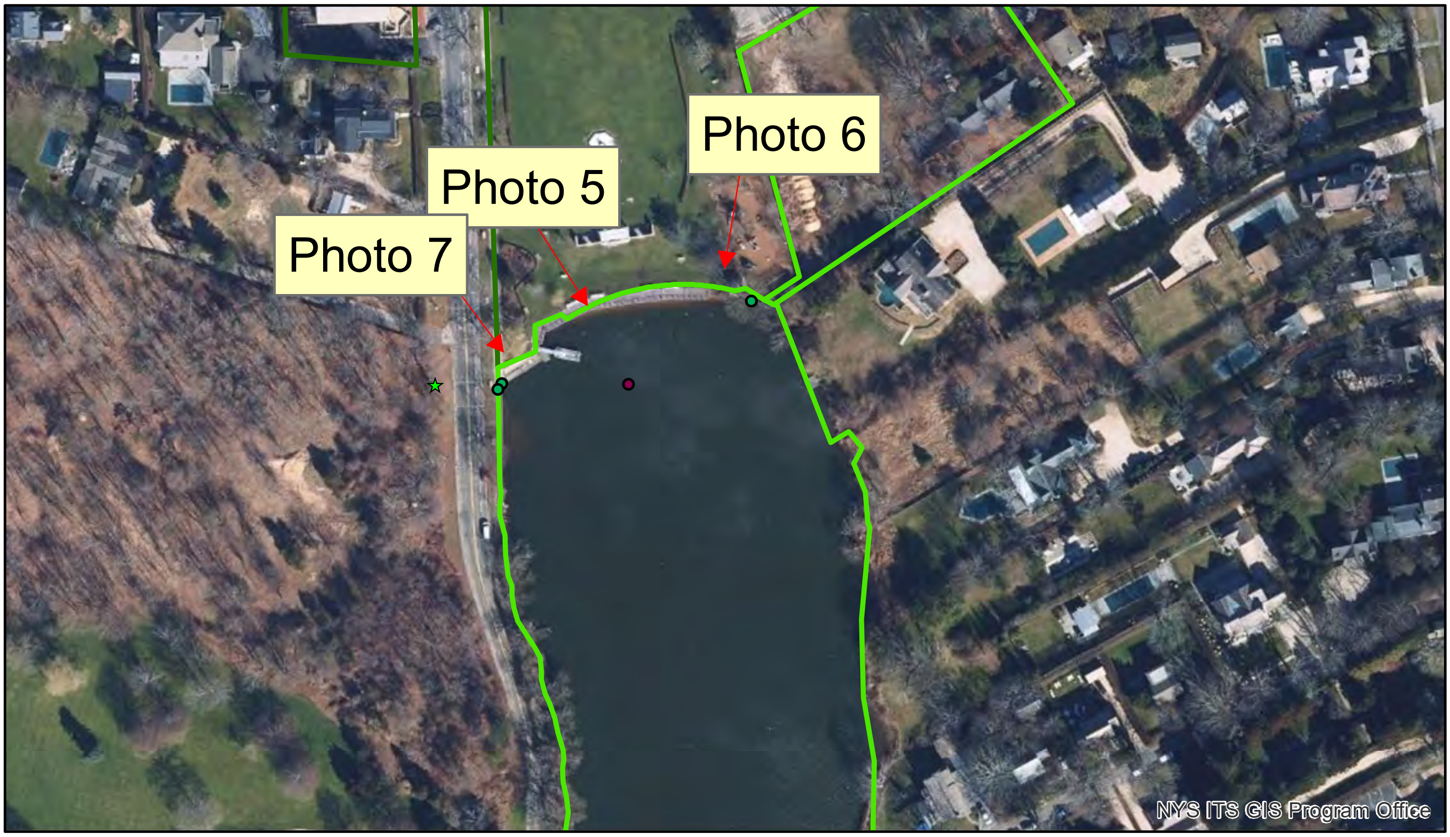
Photo 5. Looking southeast.

Photo 6. Looking south.

Photos taken by Chic Voorhis on 7/21/2020

Photo 7. Looking southwest.

Photos taken by Chic Voorhis on 7/21/2020

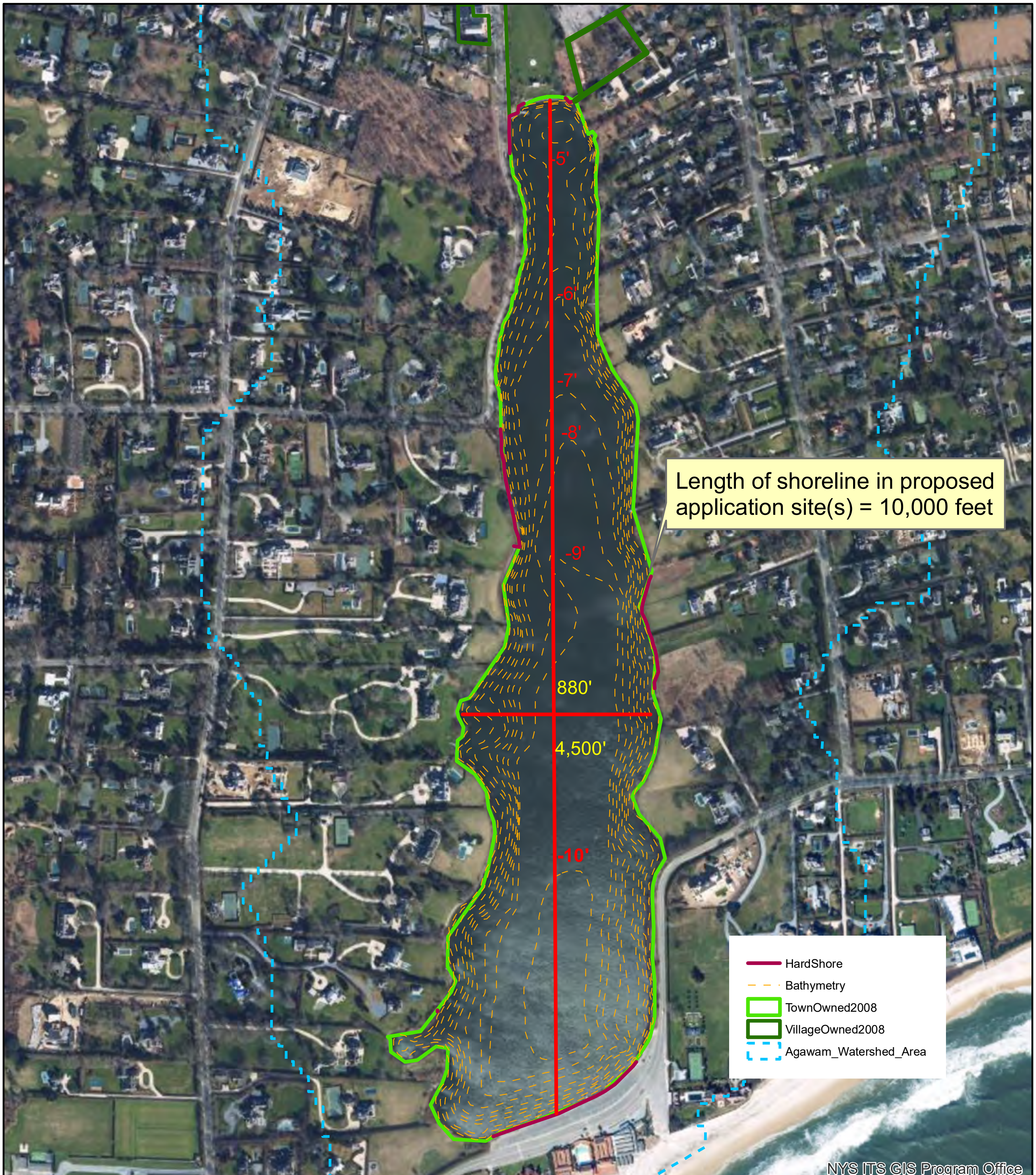


NPV

AERIAL MAP AND PHOTO KEY

Source: NYS Orthophotography, 2016
Scale: 1 inch = 200 feet

Lake Agawam
Southampton, NY



NPV

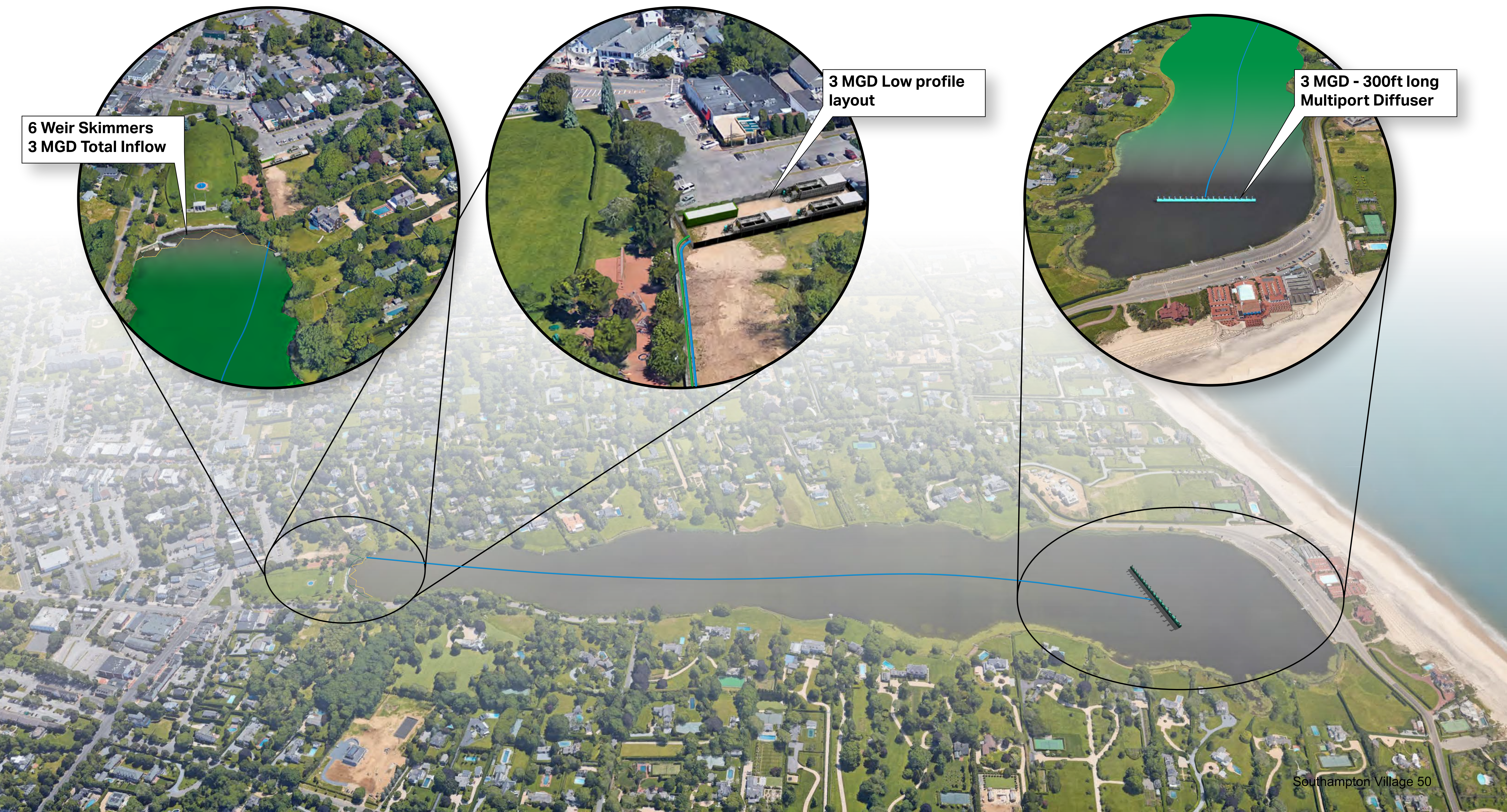
Site Plan (Area of Treatment equals entirety of Lake Agawam)

Source: ESRI Web Mapping Service, USGS 2016 data, SIM 3398
Scale: 1 inch = 600 feet

N

Lake Agawam
Southampton, NY

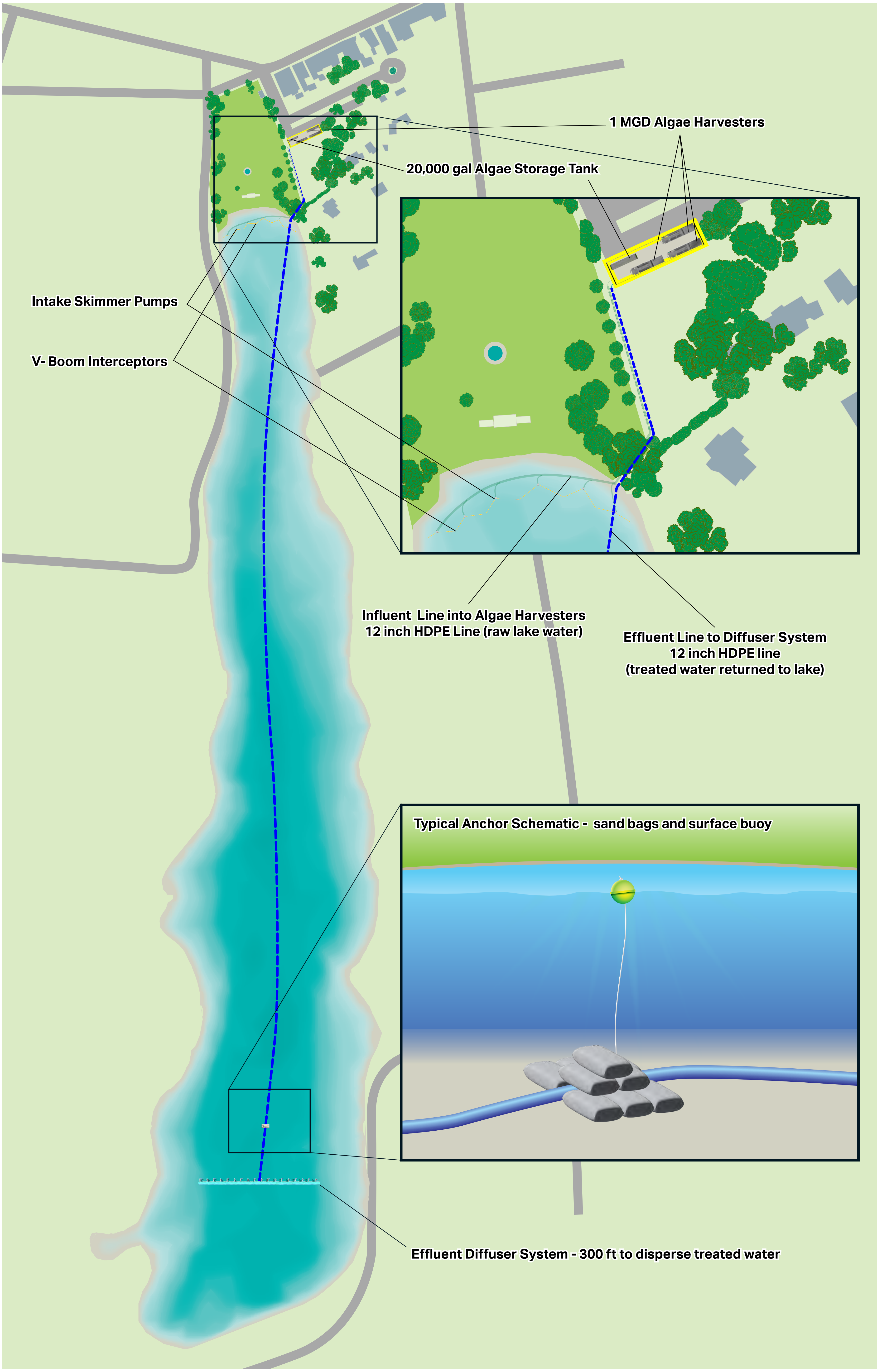
Prepared on: 7/26/2020


6 Weir Skimmers
3 MGD Total Inflow
3 MGD Low profile layout
3 MGD - 300ft long Multiport Diffuser

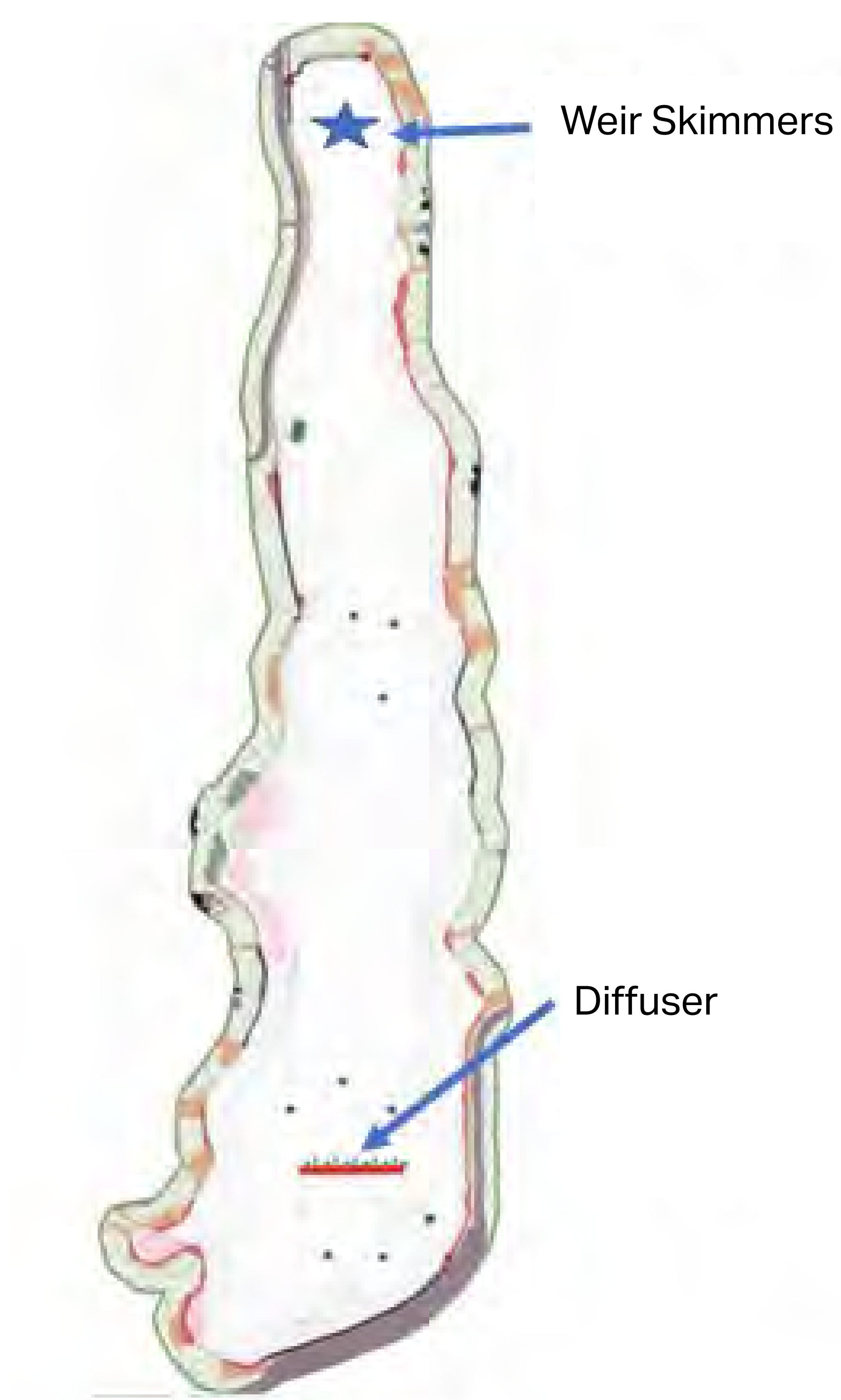
AECOM

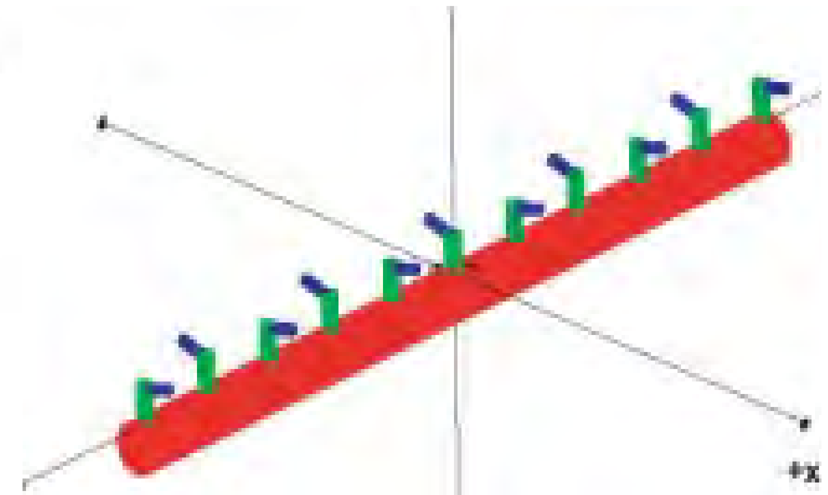
Algae Harvester Treatment System Configuration – Plan View
2 or 3 algae harvesters each 1 Million gallon per day (MGD) processing capacity

Figure 1



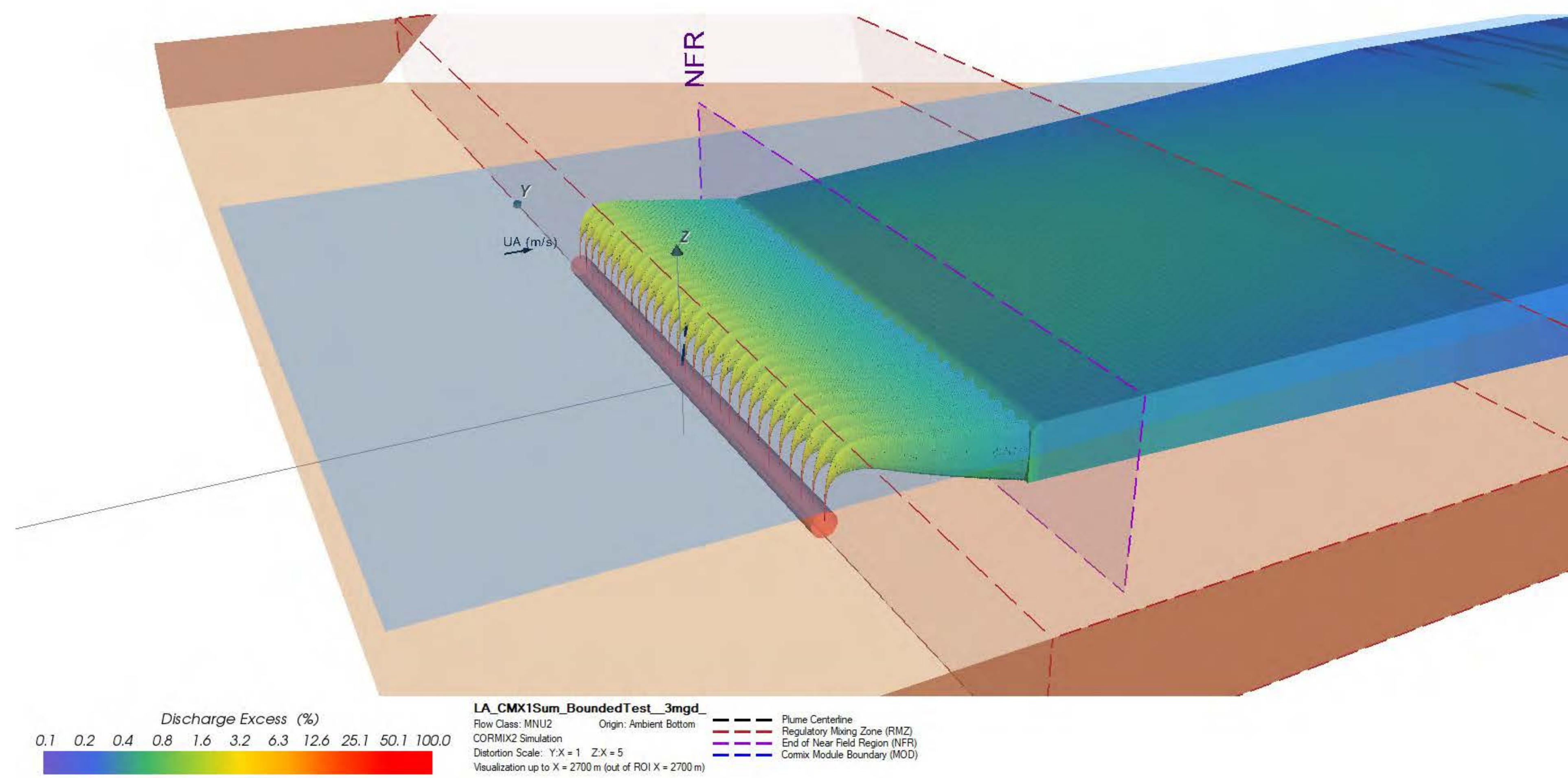
AECOM	**Plan View** Lake Agawam Algae Piping Layout	Figure 2





Algae Harvester outflow: 300 ft long Multiport Diffuser at south end of the lake at water depth ~ 10 ft.

Algae Harvester inflow: Up to 6 weir skimmers (50 ft apart) at north end of the lake at water depth ~ 4.5 ft.



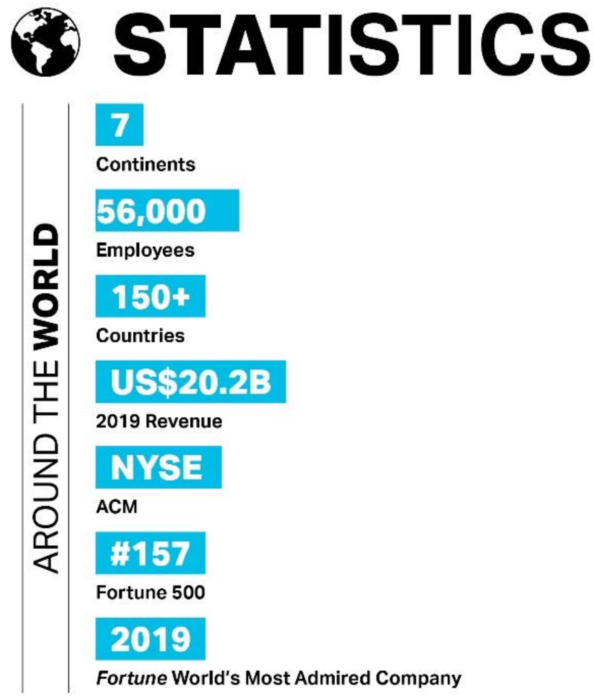
AECOM	Lake Agawam Algae Harvester inflow and outflow locations and layout	Figure 3

Overview

AECOM launched 29 years ago when a handful of employees from design and engineering companies shared a dream of creating an industry-leading firm dedicated to making the world a better place. AECOM became an independent company formed by the merger of five entities. While our official founding was in 1990, many of our predecessor firms, such as Dames & Moore, Woodward Clyde, ENSR, Metcalf & Eddy, and Radian have distinguished histories. Since 1990, more than 50 companies have joined AECOM and, in 2007, we became a publicly traded company on the New York Stock Exchange. In 2014, we more than doubled our revenue and workforce with the acquisition of URS, which expanded our capabilities and solidified us as a premier, fully integrated infrastructure firm.

At AECOM, we work closely with clients and communities to solve the most complex environmental challenges throughout the business life cycle. For example, our innovative algae harvesting and nutrient reduction program provides the framework for restoring nutrient impact waterways worldwide. The program has grown from its early studies and field-scale demonstrations to a multi-million-dollar emergency clean-up program that provided immediate relief from last summer's ecological disaster in Florida. Over 90% of Lake Okeechobee (740 square miles) was covered with toxic cyanobacteria (blue-green algae) which plagued South Florida communities and forced families to move out of their homes and businesses to close. A state of emergency was declared by Florida's Governor and AECOM's algae harvesting technology was selected as the best technology to help mitigate the crisis.

Our innovative algae harvesting process, which removes the algae cells intact, also provides a biomass that can be used as a feedstock for energy production and commercial footwear products.



Point of Contact

The contact information for Dan Levy, PG is provided below:

Daniel J. Levy, PG
Vice President Environmental, DCS Americas
110 East Broward Blvd, Suite 700
Fort Lauderdale, Florida 33301
☎ 305.519.1194
✉ dan.levy@aecom.com

Background

Events in recent years have shown that Harmful Algal Blooms (HABs) are adversely affecting many coastal and inland communities across the United States.

Removing the overabundance of nutrients in surface water that promote the proliferation of HABs is an essential component in the comprehensive strategy for restoring these waterbodies and avoiding – or greatly reducing – the negative health effects to both humans and animals. This same strategy can help mitigate the significant recreational and economic losses caused by HABs. To address this issue, the AECOM Team has developed a unique solution – an algae interception technique coupled with an innovative algae harvesting and treatment system that can separate and remove both cellular and floating mat algae from surface waters, return clarified water to the water body, and dewater the recovered algae biomass into a feestock for transformation into liquid energy via Hydrothermal Liquefaction (HTL) and other valorized commodities.

Phosphorus and nitrogen – both essential for the growth and proliferation of algal blooms – are exported via intact algae cell recovery from the surface water bodies during the harvesting process. Laboratory analytical reports from National Environmental Laboratory Accreditation Program (NELAP) certified contract laboratories of samples collected during pilot tests have confirmed high removal efficiencies for microcystin (78% to 99%), total nitrogen (TN) and Total Kjeldahl Nitrogen [(TKN) 75% to 85%] and total phosphorus (85% to 95%). Other parameters with high removal rates that typically range from 85% to 95% are chlorophyll-a and Total Suspended Solids (TSS).

The efficacy of this innovative harvesting technology has been successfully proven in several Florida and New York applications (2017-2019), notably the Phase I (Year 1) 2019 pilot demonstration with the USACE ERDC at Lake Okeechobee, Florida and the 2019 pilot demonstration at Lake Agawam, Southampton, New York. The treatment units are easily scalable from a mobile trailer or barge-mounted size to a modular, fixed, large-scale installation. The harvesting unit uses an advanced Hydronucleation Flotation Technology (HFT) in a high-efficiency design to separate algae biomass from water. When deployed in a lake or surface water body with high algae concentrations, the unit converts the diluted green or brown surface water into an algae-dense slurry that contains the HAB-promoting nutrients and clarifies the water, which is returned to the surface water body as a clear stream; HFT effectively removes intact cellular algae from the water column long before an algae mat can form on the surface. The HFT is highly efficient in coagulating and flocculating algae into a skimmate using National Sanitation Foundation (NSF) International approved chemicals commonly used in the potable and wastewater treatment industry. The chemicals are bound up in a dense slurry that is produced by the algae harvester, with de minimis concentrations returned to the surface water body.

Our strategically selected, multi-disciplinary Team includes Subject Matter Experts (SMEs), ecologists, biologists, engineers, and project managers drawn from AECOM. AECOM will provide services that include project design and management, unit placement and operation, strategic planning, monitoring oversight, report preparation/data analysis, and will assist with assessing the viability of using AD as a method for biomass management and valorization, pilot project design, research and monitoring, data analysis, and reporting. The Team will utilize the services of an Advisory Committee composed of SMEs, decision makers, opinion leaders, and others with expertise on/interest in the issue. Our Leadership Team for the pilot project consists of the following:

Dan Levy, PG, is a Vice President with the AECOM Environmental Business Line and has more than 33 years of experience in the environmental industry. Dan's experience includes research and development of innovative treatment technologies for the prevention of HABs and the implementation of algae harvesting treatment to remediate toxic algal blooms. Dan served as the Project Director for the algal bloom restoration programs that occurred last summer (2018) in both Lee and Martin Counties. He is also the co-inventor of the patented SEDCUT dredging technology and the patent pending Hydronucleation Flotation Technology to harvest intact cellular algae.

innovation.

Bill Colona, PG, has 34 years of experience conducting hydrologic assessments and remediation services throughout Florida. Bill has in-depth experience working with state/municipal government and community stakeholders on Basin Management Action Plans (BMAPs) and springshed Restoration Focus Area (RFA) related projects that use nutrient pathway groundwater tracer studies and innovative stormwater and surface water nutrient management/reduction strategies, including the use of Bio-Sorption Activated Media (BAM). Since 2016, Bill has been heavily involved with the development of AECOM's nationwide algae harvesting strategy and has participated in several proof-of-concept algae harvesting pilot tests and a three-month remediation campaign (2018) in Lee County to combat cyanobacteria HABs. He recently joined the Technology and Regulatory Council's Strategies for Preventing & Managing Harmful Cyanobacterial Blooms (HCBs) Team.

Michael Donahue, PhD, will serve as **Technical Advisor**, assist with project management duties, and support data interpretation and report preparation tasks. Mike is a Vice President and Director of AECOM's National Coastal and Ecosystem Restoration Practice. With a doctorate in environmental master planning and over 35 years of public and private sector leadership experience, Mike has been extensively involved in addressing water quality and algal bloom issues nationwide.

David Pinelli, BS, SME, will serve as Technical Lead for Algae Harvesting and Processing activities. David has over 35 years of liquid-solid separation experience for water recovery, product recovery, and industrial wastewater pretreatment. Application experience spans a broad spectrum of industries, including Energy, Chemical, and Allied Trades; Oily Wastes; Transportation; Food Processing; and numerous others where projects are often begun with bench-scale evaluation culminating with full-scale deployment and commissioning. With a primary focus in Dissolved Air Flotation applications, David's focus the last five years has been working in algae biomass recovery, initially for a bioplastics startup company and more recently with AECOM for Nutrient Export, Lake Remediation, and Mitigation of HABs. David developed the harvesting technology slated for use in the proposed work.

Tammy Karst-Riddoch, PhD, is an accomplished senior limnologist bringing more than 25 years of research and consulting experience to the AECOM team. She has acted as Project Manager, Technical Lead and Scientific Advisor on complex surface water and watershed management projects across Canada and in the United States for government, industry, and private stakeholders. Tammy is a member of AECOM's Algae Solutions Team and was a technical lead for the Lake Agawam Algae Harvesting Demonstration Project, Southampton, New York in 2019.

Tammy specializes in the use of physical, biological, chemical and geochemical information to assess the responses of aquatic systems to natural (e.g., climate change and variability, hydrological changes, vegetation dynamics, fire, etc.) and human disturbances (e.g., effluent discharge, mining, land-clearance, agriculture, watershed development, river regulation, flooding, etc.). She has developed and applied watershed-scale contaminant loading and lake water quality models, assessed large complex water quality data sets, and identified factors contributing to water quality degradation and nuisance aquatic plant and algae growth in lakes, ponds, and rivers. Tammy has expert knowledge of approaches to improve the health of natural and built aquatic systems and has developed mitigation and management plans that address site-specific issues while considering social, political, and economic concerns.

Tammy is well respected in the scientific community; she has published 15 papers on topics of paleolimnology, limnology, hydrology and ecology; has acted as a peer reviewer of original research (Journal of Lake and Reservoir Management, Journal of Paleolimnology); and is a qualified expert witness with the Ontario Municipal Board for surface water quality and lake capacity assessment.

Tammy's key skills and areas of expertise are surface water and watershed management; limnology and paleolimnology; algae bloom dynamics, aquatic plant and nutrient management; scientific synthesis, peer review, and expert testimony; advanced statistical analysis; effluent receiving water and assimilative capacity assessment; and aquatic monitoring program design and implementation.

THE ASSEMBLY
STATE OF NEW YORK
ALBANY

COMMITTEES
Rules
Environmental Conservation
Oversight, Analysis and Investigation
Transportation

FRED W. THIELE, JR.
Assemblyman 1st District

CHAIR
Committee on
Local Governments

April 13, 2022

Hon. Jesse Warren
Village of Southampton
23 Main Street
Southampton, NY 11968

Dear Mayor Warren,

I am writing to express my support for the Village of Southampton's proposed installation and application of an algae removal system to Lake Agawam along with related grant applications being submitted by the Village.

Lake Agawam is a vital foundation of life and culture in Southampton Village but, unfortunately, its health has been deteriorating due to toxic algal blooms. Such algal blooms occur because of excess nutrients (nitrogen and phosphorus) in the Lake which promote the rapid growth of algae during certain seasonal and temperature cycles. When the algae die off, it consumes dissolved oxygen (DO) in the Lake, thus depleting DO levels and causing fish kills and a myriad of water quality issues. Certain types of algae and algal blooms are known to be harmful to humans and pets, not to mention their impact on water quality and aesthetics.

Clearly, removal of algae from Lake Agawam is critically important for water quality and the overall health of the Lake. The New York State Department of Environmental Conservation has prepared a Harmful Algal Bloom (HAB) Action Plan to address factors that contribute to degraded water quality and algal blooms in Lake Agawam. The Village, along with other levels of government and non-profit organizations, are deeply involved with water quality projects to reduce nutrient loading to Lake Agawam in order to control these occurrences and improve water quality. One measure identified in the HAB Action Plan is installing and operating an algae skimmer to remove algal biomass from the Lake before it degrades causing depleted DO levels and associated water quality and aesthetic impacts.

As the New York State Assemblyman representing the 1st Assembly District, I support the Village's effort to clean Lake Agawam through their proposed installation and application of an algae removal system and related grant applications. I believe the impact of this project would enhance the quality of life for residents of Southampton Village while providing lasting environmental benefits for the entire community.

Thank you for your time and consideration of this matter.

Sincerely,

Fred W. Thiele, Jr.
Member of Assembly

ALBANY OFFICE: Room 837, Legislative Office Building, Albany, New York 12248 • 518-455-5997, FAX: 518-455-5963
DISTRICT OFFICE: 3350 Noyac Road, Building B, Sag Harbor, New York 11963 • 631-537-2583, FAX: 631-725-2372
EMAIL: thielef@nyassembly.gov

LAKE AGAWAM
CONSERVANCY

April 13, 2022

Mayor Jesse Warren
Village of Southampton
23 Main Street, Southampton, New York 11968

Dear Mayor Warren,

On behalf of the Lake Agawam Conservancy, I write to provide our strong support for Southampton Village's proposed installation and application of an algae removal system to Lake Agawam and all accompanying grant applications by the Village.

Lake Agawam, once known as the "jewel of Southampton," is a crucial cornerstone of Village life. For the past 20 years, there has been much discussion about how to clean up the Lake, but the water continues to get more toxic. We can now longer sit by and hope for some improvement. This toxic water now threatens our health, our homes, and the future of our Village itself.

Removal of algae from Lake Agawam is critically important for water quality, and the health of the Lake. Algal blooms occur because of excess nutrients (nitrogen and phosphorus) in the Lake, which promote the rapid growth of algae during certain seasonal and temperature cycles. When the algae dies off, it consumes dissolved oxygen (DO) in the Lake, thus depleting DO levels and causing fish kills and other water quality issues. Certain types of algae and algal blooms are known to be harmful to pets and humans and impact water quality. The New York State Department of Environmental Conservation prepared a Harmful Algal Bloom (HAB) Action Plan to address factors that contribute to degraded water quality and algal blooms in Lake Agawam.

The Village, along with other levels of government and non-profit organizations, are deeply involved with water quality projects to reduce nutrient loading to Lake Agawam in order to control these occurrences and improve water quality and aesthetic impacts. One measure identified in the HAB Action Plan is installing and operating an algae skimmer to remove algal biomass from the Lake before it degrades and causes depleted DO levels and associated water quality and aesthetic impacts.

The Lake Agawam Conservancy fully supports the Village's proposed installation and application of an algae removal system and their grant applications. The Conservancy is dedicated to rehabilitating Lake Agawam, and we believe an algae removal system will have a positive long-term impact that aligns with our core mission.

Thank you for your steadfast support for the health of Lake Agawam.

Sincerely,

Robert J. Giuffra, Jr.
President

SHINNECOCK INDIAN NATION
Shinnecock Indian Territory
P.O. Box 5006 Southampton, New York 11969-5006
Phone (631) 283-6143 ext. 2 Fax (631) 283-0751

The oldest self-governing
Tribe of Indians in the United States

April 14, 2022

Village of Southampton
23 Main Street
Southampton, NY 11968

Dear Mayor Warren,

I am writing to express my support for Southampton Village's proposed installation and application of an algae removal system to Lake Agawam and grant applications being submitted by the Village.

Lake Agawam is a crucial cornerstone of Southampton Village life and culture. Unfortunately, the Lake's health has been deteriorating as the Village battles toxic algae blooms. Removal of algae from Lake Agawam is critically important for water quality, the health of the Lake, and aesthetics. Algal blooms occur due to excess nutrients (nitrogen and phosphorus) in the Lake, which promote the rapid growth of algae during certain seasonal and temperature cycles. When the algae dies off, it consumes dissolved oxygen (DO) in the Lake, thus depleting DO levels and causing fish kills and other water quality issues. Certain types of algae and algal blooms are known to be harmful to pets and humans and impact aesthetics and water quality. The New York State Department of Environmental Conservation prepared a Harmful Algal Bloom (HAB) Action Plan to address factors that contribute to degraded water quality and algal blooms in Lake Agawam.

The Village, along with other levels of government and non-profit organizations, are deeply involved with water quality projects to reduce nutrient loading to Lake Agawam in order to control these occurrences and improve water quality and aesthetic impacts. One measure identified in the HAB Action Plan is installing and operating an algae skimmer to remove algal biomass from the Lake before it degrades and causes depleted DO levels and associated water quality and aesthetic impacts.

As the Chairman of the Shinnecock Indian Nation Council of Trustees, I care deeply about our community's environmental wellbeing. I enthusiastically support the Village's proposed installation and application of an algae removal system and their grant applications. It is my hope that this technology can clean Lake Agawam and the surrounding ecosystem. I believe the Village's plan to restore this shared resource will benefit our community's overall public health. I look forward to working together to create lasting change.

Sincerely,

Bryan Polite,
Chairman, Shinnecock Indian Nation

THE ASSEMBLY
STATE OF NEW YORK
ALBANY

KEITH BROWN
Assemblyman 12th District

RANKING MINORITY MEMBER
Committee on
Alcoholism and Drug Abuse

COMMITTEES
Judiciary
Environmental Conservation
Housing
Social Services

Hon. Jesse M. Warren
South Hampton Village
23 Main Street
South Hampton, NY 11968

April 14, 2022

Dear Mayor Warren,

I am writing to express my support of Southampton Village's Algae Skimmer Project for Lake Agawam and the respective Community Project Funding grant application.

Lake Agawam is an important lake and freshwater body on Long Island and has suffered from dense and toxic Harmful Algae Blooms (HABs). The toxic algae, which has now become a nationwide problem, produces cyanobacteria which can be harmful to the central nervous system of both humans and pets alike and has resulted in prior fish kills. It can also be harmful when touched or ingested.

I fully support the efforts to enhance the water quality throughout Suffolk County and Long Island.

Southampton has been on the forefront of projects to reduce HABs and to remediate their water bodies and hopes to deploy this new technology with AECOM. The use of this technology and its three million gallon per day harvester will be the first in New York State. If this grant is awarded, it may help to provide the framework for the rollout of this technology. We would be setting a precedent for not only the county, but the entire State of New York. Projects like this would benefit many upstate regions which are home to many of the most important water bodies in the state.

With the goal to improve the water quality by controlling the algal occurrences, I support Southampton Village's proposed project to improve the water quality of Lake Agawam with the Algae Skimmer Project. I appreciate Southampton's strong commitment to rehabilitating Lake Agawam and for being a leader in the fight against harmful algae blooms as well as the improvement of water quality.

Sincerely,

Keith P. Brown
Member of the Assembly
12th Assembly District

PLEASE REPLY TO: ❑ Room 719, Legislative Office Building, Albany, New York 12248 • 518-455-5952, FAX: 518-455-5804
❑ 75 Woodbine Avenue, 2nd Floor, Northport, New York 11768 • 631-261-4151, FAX: 631-261-2992
EMAIL: brownk@nyassembly.gov

Stony Brook University
School *of* Marine and
Atmospheric Sciences

April 8, 2022

Village of Southampton
23 Main Street, Southampton, NY 11968
Dear Mayor Warren,

I am writing in support of Southampton Village's proposed installation and application of an algae removal system to Lake Agawam and grant applications being submitted by the Village.

Lake Agawam is a crucial cornerstone of Southampton Village life and culture. Unfortunately, the Lake's health has been deteriorating as the Village battles toxic algae blooms. Removal of algae from Lake Agawam is critically important for water quality, the health of the Lake, and aesthetics. Algal blooms occur due to excess nutrients (nitrogen and phosphorus) in the Lake, which promote the rapid growth of algae during certain seasonal and temperature cycles. When the algae dies off, it consumes dissolved oxygen (DO) in the Lake, thus depleting DO levels and causing fish kills and other water quality issues. Certain types of algae and algal blooms are known to be harmful to pets and humans and impact aesthetics and water quality. The New York State Department of Environmental Conservation prepared a Harmful Algal Bloom (HAB) Action Plan to address factors that contribute to degraded water quality and algal blooms in Lake Agawam.

The Village, along with other levels of government and non-profit organizations, are deeply involved with water quality projects to reduce nutrient loading to Lake Agawam in order to control these occurrences and improve water quality and aesthetic impacts. One measure identified in the HAB Action Plan is installing and operating an algae skimmer to remove algal biomass from the Lake before it degrades and causes depleted DO levels and associated water quality and aesthetic impacts.

As Endowed Chair of Coastal Ecology and Conservation School of Marine and Atmospheric Sciences, Director of New York State Center for Clean Water Technology Stony Brook University, and Science Advisor to the Lake Agawam Conservancy; I support the grant applications being submitted by Village and their proposed installation and application of an algae removal system. Lake Agawam is one of the most polluted lakes in New York State, and I believe this technology will be important in cleaning this lake.

Sincerely,

Christopher J. Gobler, Ph.D.
Endowed Chair of Coastal Ecology and Conservation
Professor
School of Marine and Atmospheric Sciences
Stony Brook University
Southampton, NY 11968
631-632-5043
Christopher.gobler@stonybrook.edu

SCVOA Suffolk County Village Officials Association

FIGHTING FOR VILLAGE RESIDENTS SINCE 1934

April 12, 2022

Village of Southampton
23 Main Street
Southampton, NY 11968

Dear Mayor Warren,

We are writing to voice our support for Southampton Village's proposed installation and application of an algae removal system to Lake Agawam and grant applications being submitted by the village.

Lake Agawam is a crucial cornerstone of Southampton village life and culture. Unfortunately, the Lake's health has been deteriorating as the village battles toxic algae blooms. Removal of algae from Lake Agawam is critically important for water quality, the health of the lake, and aesthetics. Algal blooms occur due to excess nutrients (nitrogen and phosphorus) in the lake, which promote the rapid growth of algae during certain seasonal and temperature cycles. When the algae dies off, it consumes dissolved oxygen (DO) in the lake, thus depleting DO levels and causing fish kills and other water quality issues. Certain types of algae and algal blooms are known to be harmful to pets and humans, and impact aesthetics and water quality. The New York State Department of Environmental Conservation prepared a Harmful Algal Bloom (HAB) Action Plan to address factors that contribute to degraded water quality and algal blooms in Lake Agawam.

The village, along with other levels of government and non-profit organizations, are deeply involved with water quality projects to reduce nutrient loading to Lake Agawam in order to control these occurrences and improve water quality and aesthetic impacts. One measure identified in the HAB Action Plan is installing and operating an algae skimmer to remove algal biomass from the lake before it degrades and causes depleted DO levels and associated water quality and aesthetic impacts.

Suffolk County Village Officials Association works to support and advocate for the 32 villages of Suffolk County. We support the Southampton Village's proposed installation and application of an algae removal system and their grant applications. Lake Agawam is one of the most polluted water bodies in New York State, and we applaud the village's efforts to restore it. We are hopeful that through this technology, Southampton Village will be able to improve the health of the lake and the well-being of its residents.

Sincerely,

Paul J. Tonna
Executive Director

69 Chichester Road Huntington, NY 11743 631.327.7342
www.scvoa.com

Cornell University
Cooperative Extension
of Suffolk County

Strengthening Families & Communities
Protecting & Enhancing the Environment
Fostering Economic Development
Promoting Sustainable Agriculture

April 8, 2022

To whom it may concern,

I am writing to express my support of Southampton Village's Algae Skimmer Project for Lake Agawam.

CCE-Suffolk is a not-for-profit organization that has served the needs of residents and businesses since 1917. The health of our residents and our environment is key to our mission. Our Marine program is renowned for their work on water quality issues. Algal blooms occur as a result of excess nutrients in the water and can be harmful to both pets and humans. CCE-Suffolk supports efforts to enhance the water quality of our waterways throughout Suffolk County,

Southampton Village's proposed algae removal system at Lake Agawam is a technologically advanced system to reduce nutrient loading at the site. The goal is to improve the water quality by controlling the algal occurrences.

I support Southampton Village's proposed project to improve the water quality of Lake Agawam with the Algae Skimmer Project.

Sincerely,

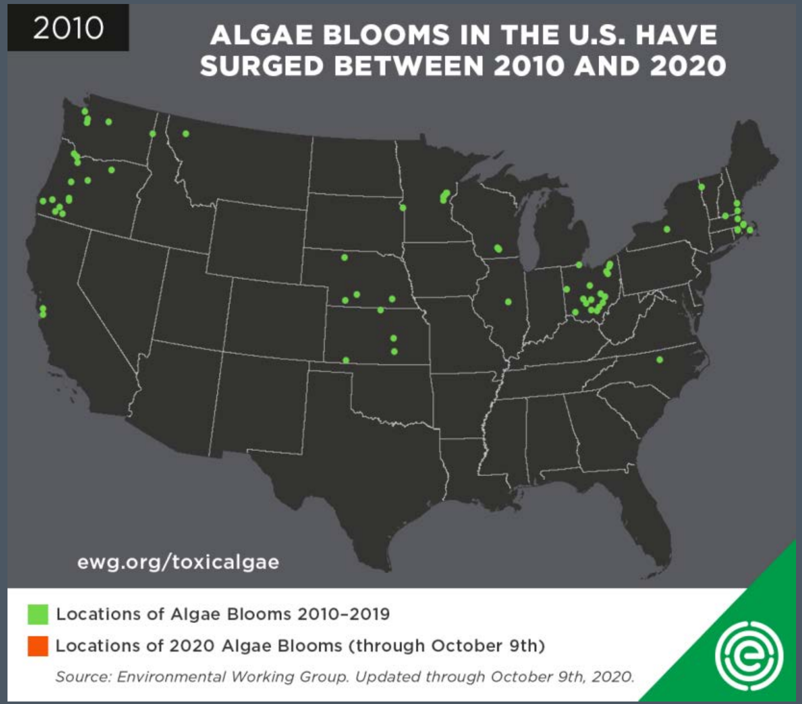
Vanessa Lockel

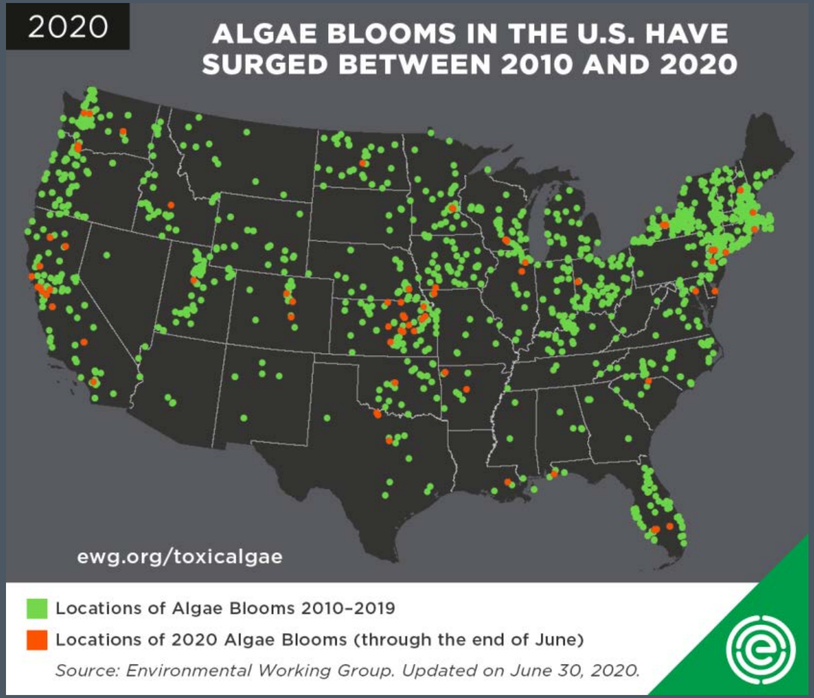
Vanessa Pino Lockel
Executive Director

423 Griffing Avenue, Suite 100 • Riverhead, New York 11901-3071 • 631.727.7850 • www.ccesuffolk.org

Innovative Algae Harvesting Technology

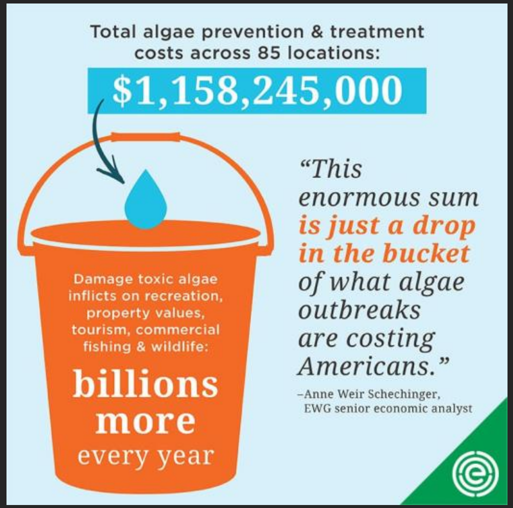
AECOM Imagine it. Delivered.

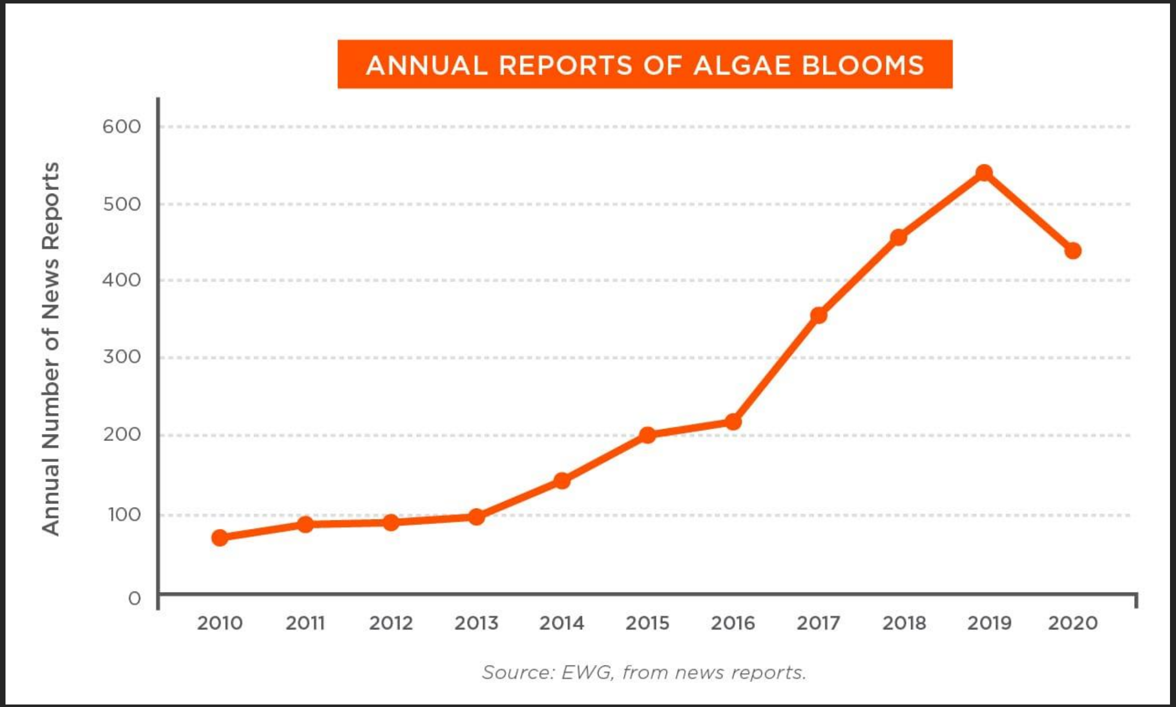




HABs

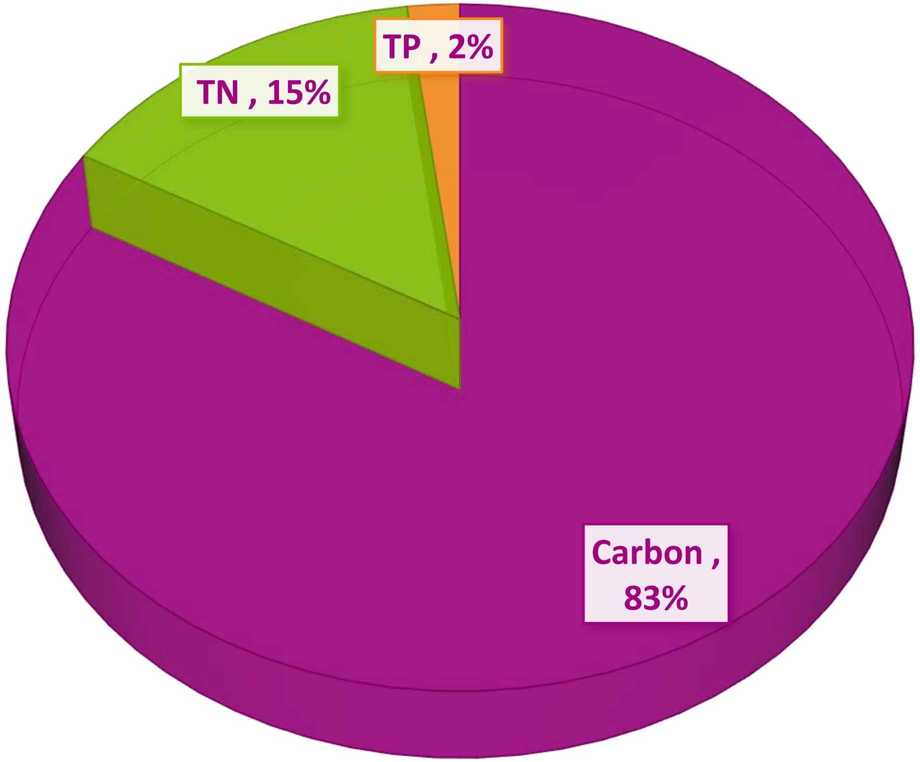
1) Increasing in Intensity
2) Lasting Longer
3) Becoming More Toxic



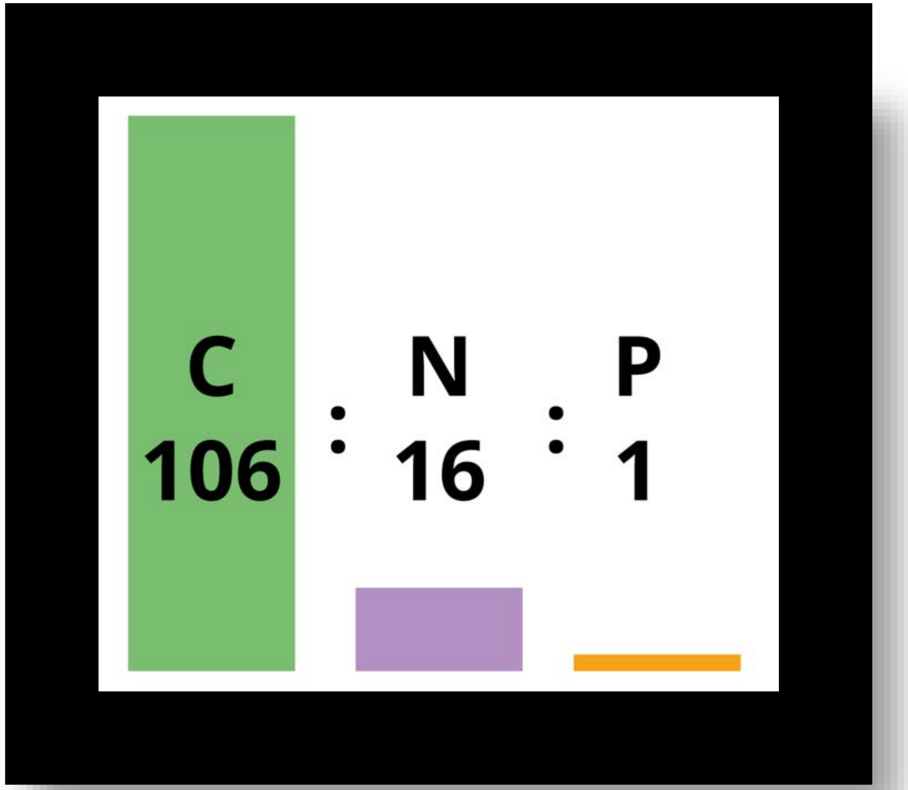


"Reduce the food….reduce the algae"

Nutrients in Algae



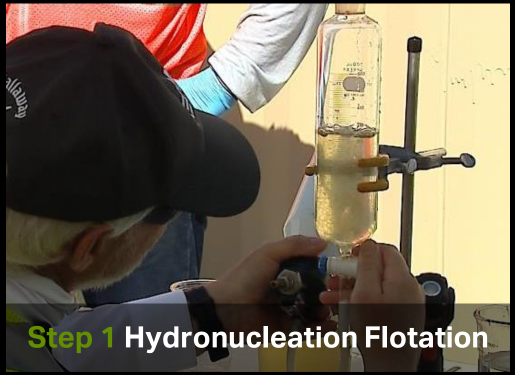
Redfield's Molar Ratio



AECOM's Algae Harvesting Technology

Our patent-pending **Hydronucleation Floatation Technology** (HFT) has proven to be a "no-harm" solution for effective removal of algae, nutrients, and algal toxins. HFT physically removes nutrients from the water and returns clean water back to the environment.

The Process



The Waters

AECOM

Algae Harvesting
10-day Pilot Test
October 7-16, 2019

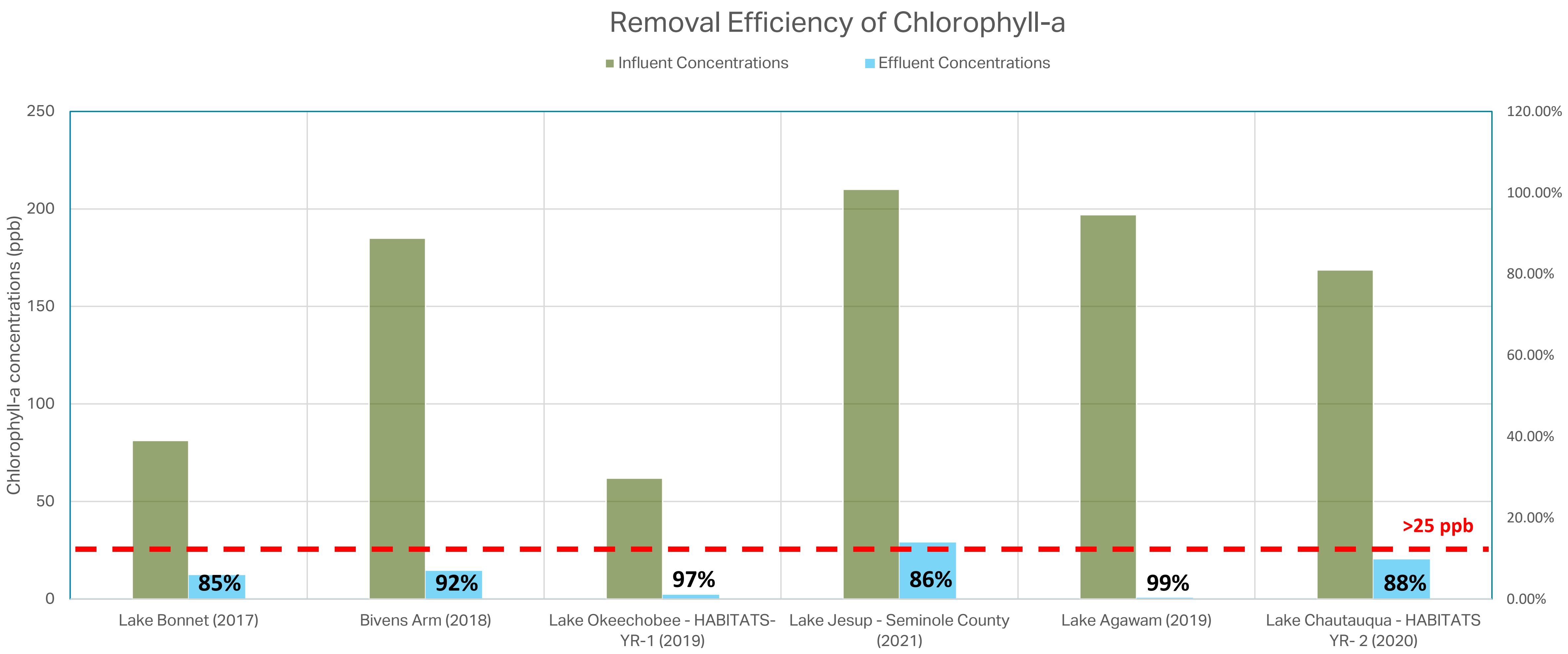
Operations Overview – Lake Agawam 2019

- Implemented Pilot Study in accordance with a NYSDEC-approved Quality Assurance Project Plan (QAPP).
- All NYSDEC operational and monitoring requirements were **successfully met.**
- Proved the key nutrients that fuel algae growth **(N & P), carbon**, and any **cyanotoxins** present can be safely removed from the lake.

Days of Operation	10 days
Total Run Time	58.8 hours
Volume of Water Treated	257,000 gallons (**0.1% of lake volume**)
Coagulant (ACH) Used (250 mg/L approved by NSF)	16 mg/L* (Al in effluent less than influent)

ACH - Aluminum Chlorohydrate (commonly used to improve drinking water quality)

Removal of Chlorophyll-A



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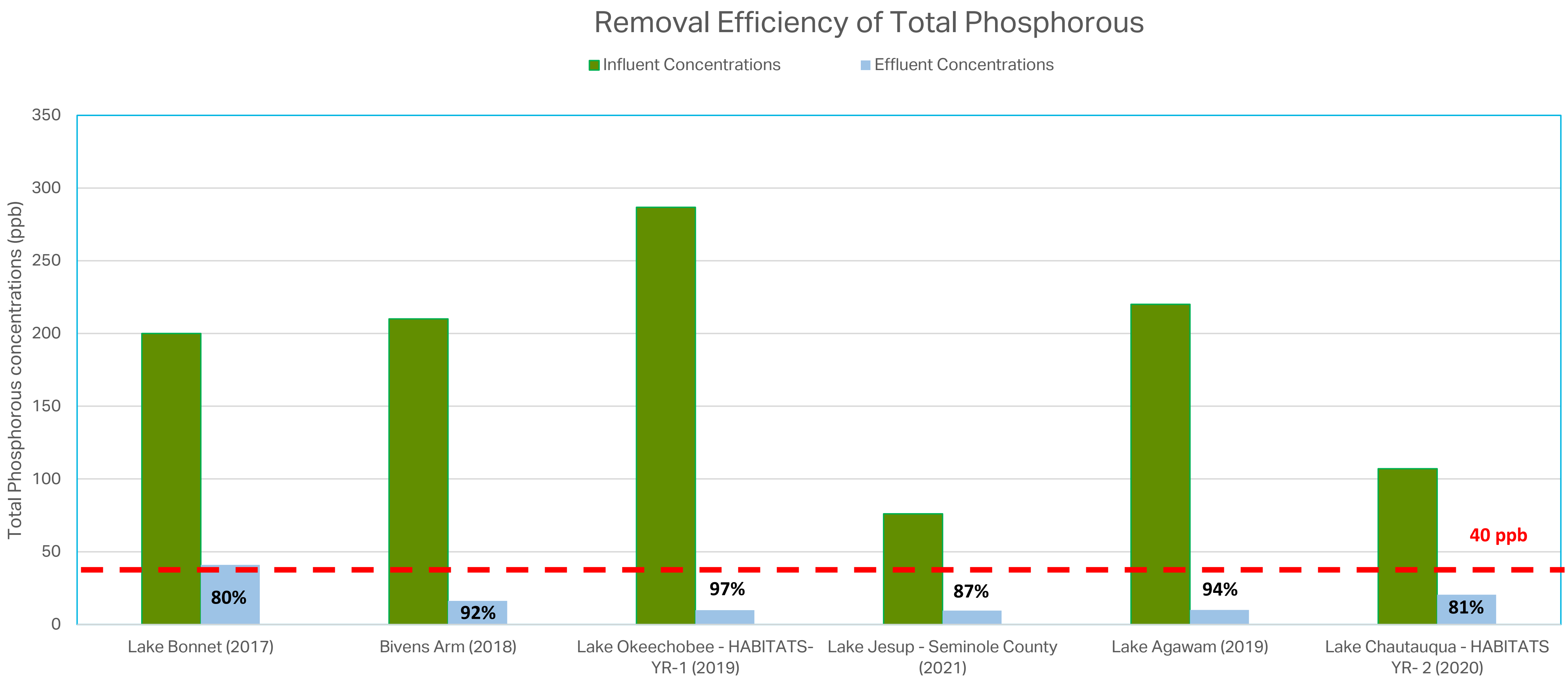
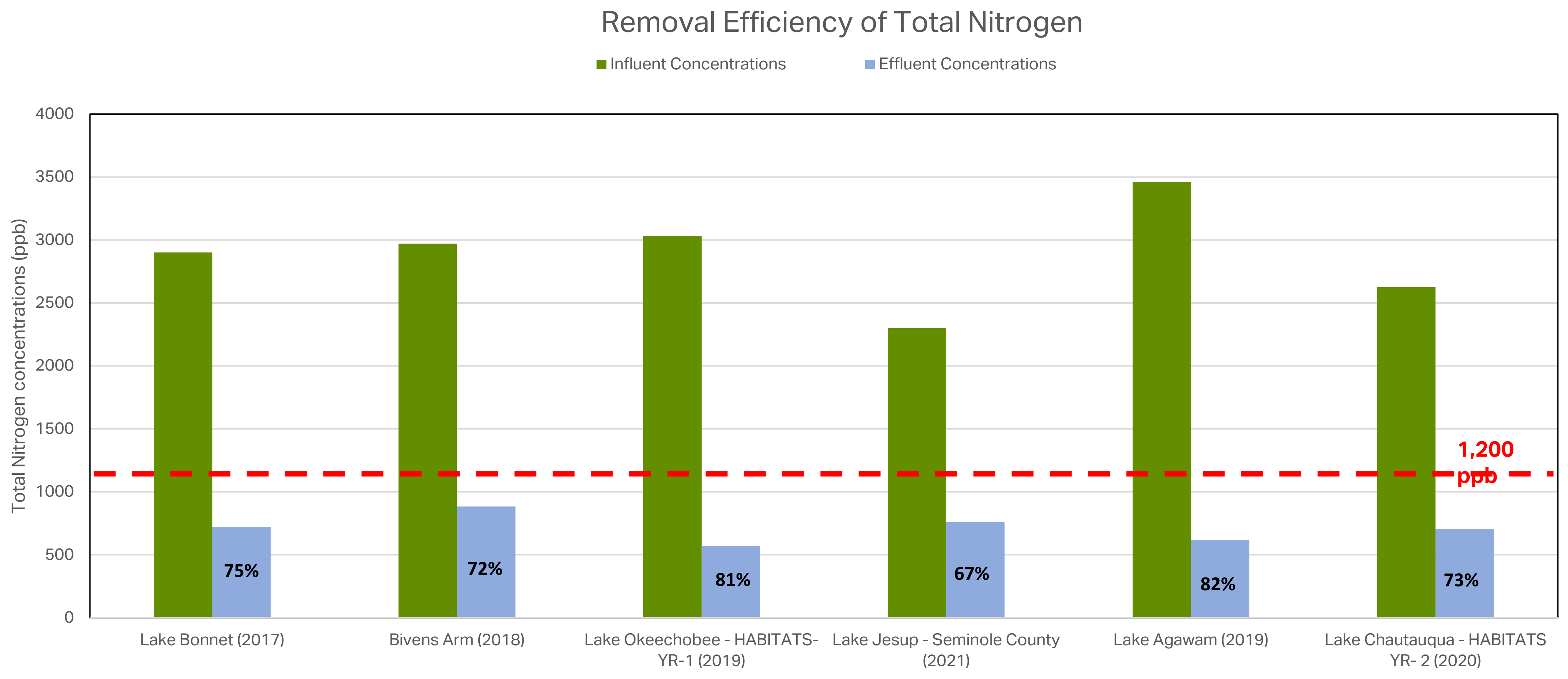
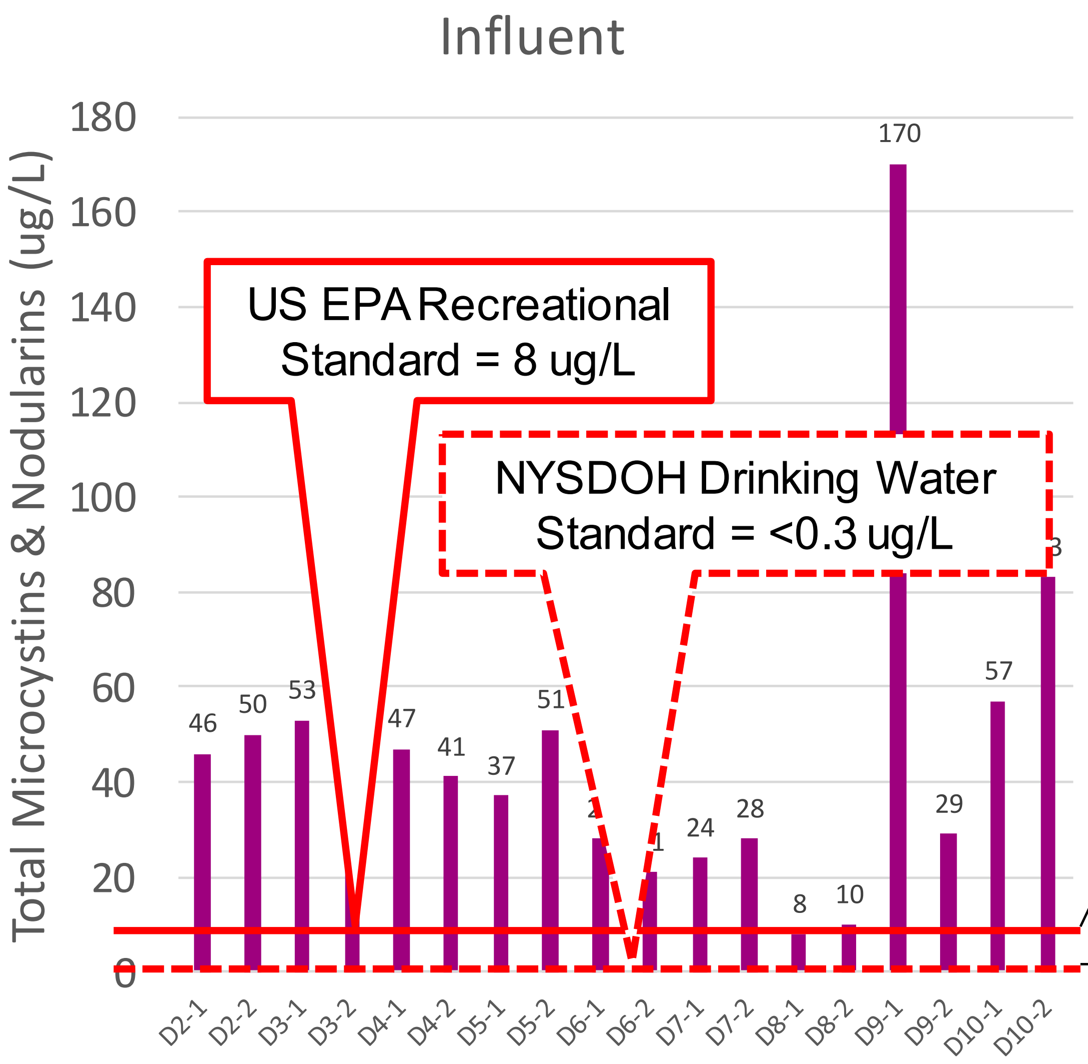
Removal of Total Phosphorous

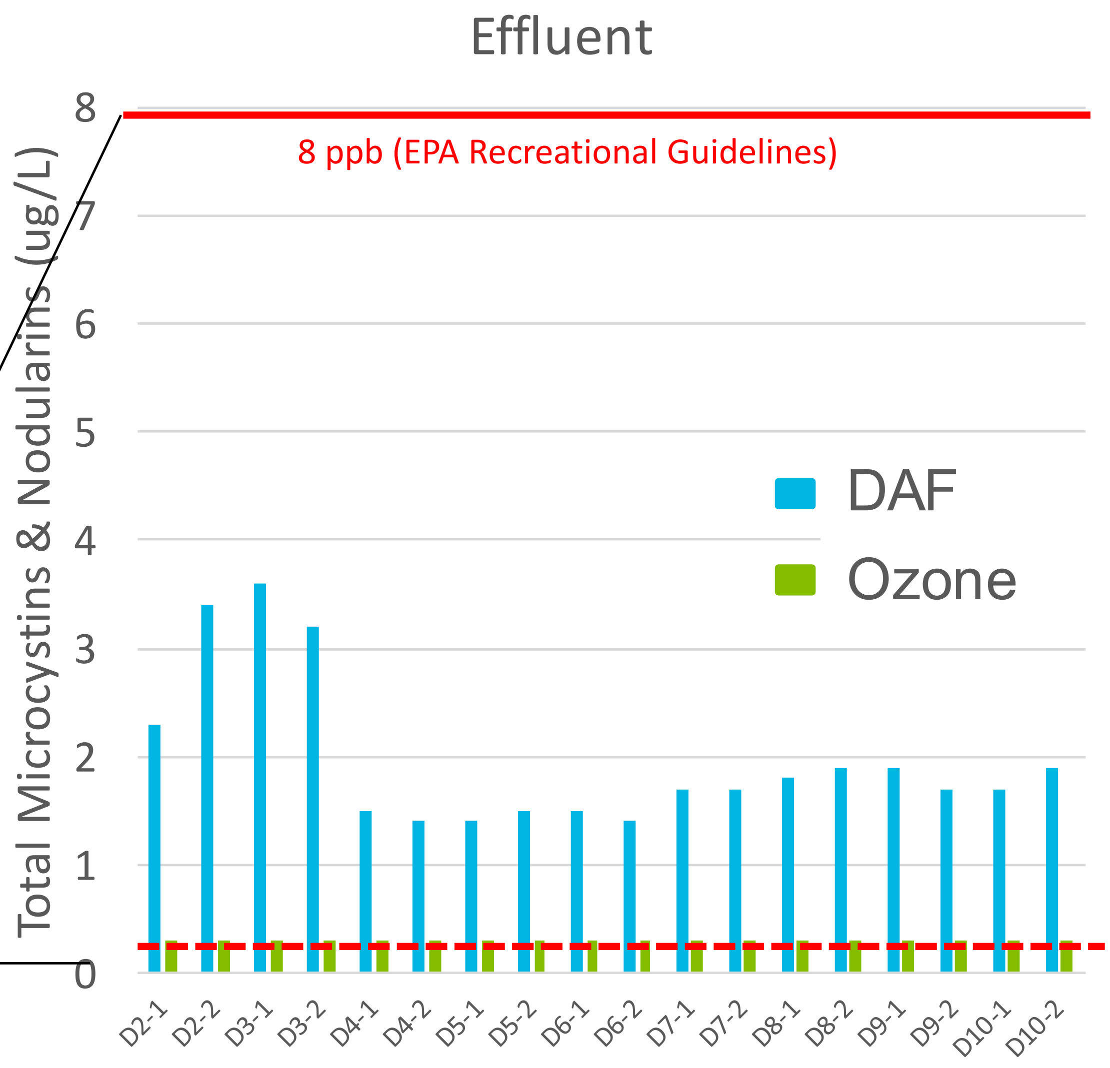


Removal of Total Nitrogen



2019 Lake Agawam Pilot-Test Results





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Lake Agawam Pilot Test Results

Key Parameters	Before Treatment	After Treatment	% Removed
Microcystin	46 ppb	<1 ppb	99.0%
Chlorophyll a	197 ppb	<1 ppb	99.7%
Total Phosphorus	220 ppb	10 ppb	94.5%
Total Nitrogen	3,640 ppb	550 ppb	82.1%

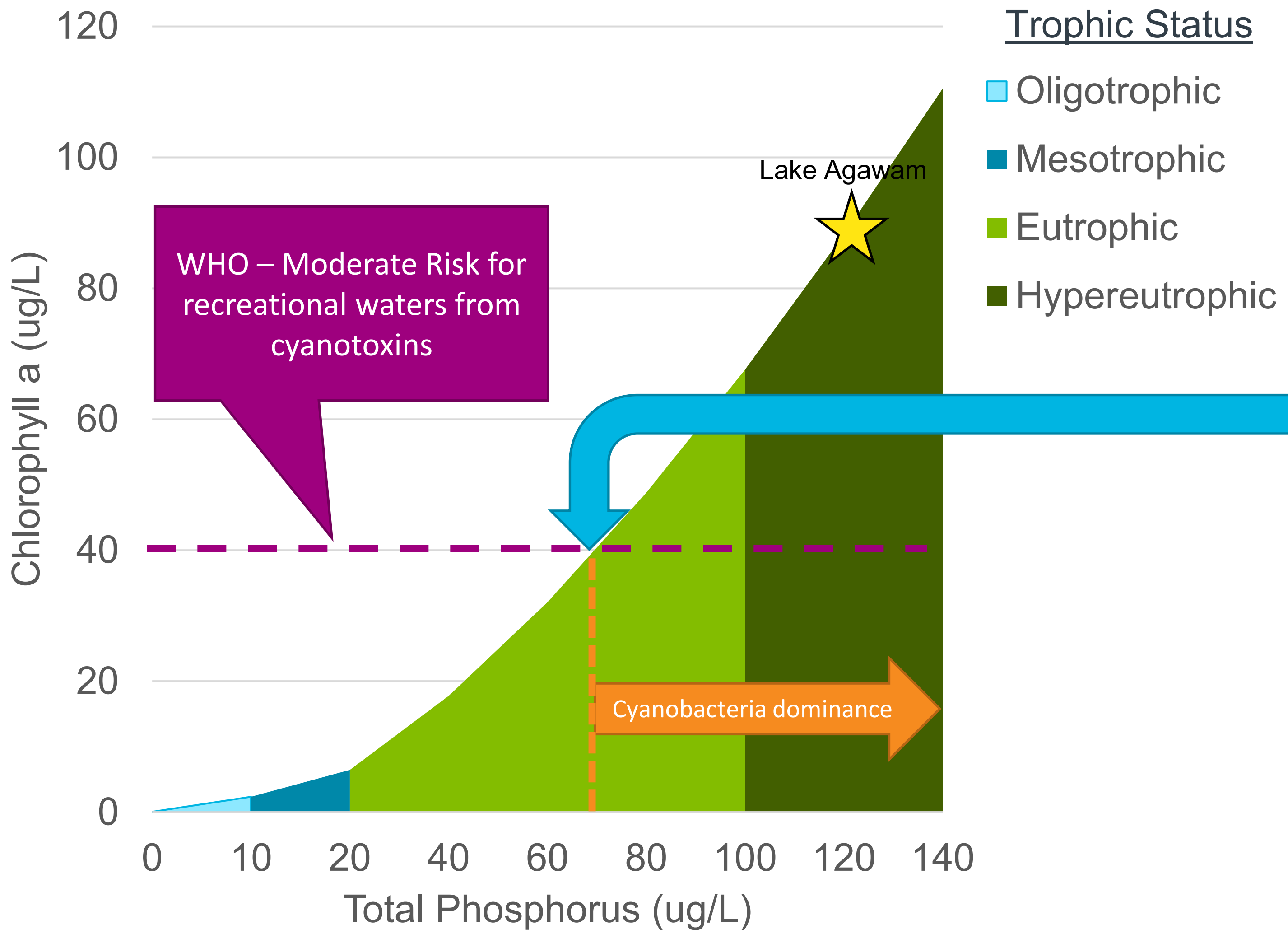
Lake Agawam -2020 Management Plan

Lake Agawam – Nutrient Concentrations

Table 1. A comparison of the total phosphorus levels (TP), secchi disc depth or water clarity depth (Secchi), and chlorophyll *a* thresholds US EPA uses to define the trophic status of lakes. By these definitions, Lake Agawam is a hypereutrophic waterbody.

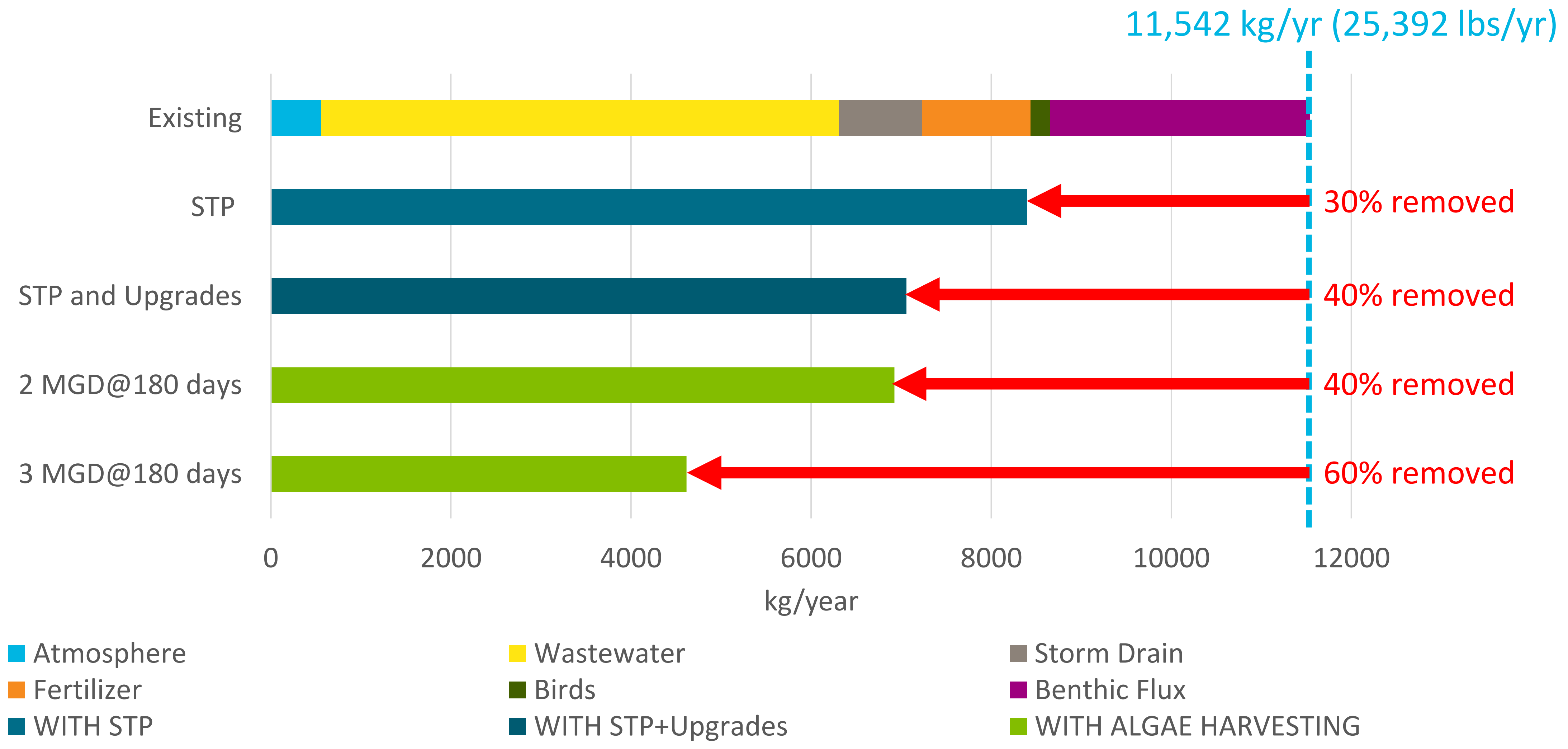
		TP (ug / L)	Secchi (m)	Chlorophyll (ug / L)	TN (µg/L)
Good Health	Ultraoligotrophic	< 3	> 6	< 1	-
	Oligotrophic	4 - 12	3 - 6	1- 4	<350
	Mesotrophic	12 - 30	2 - 3	4 - 8	350-560
	Eutrophic	30 - 100	0.8 - 2	8 - 25	651-1,200
Bad Health	<u>Hypereutrophic</u>	> 100	< 0.5	> 25	>1,200
	Lake Agawam, (annual average)	120	0.46	110	??
Danger Zone	**2019 Pilot Test**	220 (120% higher)		197 (780% Higher)	3,600 (300% higher)

Phosphorus and Chl-a Management Targets

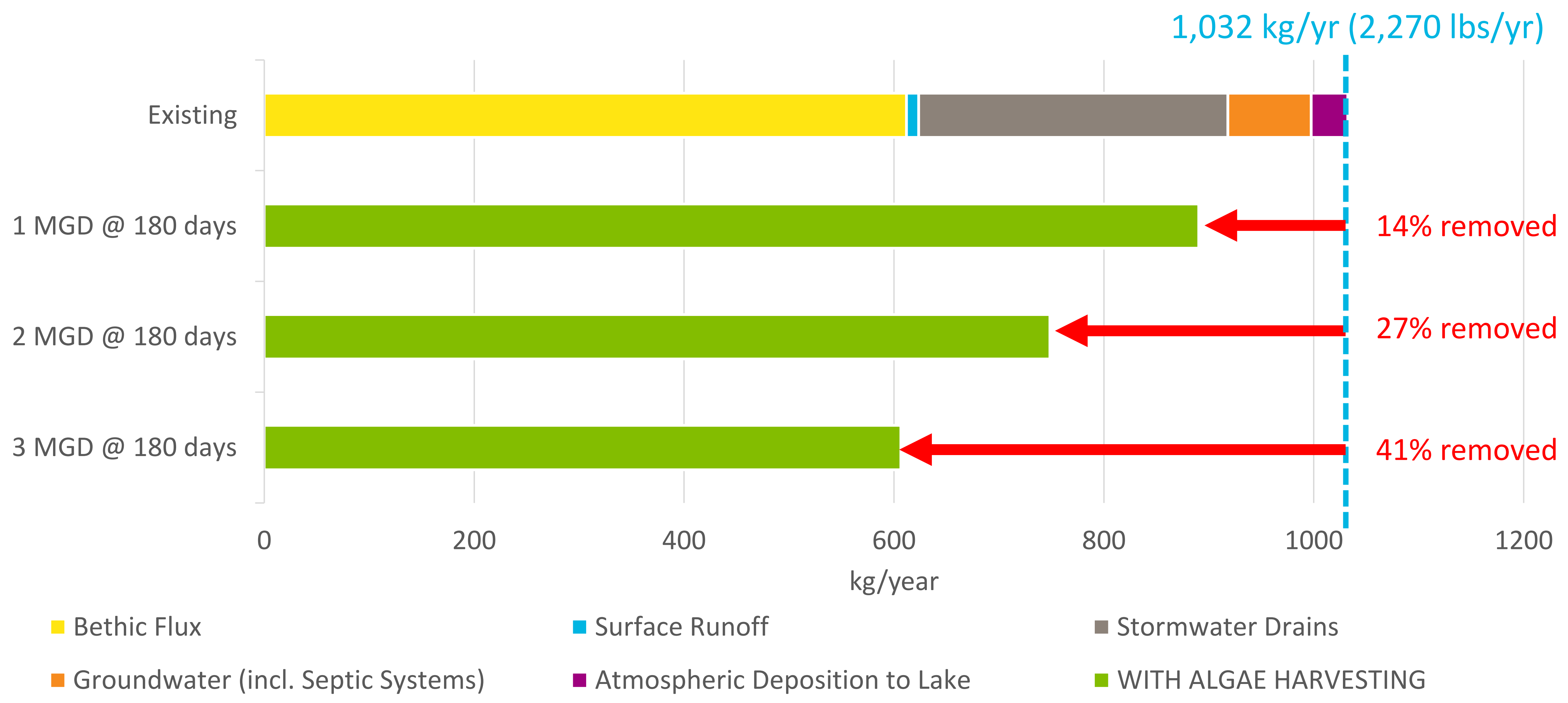


Targets need to be below:
Chl-a <40 ppb
TP <70 ppb

Nitrogen Load into Lake Agawam



Phosphorus Load into Lake Agawam



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What’s Needed for Lake Agawam

Algae Harvesting Goals and Objectives

Scenario	TP (kg/yr)	TN (kg/yr)	Comments
Existing Nutrient Load into Lake Agawam	2,200	25,000	• Lake hypereutrophic
Proposed Targets	1,320 40% Reduction	15,528 40% Reduction	• TN (equal to STP + upgrades) - to reduce cyanobacteria biomass by 55% • TP - to achieve 70 ppm and reduce risk of cyanobacteria dominance
Nutrient Load into Lake Agawam with:			
Sewage Treatment Plant (STP)	?	18,471	• achieved 10-20 years after implementation
Sewage Treatment Plant (STP) with Upgrades	?	15,528	
1 MGD Harvesting	1,959	20,314	• achieved within 6 months • TN target met with 2 MGD • TP target met with 3 MGD • 2 MGD will lower TP to <100 ppm in lake (eutrophic)
2 MGD Harvesting	1,647	15,235	
3 MGD Harvesting	1,335	10,157	

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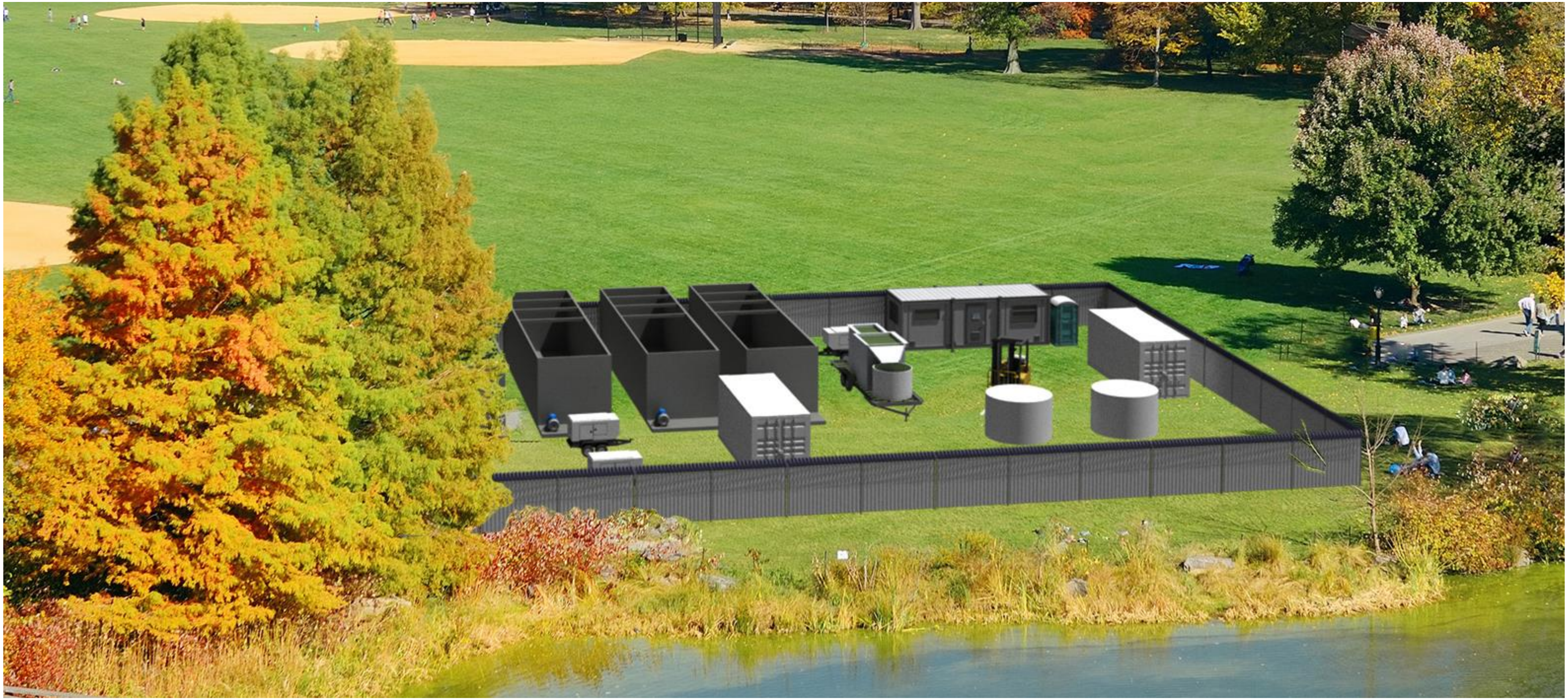
Conceptual Rendering for 3 MGD Harvester (3,500 sq-ft)

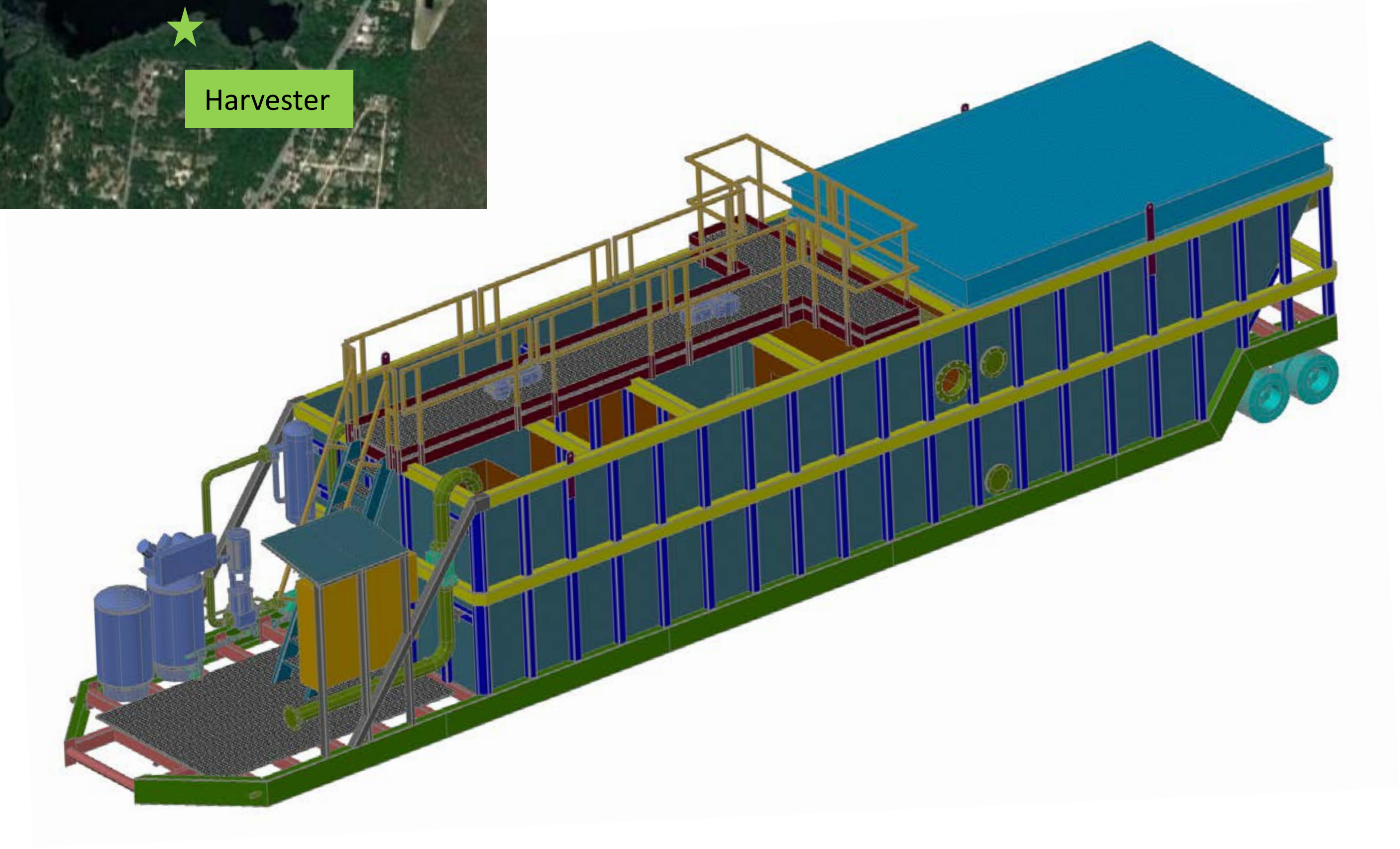


Questions

Florida Projects Underway

Mobile Land Harvester (1 MGD)

Lake Munson
255 Acres



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Lake Jesup

Innovative Technology Kickoff Scheduled

September 7, 2021

Senator Brodeur and Rep. Truenow

AECOM Imagine it. Delivered.

Lake Agawam

Innovative Algae Harvesting Demonstration Project

SD089 Lake Agawam, Southampton, NY

New York State Office of General Services

February 2020

FINAL

Prepared for
New York State Department of Environmental Conservation, Bureau of Water Assessment Management

625 Broadway, Albany, NY 12233

Statement of Qualifications and Limitations

The attached Report (the "Report") has been prepared by AECOM Technical Services ("AECOM") for the benefit of the New York Office of General Services ("Client") in accordance with the agreement between AECOM and Client, including the scope of work detailed therein (the "Agreement").

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- may be based on information provided to AECOM which has not been independently verified;
- has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued;
- must be read as a whole and sections thereof should not be read out of such context;
- was prepared for the specific purposes described in the Report and the Agreement; and
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Quality Information

Prepared by	Checked by	Verified by	Approved by
Tammy Karst-Riddoch, PhD David Pinelli	Chandy John, PhD	William Colona, PG	Daniel Levy, PG

Revision History

Revision	Revision date	Details	Authorized	Name	Position
1	2020-01-20	Draft report edits	Daniel Levy, PG	Tammy Karst-Riddoch, PhD	Senior Limnologist
2	2020-01-24	Draft Final report peer review	Daniel Levy, PG	Daniel Levy, PG	Project Director
3	2020-02-24	Final report edits	Daniel Levy, PG	Tammy Karst-Riddoch, PhD	Senior Limnologist

Distribution List

# Hard Copies	PDF Required	Association / Company Name
	Yes	New York State Office of General Services
	Yes	New York State Department of Environmental Conservation

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Executive Summary

New York State's Harmful Algal Blooms (HABs) Initiative was launched in 2018 with $82 million state funding that has been allocated to identify contributing factors fueling HABs and implement strategies to reduce the frequency of the blooms, address their causes, and protect water quality. Advanced algae harvesting technology that uses Dissolved Air Flotation (DAF) has proven effective at removing algae from waterbodies and may offer an effective and environmental-friendly solution to address HABs in New York. The New York State Office of General Services (OGS) and the New York State Department of Environmental Conservation (NYSDEC) contracted with AECOM to conduct a proof-of-concept Pilot Demonstration to demonstrate the effectiveness of AECOM's DAF algae harvesting technology at Lake Agawam, Southampton, New York. If proven successful, the DAF treatment system could be applied to Lake Agawam and other water bodies in New York and elsewhere to provide an effective and environmentally-friendly solution to combat HABs.

The DAF technology takes advantage of the inherent characteristic of algae to float. Algae-laden water is withdrawn from the water body and conditioned by adding a small amount of commonly used potable water treatment chemical to create an algae floc. Microscopic air bubbles generated by the DAF process attach to algae floc, which imparts buoyancy. The algae floc then floats to the surface of the water in a flotation tank, where it can be skimmed thereby effectively removing algae and associated nutrients and algal toxins. Advanced treatment methods such as chemical oxidation using ozone, hydrogen peroxide or both can be applied to DAF treated water to destroy remaining microcystins if present, to meet stringent water quality guidelines for the protection of human health. The treatment is a no-harm solution in that no chemicals are applied directly to the water body. Moreover, recovered algae can potentially be used in agriculture as fertilizer, for gas generation by aerobic digestion, in the manufacture of bioplastics, and converted to a biocrude for energy production.

The launch of the DAF algae harvesting pilot demonstration was announced by New York Governor Andrew M. Cuomo at a press conference on October 3, 2019 and attended by several state and local dignitaries. The demonstration was conducted over a 10-day period from Monday, October 7 through Wednesday, October 16, 2019, and followed a Quality Assurance Project Plan and a Health and Safety Plan developed for the project. Intensive monitoring was conducted over the duration of operations to evaluate and document treatment effectiveness to remove algae and associated nutrients and toxins from Lake Agawam.

The Lake Agawam ten-day demonstration project was successful and provided site-specific data and supporting evidence that use of DAF technology was safe and effective in removing algal biomass and associated microcystins and nutrients (phosphorus and nitrogen). The treatment exceeded project expectations with average removal efficiencies of:

- Chlorophyll a >99%;
- Total Suspended Solids >80%;
- Total Microcystin and Nodularin >90%;
- Total Phosphorus >90%; and
- Total Nitrogen >80%.

Moreover, additional treatment of the DAF effluent by ozonation removed microcystins to levels below laboratory reportable limits, such that water returned to Lake Agawam met Federal and State drinking water guidelines for this toxin.

No significant treatment effects due to the use of coagulants and ozonation, or health and safety issues due to air quality, were experienced over the duration of the project. Potential parameters of concern remained below applicable standards and guidelines, including pH, aluminum and VOCs in effluent discharged back to the lake, and airborne toxins (i.e., microcystins, endotoxins and VOCs).

The success of the demonstration project supports implementation of DAF technology as an option to address HABs in Lake Agawam as well as other waterbodies in New York.

1. Introduction

1.1 Harmful Algal Blooms (HABs) in New York State

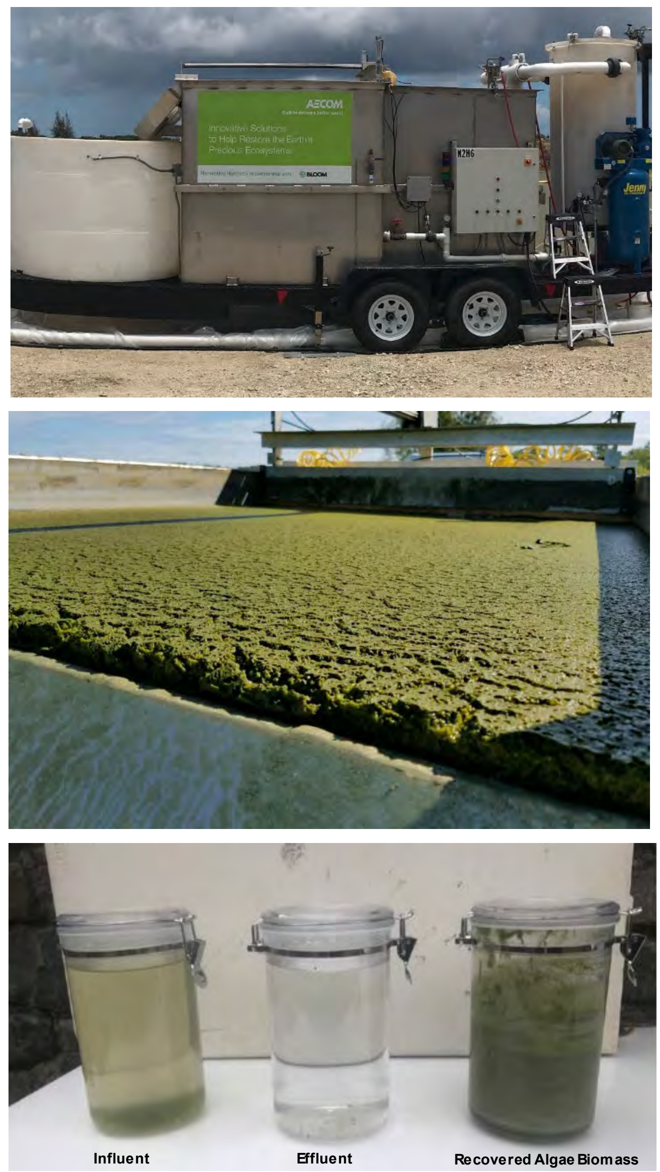
Harmful Algal Blooms (HABs) are increasing in frequency, intensity, and duration and have the potential to adversely affect human health, economic prosperity, and the water quality of both potable and recreational waters of the state of New York. In 2018, the New York State Department of Environmental Conservation (NYSDEC) received notifications of HAB events on more than 170 lakes throughout the state (NYSEC, 2018).

Since Governor Andrew M. Cuomo launched New York State's HABs Initiative in 2018, more than $82 million in state funding has been allocated to identify contributing factors fueling HABs and implement strategies to reduce the frequency of the blooms, address their causes, and protect water quality. As part of this initiative, the state is actively seeking and deploying new and innovative tools to treat and prevent HABs. Advanced algae harvesting technology that uses Dissolved Air Flotation (DAF) has proven effective at removing algae from waterbodies and may offer an effective and environmental-friendly solution to address HABs in New York.

1.2 DAF Treatment Technology

The algae-harvesting technology developed by AECOM uses DAF, a process that was initially developed for use in the aquaculture industry (i.e., fish farming) in the southeastern United States. The process was originally used to recover algae biomass from catfish farms for a biotechnology startup company utilizing the biomass as a feedstock in the development and manufacture of bioplastics. Controlling algal populations in the ponds was a secondary objective. The DAF technology was advanced and optimized by AECOM to operate at a high hydraulic loading rate while efficiently capturing algae and associated toxins and nutrients in the form of concentrated slurry, thus converting a green or brown water stream into a clear, sparkling water stream. The captured slurry contains nutrients and organic compounds may be further processed for secondary uses such as fertilizer and biofuel production.

The DAF harvesting system takes advantage of the inherent characteristic of algae to float. Algae-laden water is conditioned by adding a small amount of commonly used potable water treatment chemical(s), which coagulate (clump) the algae into larger particles to create a "floc" as the water flows through a series of treatment and mixing tanks. Microscopic air bubbles generated by the DAF process attach to algae floc, which imparts buoyancy. The algae floc then floats to the surface of the water in a flotation tank, where it forms a dense "skimmate" layer (the float blanket).



A mobile Dissolved Air Flotation unit (top) that captures and flocculates algae (middle) to clarify water (bottom).

The skimmate layer is efficiently separated from the water by a skimmer that moves across the top of the flotation tank discharging the slurry to a holding tank. The technology is scalable and can be operated in configurations ranging from a mobile trailer or barge-mounted unit to larger-flow modular units that can be connected and run in parallel, or placed at pre-determined, strategically selected locations (lakeside or discrete locations out of public view). The system can therefore be deployed to a wide range of surface water bodies, from small ponds to large lakes, and rivers.

Phosphorus and nitrogen are the nutrients essential for algae growth and elevated concentrations of these nutrients can fuel algae blooms. These nutrients take many forms in the environment, including dissolved or soluble fractions and particulate or bound fractions, and vary in their biologic availability. Organic matter (e.g., aquatic plants, phytoplankton, fish, etc.) also serve as a source or sink for nutrients during biological processes. For example, cyanobacteria and algae take up nutrients and incorporate them intracellularly, using nitrogen for protein synthesis and phosphorus to fuel chemical reactions. When suspended solids and intact cyanobacteria and algae are removed via the DAF process, the fraction of particulate nutrients bound to those particles or within those organisms are also removed.

Removal of intact algae also removes toxins contained within the algae cells. Advanced treatment methods such as chemical oxidation using ozone, hydrogen peroxide or both can be applied to DAF treated water to destroy remaining microcystins if present, to meet stringent water quality guidelines for the protection of human health.

In July 2019, AECOM collaborated with the US Army Corps of Engineers, through its Environmental Research & Development Center (ERDC) in in Phase 1 of the Harmful Algal Bloom Interception, Treatment, and Transformation System (HABITATS) project (Page *et al.* 2020). This study demonstrated that the DAF process was effective in clarifying water and concentrating algae, greatly reducing the volume of waste to be managed. The clarified and oxidized water had no measurable toxicity and greatly reduced levels of phosphorus and nitrogen, making it suitable for discharge into the environment. Research is ongoing to evaluate the use of recovered algal biomass to produce biocrude (Page *et al.* 2020).

1.3 Study Purpose and Objectives

The objective of this pilot project was to demonstrate the effectiveness of AECOM's DAF algae harvesting technology in a freshwater lake in New York State that is impaired by HABs and to determine the effectiveness of the treatment to remove algae and associated toxins from the source water through comparison of key water quality parameters in influent and effluent from the system.

2. Demonstration Program Development

To help identify credible technologies and approaches to mitigate and manage HABs, the New York State Office of General Services (OGS) and NYSDEC contracted with AECOM to conduct a short-duration (two-week) proof-of-concept Pilot Demonstration project for the capture and removal of a HAB at a waterbody in New York.

On Friday, September 20, 2019, a telephone and e-mail dialog began between OGS and AECOM. During these communications, the State of New York expressed interest in immediately implementing a HAB control pilot demonstration at a to-be-determined surface water body. OGS requested that staff from AECOM travel to Albany, New York on Monday September 23, 2019, to participate in a one-day project scoping meeting, the thought being to directly engage qualified staff from OGS, NYSDEC, and AECOM, thereby starting a collaborative effort to develop the pilot demonstration program.

AECOM submitted a proposal for a pilot demonstration to OGS on September 22, 2019, which outlined the understandings and objectives of the project. OGS authorized Task 1 and Task 2 of that proposal:

- **Task 1** – Project Planning /Work Scope Development: Key members of AECOM's Algae Solutions Team, along with a representative from the AECOM Albany, New York office would attend up to two days of meetings with the OGS team in the OGS Albany office (9/23/2019 and 9/24/2019) to help develop and finalize the project scope and schedule.
- **Task 2** – Algae Harvester Mobilization to Albany, New York: AECOM would immediately mobilize one Algae Harvester Unit and supporting equipment to Albany, New York for temporary storage and staging. Once a site was identified by OGS or NYSDEC, AECOM would transport the harvester and equipment to the designated location. Site access, security, electricity requirements, biosolids management, etc., would be determined once a site has been identified.

Subsequent scope changes were managed via a Modification to the initial contract issued by OGS.

2.1 Study Site Selection

A project scoping meeting was held on September 23, 2019, on the 33rd Floor, Corning Tower, ESP, Albany, New York with representatives from OGS, NYSDEC, and AECOM. Following the scoping meeting, AECOM mobilized its trailer-mounted DAF unit to New York on September 27, 2019, for temporary staging prior to deployment.

On October 2, 2019, OGS and NYSDEC selected Lake Agawam for the pilot test. Lake Agawam is in the Village of Southampton, New York and has an approximate surface area of 64 acres and a shoreline length of 2.06 miles. Lake Agawam has a history of significant HAB events. Visual observations and sampling conducted by NYSDEC confirmed that Lake Agawam was experiencing a lakewide HAB event.

The algae harvesting test equipment was deployed to Lake Agawam. A press conference was hosted on site on October 3, 2019, by New York Governor Andrew M. Cuomo, announcing the launch of the innovative new pilot project to combat HABs and return clean water to Lake Agawam. The pilot project is a component of the State's $82 million initiative to study, respond to, and prevent HABs in New York water bodies.

2.2 Quality Assurance Project Plan (QAPP)

On September 27, 2019, AECOM submitted a draft project-specific Quality Assurance Project Plan (QAPP) to NYSDEC for review following the requirements set forth in the US Environmental Protection Agency (EPA) Requirements for Quality Assurance Project Plans (QA/R-5) - March 2001 (Reissued May 2006), EPA/240/B-01/003, and other applicable guidance provided on US EPA's Quality Assurance website (www.epa.gov/quality/qapps.html).

The final QAPP incorporated revisions requested by OGS/NYSDEC and was executed on September 30, 2019 and later amended on October 16, 2019.

2.3 Health and Safety Plan (HSP)

A site-specific health and safety plan (HASP) was prepared to address the physical hazards that may be present or encountered during execution of the demonstration pilot. The HASP was prepared in compliance with the requirements of 40 CFR §300.150 and 40 CFR §1910.120.

The HASP is intended to identify known potential hazards and to facilitate communication and control measures to prevent injury or harm. Additionally, provisions to control the potential for environmental impact from these activities are included where applicable.

AECOM observed the mobilization, operation, and demobilization of a mobile algae harvesting system. The primary components of the system are a trailer-mounted algae harvester, an ozone and hydrogen peroxide water treatment unit, a trailer-mounted dewatering press, a portable diesel-powered electric generator, a small water craft with booms and a weir-skimmer, and an industrial vacuum truck.

The potential physical hazards associated with the project included:

- Drowning hazard;
- Biological hazards (blue-green algae [cyanobacteria] toxins);
- Chemical hazards associated with chemical products used in the treatment process;
- Mechanical hazards associated with the algae harvester; and
- Electrical hazards associated with equipment.

2.4 Effectiveness Measures

As outlined in the QAPP, information co

llected during the Pilot Demonstration is intended to assess the effectiveness and appropriateness of the Pilot Demonstration technology to remove algae and associated nutrients and toxins from Lake Agawam. Information to be collected and assessed included:

- Documentation of changes in water quality parameter concentrations at each point in the treatment train, including influent to the DAF, between the DAF and the oxidation units, and the effluent after oxidation, as calculated by percent removal and flow rate in relation to volume treated;
- Evaluation of the amount of sludge produced per day in gallons, as estimated by the volume contained in the polypropylene slurry tank prior to daily waste removal and verified by waste hauler upon disposal;
- Evaluation of the energy usage through the DAF and oxidation units independent of one another, as a ratio of kW energy expended per gallon of water treated (kW/gal);
- Evaluation of total microcystin toxin removal by the DAF and further removal by the oxidation units; and
- Verification of comparability of treatment effects on water quality through the treatment unit stages.

3. Study Site – Lake Agawam

Lake Agawam is a 64-acre body of water located in the Village of Southampton, Suffolk County, New York (Figure 1). Historically the lake has been used for recreation including sailing, boating, fishing and ice skating, and has been a source of enjoyment for Village residents since Village incorporation in 1894.

Lake Agawam sits at an approximate elevation of 10 feet above mean sea level and has a shoreline length of 2.06 miles (NYSDEC 2013). The lake is a focal point within the Village, lying centrally within the Village boundaries and extending from the west part of the Village downtown business district, south of Jobs Lane, to the Southampton Bathing Corporation along Gin Lane, south of which is the Atlantic Ocean. The north side of Lake Agawam is bounded by Agawam Park, and the water body is readily visible from Jobs Lane, Pond Lane, and Gin Lane, thus establishing its prominence as an important feature in the Village (NP&V 2009).

The formation of Lake Agawam is well characterized in the *Comprehensive Management Plan for Lake Agawam* (NP&V 2009):

> "Like a number of other lakes in Southampton Village and along the south shore of Southampton Town, Lake Agawam was likely a basin created as a result of glacial meltwater traversing from the moraines and outwash plains to the north, south to the Atlantic Ocean. The lake was likely once connected to the ocean, but littoral drift along the south shore has created an east-west trending barrier beach which separates many similar water bodies from the ocean. Lake Agawam is now a freshwater body, and the only connection to the ocean is an outflow pipe used to relieve lake water levels by controlled release to the ocean through a manually operated valve".

The migration of nutrients from land surface and groundwater discharge into Lake Agawam has led to a host of environmental problems including toxic and extensive algal blooms, which in turn have created hypoxic zones, habitat loss and resulted in past fish kills (NP&V 2009, Davis *et al.* 2009, Gobler *et al.* 2007, Gobler 2017). Since monitoring of Lake Agawam began in 2003 by researchers at Stony Brook University, dense, toxic cyanobacteria blooms have generally persisted from May through November of each year l (Gobler *et al.* 2007, Gobler 2017). These blooms are comprised primarily of *Microcystis* although *Anabaena* can sometimes be numerically dominant, particularly in early summer months (Gobler 2019). Concentrations of microcystin, a hepatotoxin, have often been elevated during bloom conditions and have exceeded the World Health Organization recommended recreational guideline of 20 µg/L (Chorus and Bartram, 1999), and the neurotoxin, anatoxin-a, has been occasionally documented (Gobler 2017).

Lake Agawam was listed as an impaired water body under Section 303(d) of the Federal Clean Water Act in 2008 due to elevated phosphorus and low dissolved oxygen that restrict beneficial uses of the lake, and a Total Maximum Daily Load (TMDL) or other strategy is therefore required to restore and protect such uses.

The Village of Southampton and concerned citizen action groups such as the Lake Agawam Conservation Association and Lake Agawam Conservancy Group have taken significant measures to help mitigate adverse environmental effects of nutrient enrichment on Lake Agawam. This has included publishing an "owners guide" for residents showcasing Best Management Practices (BMPs) to reduce nutrient transport to the lake including the use of riparian buffer zones incorporating native plants, proper timing and application rates for lawn fertilization and proper septic tank inspection and maintenance. The Village has also intensified efforts to upgrade sewer and stormwater infrastructure that will aid in reducing contaminant and nutrient loading to Lake Agawam. Notwithstanding these efforts, Lake Agawam remains impaired and will benefit from continued restoration efforts.

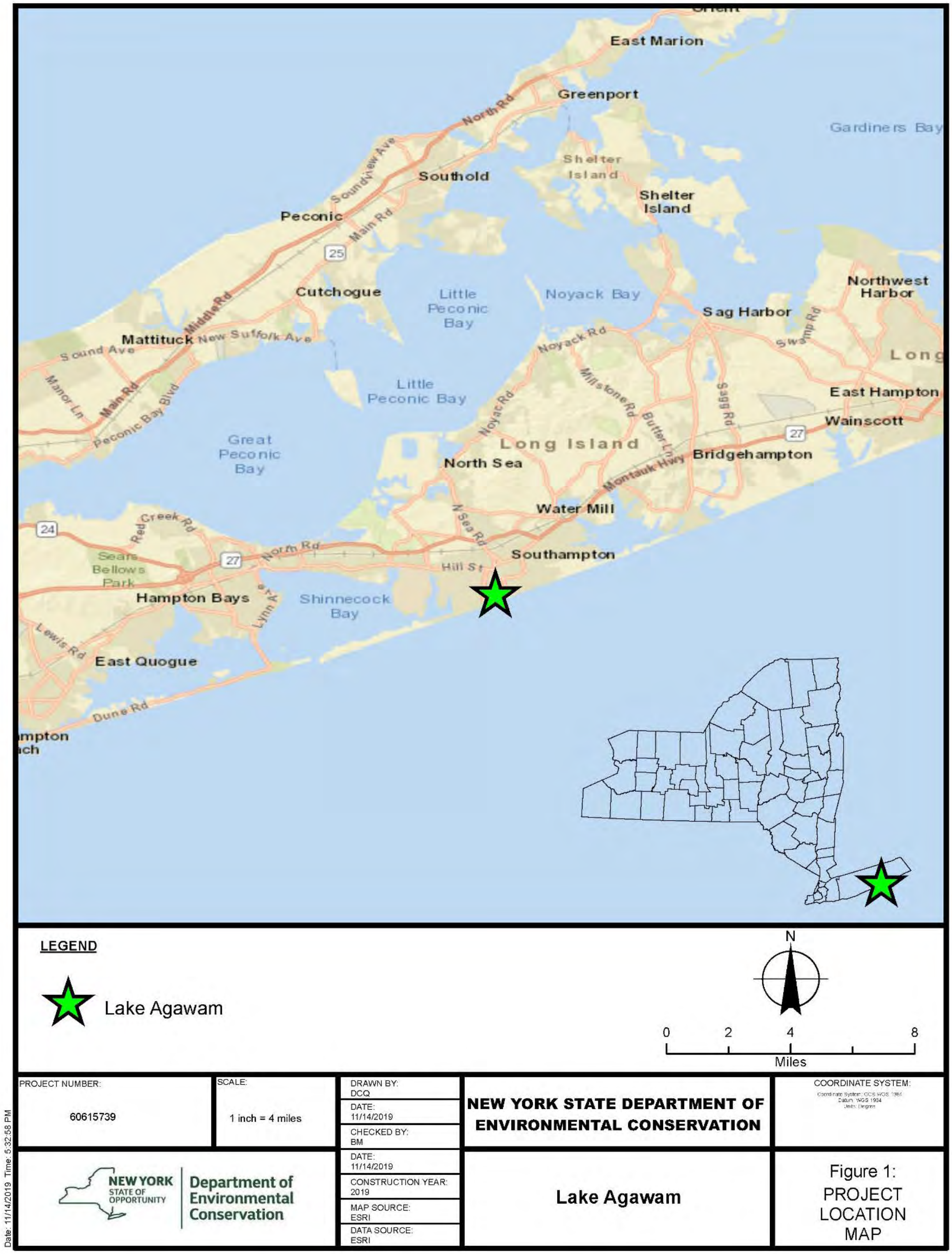


Figure 1: Location of Lake Agawam, Southampton, New York

4. Field Activities

Field activities conducted over the course of the project are described in the sections that follow. A photo-log documenting the field activities is presented as **Appendix A**.

4.1 Bench-Scale Testing

4.1.1 Test Procedures

Lake Agawam water samples were screened for the response to coagulation with Aluminum Chlorohydrate (ACH) and the further response to flocculation with Polyacrylamide flocculants. Conditioned lake water samples exhibiting favorable characteristics were floated using a bench-scale flotation testing technique and further assessed to maximize DAF system performance.

Most bench work used 300 mL sample aliquots. A precise amount of diluted treatment chemical was added to the water samples using 1 mL syringes and mixed manually using a stainless-steel spatula. Selected chemically treated samples were then floated in a bench-scale flotation test apparatus comprising a 500 mL graduated separatory funnel as the flotation vessel and a 0.5 L, handheld, aluminum pressure vessel for simulation of the Recycle Pressurization System of the DAF system. This testing technique generates valuable information that is predictive of full-scale DAF system performance, including:

- Air Bubble Stability;
- Air Bubble/Solids Agglomerate Rise Rate;
- Air/Solids Bond Strength;
- Wet Consolidated Solids (Float) Volume; and
- Effectiveness of Treatment (Effluent Clarity).

Coagulated and flocculated samples were visually assessed for floc particle size, strength, and break (apparent clarity between floc particles). Duplicates of each conditioned sample were prepared, with one of the paired samples subjected to full pressurization in a bench-scale flotation test apparatus. This step generated clarified water for use as the recycle stream for generating effluent and assessing flotation characteristics.

Initial bench work indicated that an ACH dosage in the range of 20 to 30 parts per million (ppm), coupled with a cationic flocculant (Polytec 2160) dosage of 1 to 2 ppm, sufficiently conditioned the water for clarification by flotation.

The bench-scale treatment and flotation testing demonstration conducted for state and local dignitaries on October 3, 2019, used 20 ppm ACH and 1 ppm Polytec 2160, coupled with flotation using approximately 20% recycle.

4.2 Mobilization and System Setup

Equipment began arriving at the Lake Agawam site late on Wednesday October 2, 2019. First to arrive was the U-Haul box truck containing the floating surface skimmer along with support equipment. A portable pull-behind light stand, two portable pull-behind diesel generators, and a large fork truck (loader) arrived as well. The trailer-mounted M2H7 Algae Flotation Harvester was delivered to the site by New York State Department of Transportation (NYSDOT) early morning on Thursday, October 3, 2019. By midday of October 3, the harvester was connected to generator power, the temporary intake system was deployed in Lake Agawam, and setup was underway. The portable diesel generator-powered light stand was repositioned and repurposed as a single-phase power source. By approximately 1:00 pm the weir skimmer and floating boom were deployed in the lake, chemical feed systems were in place and primed, and flocculant was being mixed, which allowed the system to operate during the tour by dignitaries.

Initial mobilization was the culmination of efforts by New York State executive staff and numerous agencies, including the OGS, NYSDEC, and NYSDOT. In addition, critical services were provided by the Village of South Hampton Department of Public Works.

In the succeeding three days, NYSDOT-provided generators were exchanged for those provided by AECOM; an electrical distribution system was constructed to power major equipment components; the oxidation system container and office trailer arrived and were placed and powered. In addition, the weir skimmer was repositioned, a new boom with screen was deployed, the receiving tank was placed, and interconnecting piping was installed.

Figure 2 depicts the site configuration showing the position of the boom and weir skimmer in Lake Agawam and the location of the operations site adjacent to the lake. The “As-Built” process configuration of the treatment system is provided in **Appendix B**.

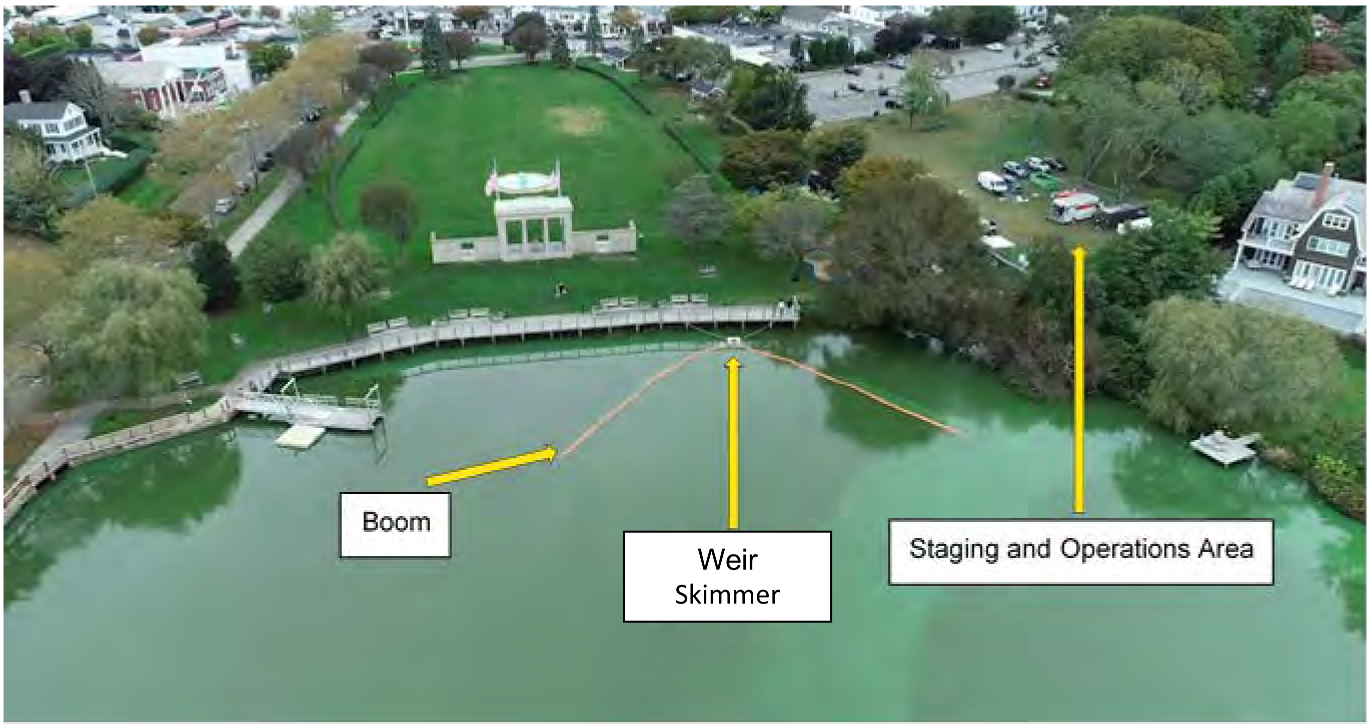


Figure 2: Aerial Photograph of Lake Agawam Showing the Configuration of the Treatment System

4.3 System Operations

4.3.1 Dissolved Air Flotation (DAF)

Algae removal by DAF was demonstrated over a 10-day period from Monday, October 7 through Wednesday, October 16, 2019.

Algae and associated constituents were coagulated with ACH in the first of two conditioning tanks at the inlet end of the M2H7 Flotation Harvester. Further conditioning of the influent stream (particle growth and flocculation) occurred in the second of the two compartments prior to the stream entering the mixing zone, where contact was made with the incoming microbubble (whitewater) stream. The harvester is equipped with a highly efficient recycle pressurization and release system for generation of microbubbles needed for flotation separation. Floated algae accumulated on the surface of the 30 ft^2 flotation compartment. A timer-controlled pneumatic skimmer moved floated algae to a 900-gallon algae slurry collection tank.

The M2H7 Flotation Harvester is capable of processing water at a rate of 200 gallons per minute (gpm) or at a hydraulic loading rate of 8.0 gpm/ft^2 of flotation surface area [(200 gpm process water flow + 40 gpm recycle flow) ÷ 30 ft^2 of flotation surface area]. For most of the pilot demonstration, the harvester was operated under the more conservative process water flow rate of approximately 60 gpm to balance with the hydraulic capacity of the oxidation system. The resulting hydraulic loading rate averaged 2.4 gpm/ft^2.

Key harvester operating parameters were monitored, adjusted, or purposely varied throughout the 10-day operating period to optimize separation of algae from the water. Those parameters included:

- Influent Flow Rate – monitored and adjusted to maintain a balance with the hydraulic capacity of the oxidation step, and purposely varied to assess system performance. For example, on Day 10, flow was increased to the maximum output of the surface skimmer (88 gpm) to asses system performance at higher flow.
- Coagulant (ACH) Flow Rate (dosage) - a process variable adjusted to generate removal efficiency data over a range of dosages to determine the minimum dosage required to meet algae removal objectives.
- Flocculant Type – a very low dosage of cationic flocculant was used throughout the 10-day demonstration except for Day 3 when bench work suggested an anionic flocculant would be more effective. The observed response helped diagnose the coagulant dose was high due to a bench scale to full scale calculation error.
- Flocculant Stock Solution Concentration - due to the relatively low lake water flow rate and the very low flocculant dosage requirement, stock solution was reduced incrementally to as low as 0.025% by weight to allow the flocculant feed pump to operate effectively. Flocculant pump capacity was much greater than required under the demonstration flow conditions.
- Conditioning Tank Mixer Speed - adjusted to optimize apparent floc particle form and structure.
- Flocculant Flow Rate (dosage) - adjusted to optimize flocculant dosage for performance and to balance stock concentration with pump output. No flocculant was used on Day 7.
- Recycle Flow Rate - a process variable adjusted to optimize at low end of flow rate that maintained good system performance.
- Process Air Flow Rate - a process variable adjusted to optimize at low end of flow rate that maintained good system performance.
- Skimming Cycle - a process variable adjusted to optimize system performance, i.e., to maximize the solids concentration of recovered biomass.

Key operating parameters were as follows:

- The daily run time varied over the 10-day period from 5.5 hours on Day 1 to 7.2 hours on Day 5, with a total run time of 58.8 hours.
- The average influent flow rate was 60 gpm from Day 1 to Day 9 and was increased to 88 gpm on Day 10 to assess performance at a higher flow rate.
- The total volume of influent treated was approximately 257,000 gallons with a range of 18,800 gallons to 39,600 gallons treated per day.
- The average daily coagulant (ACH) dosage from Day 1 until 12:15 pm on Day 3 was 130 mg/L (gravimetric) resulting in a total ACH usage of 59 lbs.
- The coagulant (ACH) dosage was lowered on Day 3 following identification of a calculation error. Average daily coagulant dosage from 12:15 pm on Day 3 to Day 10 was 16 mg/L with a total ACH usage of 27 lbs.
- The total coagulant (ACH) usage over the 10 days of operation was 86.75 lbs.
- The average daily flocculant dosage ranged from 0 mg/L on Day 7 to 1.10 mg/L on Day 3. One exception was on Day 10 when flocculant dosage was increased to 1.58 mg/L to exhaust flocculant inventory at the end of operations.
- The total flocculant usage over the 10 days of operation was 1.44 lbs.

The Operating Log provides additional details on the daily operating conditions recorded during the demonstration (**Appendix C**).

4.3.2 Oxidation with Ozone

The process treatment train included oxidation process technology provided by APT Water. The system provides ozonation of process water or a combination of ozone and hydrogen peroxide oxidants as an Advanced Oxidation Process (AOP). The efficacy of destruction of microcystin, (a commonly measured cyanotoxin) by ozone has been broadly demonstrated (e.g., Rositano *et al.* 1998, Hoeger *et al.* 2005, Shawwa and Smith 2010, Didi *et al.* 2015).

The containerized oxidation system consisted of two liquid oxygen-fed ozone generators and two plug flow, serpentine reactor trains, off-gas ozone destruction, and process monitoring equipment.

Oxidation system operation was initiated on October 8, 2019 (Operations Day 2). It was determined on Day 2 that the required residual effluent ozone concentration of trace concentration to 1 mg/L was being achieved at a relatively low ozone dose, which rendered AOP (Hydrogen Peroxide augmentation) unnecessary. Therefore, no hydrogen peroxide was used during the 10-day demonstration program.

A summary of operating conditions for the ozonation treatment recorded during the demonstration is provided in **Appendix C**.

4.4 Monitoring

4.4.1 Slurry Quality

Five slurry samples were collected from the DAF unit slurry holding tank for the analysis of total microcystins and nodularins to reflect differences in operations and site conditions according the following schedule:

- Day 5 (October 11, 2019) (duplicate field/laboratory samples)
- Day 6 (October 12, 2019)
- Day 9 (October 15, 2019)
- Day 10 (October 16, 2019)

Prior to sample collection, the slurry in the tank was thoroughly homogenized with a submersible pump. The samples were collected in a clean bucket and transferred to laboratory-issued sample bottles. The samples were placed in coolers, on wet ice, and shipped to Eurofins Eaton Analytical, LLC (Eurofins) (Day 5, Day 9 and Day 10) or GreenWater Laboratories (GreenWater) (Day 5 and Day 6) for analysis by US EPA Test Method 546 titled Determination of Total Microcystins and Nodularins in Drinking Water and Ambient Water by ADDA Enzyme-Linked Immunosorbent Assay (ELISA) (US EPA 546, ELAP Method 9168). The intended matrix of the US EPA 546 method is water; therefore, the method was used as an estimation of microcystins and nodularins content of the slurry.

4.4.2 Water Quality

Water quality monitoring was conducted at locations along the treatment train to assess treatment effectiveness. Sampling points included:

- Lake Agawam Source Water: sampled at the location of the inlet to the weir skimmer in the lake (SP-1)
- Overflow from Receiving Tank: return of raw, untreated lake water to the lake (SP-2)
- Influent to DAF: sampled from a sampling port located on the DAF unit (SP-3)
- Effluent from DAF: sampled from a sampling port located on the DAF unit (SP-4)
- Effluent from Ozone: sampled from a sampling port located on the oxidation unit (SP-5)

The locations of the sampling locations are illustrated on the Process Flow Diagram (**Appendix B**).

Influent and effluent sampling (SP-3, SP-4, SP-5) was conducted twice daily at each sample point, at approximately one (1) hour after the start of the treatment system and approximately one (1) hour prior to shutdown of the treatment system. The timing of sampling was adjusted by the on-site supervisor as needed. No samples were collected for effluent from the oxidation process on Day 1 as it was not operational until Day 2.

Several parameters were measured in the field immediately following sample collection. Temperature, specific conductivity, dissolved oxygen concentration and % saturation, and pH were measured using a YSI 556 Multiparameter System (MPS) sonde. Turbidity was measured using a Hach 2100Q turbidimeter. Ultraviolet light absorbance (UVA) at 254 nanometers (nm), an indicator of organic carbon concentration, was measured using a Real Tech 254 analyzer. Chlorophyll *a* concentration (total algae and cyanobacteria) was measured with a hand-held field screening instrument designated as an Algae Torch. Effluent samples (SP-4 and SP-5) were screened for total microcystins using Abraxis Product #520022; Immunochromatographic Strip Test for the Detection of Microcystins and Nodularins in Recreational Water at 10 ppb. The test strips provide a rapid immunochromatographic test, designed solely for the use in the qualitative screening of microcystins and nodularins in recreational water (freshwater samples only) and were used for informational purposes only.

Samples for laboratory analyses were collected on each sampling event at the influent and effluent sites (SP-3, SP4 and SP5) for the parameters listed in **Table 1**, except for total microcystins and nodularins, which were not sampled for on Day 1. Lake Agawam Source Water (SP-1) and Overflow from Receiving Tank (SP-2) sites were sampled on three occasions (unfiltered samples on Day 2, field-filtered samples on Day 9 and Day 10) for the analysis of total microcystins and nodularins only. The purpose of this sampling was to determine if the grinder pump on the weir skimmer caused breakage of cyanobacteria cells and the release of “free” microcystins into the influent water.

Sampling was conducted in accordance with the Florida Department of Environmental Protection Standard Operating Procedure FS1000 – General Sampling Procedures and Standard Operating Procedure FS2000 – General Aqueous Sampling. Laboratory-issued, labeled sample containers were rinsed with the sample water and then filled, making sure there was no headspace in volatile sample containers and that sample containers containing preservatives were not overfilled. Samples that required field-filtering were collected in clean containers, filtered using a 0.45-micron filter, and the filtrate transferred to the laboratory-issued container. Samples were placed on wet ice in coolers for processing (preservation, filtering, and packing) prior to shipment to the laboratories.

Samples at Lake Agawam Source Water (SP-1) were also collected and submitted to NYSDEC staff for additional cyanotoxin analysis via Liquid Chromatography Mass Spectrometry (LCMS) at the State University of New York College of Environmental Science and Forestry (SUNY ESF). Results of these analyses are not reported in this study.

Table 1: Laboratory Parameters and Analytical Methods

Parameter	Processing	Method	Laboratory
Alkalinity, Total	Unfiltered	SM 2320B	Eurofins TestAmerica
Aluminum	Unfiltered Field Filtered	200.7 Rev 4.4	
Haloacetic Acids 5, Total	Unfiltered	US EPA 552.2	
Iron	Unfiltered Field Filtered	US EPA 200.7 Rev 4.4	
Nitrogen, Ammonia	Unfiltered	US EPA 350.1	
Nitrogen, Nitrate + Nitrite	Unfiltered Field Filtered	US EPA 353.2	
Nitrogen, Total Kjeldahl	Unfiltered Field Filtered	US EPA 351.2	
Nitrogen, Total	Unfiltered Field Filtered	US EPA 350.1+353.2	
Phosphorus, Ortho-	Unfiltered	SM 4500 P E	

Parameter	Processing	Method	Laboratory
Phosphorus, Total	Unfiltered Field Filtered	SM 4500 P E	
Suspended Solids, Total	Unfiltered	SM 2540D	
Trihalomethanes, Total	Unfiltered	US EPA 524.2	
Chlorophyll *a*		10200H	ALS Environmental
Total Microcystins and Nodularins		US EPA 546 (ELISA)	GreenWater Laboratories, Eurofins Eaton Analytical, LLC (Note – 2)
Potentially Toxigenic (PTOX) Cyanobacteria Screen		Note - 1	GreenWater Laboratories

Notes: 1. GreenWater Laboratory Standard Operating Procedure. One ml aliquots of sample are prepared using Sedgewick Rafter cells and scanned at 100X for the presence of potentially toxigenic (PTOX) cyanobacteria using a Nikon Eclipse TE200 Inverted Microscope equipped with phase contrast optics. Higher magnification is used as needed.

2. No samples were analyzed on Day 1. Samples for Day 2, Day 3, and Day 4 were mistakenly shipped to and analyzed by GreenWater Laboratories, which is not an Environmental Laboratory Approval Program (ELAP) accredited laboratory in New York for ADDA total microcystins and nodularins. Samples for Day 5 through Day 10 were analyzed by Eurofins Eaton Analytical, LLC, which is ELAP certified in New York.

US EPA = US Environmental Protection Agency; SM = Standard Methods for the Examination of Water and Wastewater; ELISA = Enzyme-Linked ImmunoSorbent Assay.

4.4.3 Air Quality

AECOM's air monitoring program included collection of area samples and personal air samples. Area samples were collected in fixed locations and were intended to measure contaminants in the specific area sampled. Both upwind and downwind locations were selected for area sampling during AECOM's sampling event. Personal samples were collected from the breathing zone of workers and were intended to measure actual exposure of the worker for comparison with occupational exposure limits. Personal samples were collected from representative employees in each job category (e.g. harvesting technician, supervisor). The samples were collected and analyzed for three different parameters including microcystin-nodularins, endotoxins, and volatile organic compounds (VOCs).

4.4.3.1 Endotoxin Sampling and Analysis

Endotoxins are commonly associated with Gram-negative bacteria but can also be produced by cyanobacteria. A total of five (5) air samples were collected including four (4) area samples and one (1) quality control blank sample. Background area monitoring was performed during algae harvesting operations on October 5, 2019; work in progress air monitoring was conducted on October 7, 2019. The samples were collected as close as possible to the harvesting operations including upwind and downwind locations.

The samples were collected using 3-piece closed-face 37 mm cassettes with polycarbonate filters having 0.45 µm pore size. Area samples were collected at a flow rate of approximately 2 liters per minute for a period of approximately 500 minutes to obtain the maximum recommended sample volume of 1,000 liters.

Endotoxin samples were shipped to EMLab P&K in Marlton, New Jersey for analysis. Sample analysis was performed using the Limulus amebocyte lysate (LAL) assay in accordance with the laboratory's internal analytical method SOP EM-BC-S-2583. Sample results were reported in endotoxin units (EU) per cubic meter of air (EU/m^3). The laboratory has reported that one (1) EU converts to 0.125 nanograms of endotoxin.

4.4.3.2 Microcystin-Nodularins Toxin Sampling and Analysis

Microcystin is a class of over 50 different toxins produced by certain freshwater cyanobacteria but primarily *Microcystis aeruginosa*. A total of five (5) samples were collected including five (4) area samples and one (1) quality control blank sample. Background area monitoring was performed during algae harvesting operations on October 5, 2019; work in progress air monitoring was conducted on October 7, 2019. The area samples were collected as close as possible to the harvesting operations including upwind and downwind locations.

The microcystin air samples were collected using 3-piece closed-face 37 mm cassettes with glass fiber filters with 1.0 µm pore size. Area samples were collected at a maximum flow rate of approximately 20 liters per minute throughout the duration of the recovery work for a total sample volume between 5,140 and 5,380 liters. Microcystin samples were shipped to Green Water labs in Palatka, FL for analysis. Sample analysis was performed using the enzyme-linked immunosorbent assay (ELISA) method using US EPA method 546 & Ohio EPA DES 701.0. Sample results were reported in nanograms per cubic meter of air (ng/m^3).

4.4.3.3 VOC Sampling and Analysis

A total of seven (7) VOC samples were collected including four (4) area samples, two (2) personal samples, and one (1) quality control blank sample. The area samples were collected as close as possible to the harvesting operations including upwind and downwind locations. Background area monitoring was performed during algae harvesting operations on October 5, 2019; work in progress area air monitoring was conducted on October 7, 2019.

The area samples were collected using 1liter (L) stainless steel mini canisters with flow regulators set to collect a time-integrated sample over a period of approximately four hours for the background samples and eight hours for the work in progress samples. The flow regulator pressure gauge reading was recorded manually at the beginning and end of the sampling period. The samples were analyzed for a library of 61 VOCs using gas chromatography with mass spectrometer (GC/MS) in accordance with OSHA method PV2120 modified and Environmental Protection Agency (EPA) Method TO-15 from the Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition (EPA/625/R-96/010b), January 1999, for VOCs. Additional VOCs detected in the sample were analyzed as tentatively identified compounds (TICs) with estimated quantification. Results of the analysis were reported as parts per billion by volume (ppbv).

Personal air monitoring was conducted during harvesting operations on October 8, 2019. Personal monitoring was conducted using 566-A Organic Vapor Monitor passive badges manufactured by Assay Technology. Sampling was started and stopped by removing the badge cover to expose the media to air and the badge was attached to the worker’s collar. The samples were analyzed for Volatile Organic Profile 31, which includes analysis of 31 known VOCs by multiple NIOSH methods using gas chromatography/flame ionization detector (GC/FID). VOC samples were delivered via overnight courier to SGS Galson Laboratories in Syracuse, New York for analysis, which is certified by the American Industrial Hygiene Association (AIHA) Laboratory Accreditation Program (LAP). Sample results were reported as ppbv.

4.4.3.4 Quality Assurance/Quality Control

Quality Assurance and Quality Control (QAQC) measures, as per the QAPP, were followed. Field duplicate sampling was conducted for the DAF effluent (SP4) on Day 5 (October 11, 2019 at 11:10 am) and for the Ozone effluent on Day 9 (October 15 at 10:35 am). Results were similar between duplicate samples suggesting that field handling error was not significant and thus providing confidence in the results.

4.5 Demobilization

Demobilization including dismantling and removal of all equipment occurred over a two-day period from October 17 to October 18, 2019. Slurry from the DAF tank was pumped to a holding tank on site. On November 6, 2019, Eastern Environmental Solutions collected the slurry in a pumper truck, rinsed the holding tank with a pressure washer, removed the tank from the site and then transported the slurry and rinse water to the Suffolk Co SD#3 Bergen Point Sewage Treatment Plant (NY0104809), 600 Bergen Ave., West Babylon, New York, for disposal. A total of 4,000 gallons of algal slurry (~1,000 gallons) and tank cleaning rinse water (~3,000 gallons) was disposed according to the disposal manifest (Discharge Authorization ticket #0300038).

5. Results

5.1 Slurry Production

Daily slurry production ranged from 38 gallons per day (GPD) to 147 GPD with an average production of 87 GPD (**Table 2**). A total of 869 gallons of slurry was produced over the 10-day operation. Demobilization skims and rinse water added approximately 108 gallons of slurry for a total of 977 gallons of slurry produced and disposed of at the wastewater treatment facility.

Table 2: Daily Slurry Production and Total Microcystins/Nodularins Content

Day	Slurry Produced (GPD)	Total Microcystins/Nodularins[1,2] (μg/L)
1	147	-
2	120	-
3	122	-
4	69	-
5	38	(8,900 ± 200) 6,900
6	75	(9,500)
7	66	-
8	75	-
9	66	29,000
10	91	19,000
Total	869	
Average	87	

Notes: 1. Values in brackets were analyzed by GreenWater Laboratories; other values were analyzed by Eurofins.

2. Concentrations represent fully mixed slurry in the DAF slurry tank. The slurry tank was emptied on Day 5, such that samples from Day 5, Day 6, Day 9, and Day 10 represented a composite of slurry collected from Day 1 to Day 5, Day 6, Day 6 to Day 9, and Day 6 to Day 10, respectively.

Total microcystins content of the slurry varied considerably between sampling events, with concentrations ranging from 8,900 μg/L to 29,000 μg/L. Variability in microcystin content of the slurry is expected due to several factors, including differences in the concentration of cyanobacteria within the slurry tank, microcystin content of the influent water, and microcystin production and breakdown within the slurry tank.

5.2 Energy Usage

5.2.1 DAF and Oxidation Treatment System

Current draw was not recorded for the weir skimmer and DAF Harvester. **Table 3** lists each of the electrical components in the primary treatment train, their horsepower, run time factor, full load current draw (Full Load Amps – FLA), and the corresponding energy consumption in kilowatts (kW).

Table 3: Estimated Energy Consumption by DAF and Weir Skimmer

Module	Voltage	Horse Power	Phase	Full Load Amps (FLA)	Operation Factor (%)	Calculated Demand (kW)[4]	Daily Consumption in kWh (based on 6 hours runtime per day)
Weir Skimmer	230	5	3	15.2	100	6.06	36.3
DAF Harvester							
Feed Pump	230	2	3	6.8	100	2.71	16.3
Recycle Pump	230	3	3	9.6	100	3.82	22.9
Air Compressor[1]	230	2	3	6.8	20	2.71	3.25
Coag. Mixer 1	120	0.25	1	5.8	100	0.696	4.18
Coag. Mixer 2	120	0.25	1	5.8	100	0.696	4.18
Chemical System							
Eductor Pump[2]	120	0.75	1	13.8	10	1.66	0.994
Polymer Mixer[3]	120	0.5	1	9.8	15	1.18	1.06
Coag. Pump	120	0.17	1	4.5	100	0.54	3.24
Polymer Pump	120	0.5	1	9.8	100	1.18	7.06
					Total	**21.24**	**99.5**

Notes: 1. Controlled by Pressure Switch – Intermittent Operation
2. Used to fill polymer tank 40 to 60 gallons each day
3. Operated 45 to 60 minutes each day
4. On-line conversion calculator used to convert FLA to Kw using a Power Factor of 1. Items used less than 100% are multiplied by corresponding decimal factor.

With the primary treatment process from the weir skimmer through the DAF Harvester requiring 21.24 kW of instantaneous demand for operation and 99.5 kilowatt hours (kWh) for one day of operation, at a flow rate of 60 gallon per minute (gpm), or 21,600 gallons per day, energy consumption through the process is:

99.5 kWh ÷ 21,600 gallons = 0.00461 kW/gallon.

Using the above calculation, the weir skimmer and DAF Harvester operating at 150 gpm for 1 hour or processing 9,000 gallon per hour, energy consumption would be only slightly more than 0.002 kW/gallon.

Oxidation unit energy consumption was measured by Bill Flagg, APT Water. Amp draws, on the 3 phases, were 43A/39A/46A, at 208 VAC and 60.0 Hz. These Amp Draw would fluctuate about 10 percent with variations in demand.

Average Current Draw from Above: 42.6 Amp @ 208 VAC = 15.3 kW or 15.3 kWh. With the unit processing water at the slightly lower rate of ~ 56 GPM or 3,360 gph, the resulting energy consumption is 0.0046 kW/gallon.

A conservative estimate of combined energy usage for the primary (weir skimmer and DAF harvester) and secondary (oxidation) process equipment operated at Lake Agawam is:

0.005 kW/gallon + 0.0046 kW/gallon or 0.0096 kW/gallon.

5.2.1.1 DAF Harvester Energy Scale-Up

It is important to note the harvester was operated at about 30% of its rated capacity and energy required for this unit when operated at 100% capacity (9,000 gallons per hour) would be only fractionally higher due to more frequent cycling of the air compressor. Furthermore; as systems scale up to million gallon per day levels, energy consumption per gallon of water processed decreases substantially.

Table 4 below shows the estimated energy consumption for a 700 gallon per minute (1 MGD in 24 hours) harvester and demonstrates a nearly five-fold reduction in kW/gal at scale compared to the nominal 60 gallon per minute operation in October 2019. The resulting calculation:

41.53 kWh ÷ 42,000 gallons per hour = 0.001 kW/gallon.

Table 4: Estimated Energy Consumption 700 GPM Capacity DAF

Module	Voltage	Horse Power	Phase	Full Load Amps (FLA)	Operation Factor (%)	Calculated Demand (kW)[4]
Feed Pump	460	15	3	11.96	100	17.95
DAF Harvester						
Skimmer Drive	460	0.5	3	0.6	100	0.48
Recycle Pump	460	20	3	23.93	100	19.07
Air Compressor	460	5	3	5.98	20[1]	0.95
Floc. Mixer 1	460	0.5	3	0.6	100	0.48
Floc. Mixer 2	460	0.5	3	0.6	100	0.48
Chemical System						
Eductor Pump	120	0.75	1	13.8	10[2]	0.2
Polymer Mixer	120	0.5 (0.75)	1	9.8	15[3]	0.18
Coag. Pump	120	0.17	1	4.5	100	0.54
Polymer Pump	120	0.5	1	9.8	100	1.2
					Total	**41.53**

Notes: 1. Controlled by Pressure Switch – Intermittent Operation

2. Used to fill polymer tank 40 to 60 gallons each day

3. Operated 45 to 60 minutes each day

4. On-line conversion calculator used to convert FLA to Kw using a Power Factor of 1. Items used less than 100% are multiplied by corresponding decimal factor

5.2.2 Diesel Generators

To facilitate power requirements, a portable diesel generator was utilized during the two-week pilot test. For longer term tests and for larger scale operations, connection to the grid would typically be utilized to provide a more environmentally friendly and cost-effective power source. Diesel fuel consumption to power the generators is estimated to be 115 gallons. The process equipment generator was on-line for approximately 10 per operating day which included about 1 hour per day on standby. In addition, the generator operated for about 16 hours during mobilization and demobilization.

5.2.3 On-Site Staff

A minimum of five staff were on-site to operate and oversee the treatment system during operating days, including one site supervisor, one DAF operator, one oxidation system operator, and two field monitoring staff. One NYSDEC staff was present each day of operation. The site was also visited by an AECOM Senior Scientist (four days during operations) and the AECOM Project Director (two days during operations). At full-scale operation, fewer on-site staff would be required.

5.2.4 Sample Processing

A total of 70 water and algal slurry samples were collected and processed for chemical parameters from 6 sampling locations over the 10-day operational period. A total of 17 air samples were collected on three sampling events for analysis of toxins. The chemical parameters tested and laboratories performing the analyses are documented in the QAPP and in **Section 4.5**.

5.3 Treatment Effectiveness

The sections that follow provide a detailed assessment of the key parameters that demonstrate the effectiveness of the treatment, including:

- Chlorophyll *a*
- Total suspended solids
- Total microcystins and nodularins
- Nutrients (phosphorus and nitrogen)
- Toxicity screens

Parameters potentially affecting effluent quality due to the addition of coagulant and ozonation during treatment:

- pH
- Aluminum
- Volatile organic compounds

Results of the above analyses are presented in tables and figures, and treatment effectiveness is evaluated based on changes in absolute parameter values, percent removal by the DAF and combined DAF and ozonation treatments, and comparison to applicable water quality standards and criteria.

All monitoring data are provided for each sampling event by site for field parameters and chemical parameters in **Appendix D** and **Appendix E**, respectively.

Values below the laboratory reportable limits (RL) are set to the RL for data analyses. In some cases, extreme values were noted and removed from the analyses. A rationale is provided for values that were removed in footnotes of corresponding tables.

5.3.1 Chlorophyll a

Chlorophyll *a* is the primary photosynthetic pigment produced by all plants and algae as well as cyanobacteria, and it is commonly used as an indicator of algal biomass in lakes. The efficacy of DAF to remove algae biomass from Lake Agawam water is demonstrated by reduction in chlorophyll *a* concentrations in the treated water (**Table 5, Figure 3**).

Table 5: Influent and Effluent Chlorophyll *a*

	Chlorophyll *a* (µg/L)			% Removal by:	
Day-Event	**Influent from Lake**	**Effluent from DAF**	**Effluent from Ozone**	**DAF**	**DAF + Ozone**
D1-1	253	<0.4	-	99.8%	NA
D1-2	192	0.960	-	99.5%	NA
D2-1	200	2.75	0.690	98.6%	99.7%
D2-2	57.1	<0.4	<0.4	99.3%	99.3%
D3-1	-[1]	1.26	0.814	NA	NA
D3-2	-[1]	0.940	1.59	NA	NA
D4-1	14.3	0.073	0.545	99.5%	96.2%
D4-2	80.5	0.161	0.116	99.8%	99.9%
D5-1	68.9	<0.4	<0.4	99.4%	99.4%
D5-2	132	<0.4	<0.4	99.7%	99.7%
D6-1	126	<0.4	<0.4	99.7%	99.7%
D6-2	166	<0.4	<0.4	99.8%	99.8%
D7-1	130	1.00	0.460	99.2%	99.6%
D7-2	138	<0.4	<0.4	99.7%	99.7%
D8-1	109	<0.4	<0.4	99.6%	99.6%
D8-2	628	<0.4	<0.4	99.9%	99.9%
D9-1	662	0.670	<0.4	99.9%	99.9%
D9-2	119	<0.4	<0.4	99.7%	99.7%
D10-1	248	<0.4	<0.4	99.8%	99.8%
D10-2	222	0.5	<0.4	99.8%	99.8%
Average	197	0.636	0.501	99.7%	99.7%
Minimum	14.3	0.073	0.116	98.6%	96.2%
Maximum	662	2.75	1.59	99.9%	99.9%
Median	135	<0.4	<0.4	99.7%	99.7%
N	18	20	18		
N <RL	0	11	12		
% N<RL	0%	55%	67%		

Notes: 1- sample bottles broken during shipping to the laboratory; Laboratory Reportable Limit (RL) = 0.4 µg/L; DAF is Dissolved Air Flotation; Ozone is Ozonation; (-) = no data; NA = Not Applicable.

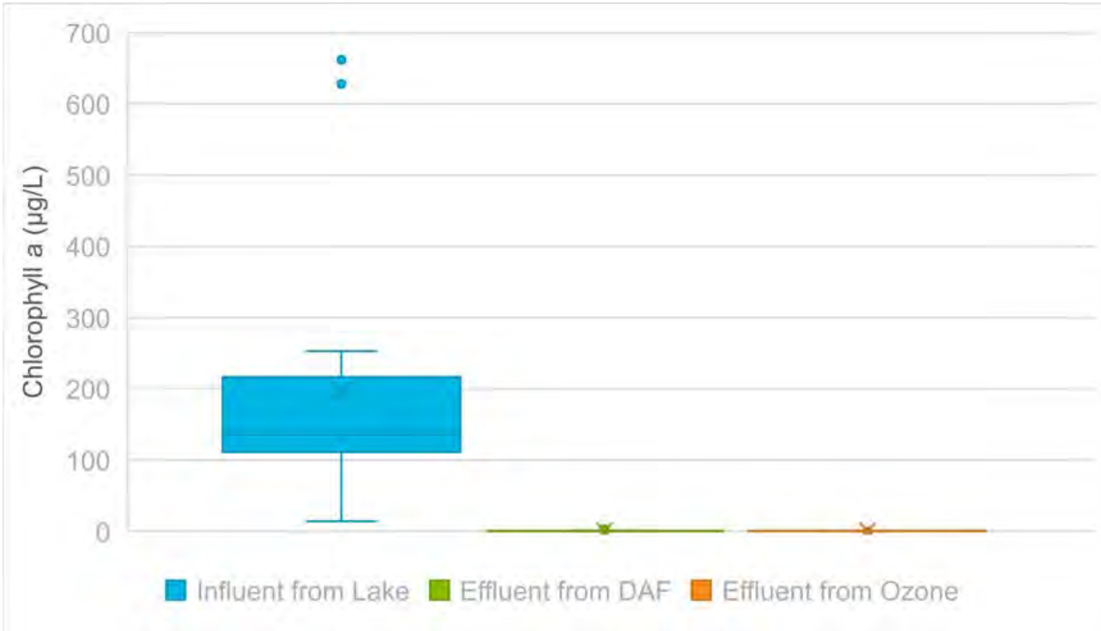


Figure 3: Box Plots of Chlorophyll *a* Concentrations Before and After Treatment

Influent water skimmed from the surface of Lake Agawam had elevated levels of chlorophyll *a*, characteristic of high algal biomass during bloom conditions. While concentrations were consistently high in source water over the course of treatment, they varied considerably within and between days from a low of 14.3 μg/L on Day 4 to a high of 662 μg/L on Day 9. High variability in chlorophyll *a* is common over short periods of time as algae cells accumulate and disperse in lakes by wind and wave action and through vertical migration of algae in the water column. Several species of cyanobacteria, including *Microcystis sp.*, can control their buoyancy allowing them to move up and down in the water column to access optimal light and nutrient conditions. Chlorophyll *a* production in algal cells varies widely with light conditions among other external factors, further contributing to variability.

Treatment by the DAF process removed more than 98% of the chlorophyll *a*, regardless of initial concentrations. Concentrations were reduced from an average of 197 μg/L to 0.636 μg/L, with 55% of post-treatment concentrations less than the laboratory reportable level (RL) of 0.04 μg/L). Treatment of the DAF effluent by ozone had no significant effect on chlorophyll *a* concentrations.

5.3.2 Total Suspended Solids

The concentration of total suspended solids is a measure of particulate matter in water, which can consist of soils, algae and other organic and inorganic debris. The water from Lake Agawam had highly variable total suspended solids (**Table 6, Figure 4**), largely reflecting the variable algae biomass over the duration of the project as inferred from the chlorophyll a data, but also potentially with the resuspension of sediments from the lake bottom on windy days.

Treatment by the DAF effectively reduced total suspended solids by an average of 81.3% to low levels characteristic of clear water with one exception. On the first day of operation, total suspended solids following DAF treatment remained elevated at 76.3 mg/L. This high concentration, however, does not reflect poor performance of the DAF to remove algae cells as chlorophyll a was reduced in that sample by 99.8% to <0.4 μg/L. The high concentration may be the result of particulate carryover from coagulant usage early in the treatment process as the system was being optimized through adjustments to operating conditions, primarily influent flow and coagulant dosage. The relatively low suspended solids in DAF effluent on all other sampling events suggests that particulate carryover was not of issue following system optimization. It is also possible that the single high total suspended solids concentration is an anomalous value.

Table 6: Influent and Effluent Total Suspended Solids

Day-Event	Total Suspended Solids (mg/L)			% Removal by:	
	Influent from Lake	Effluent from DAF	Effluent from Ozone	DAF	DAF + Ozone
D1-1	83.6	76.3	-	8.7%	NA
D1-2	111	5.6	-	95.0%	NA
D2-1	<4	<4	<4	NA[1]	NA[1]
D2-2	33.2	<4	8.8	88.0%	73.5%
D3-1	18.8	9.2	<4	51.1%	78.7%
D3-2	39.5	<4	<4	89.9%	89.9%
D4-1	37.2	<4	8.4	89.2%	77.4%
D4-2	50.8	10.8	10	78.7%	80.3%
D5-1	40.8	4.4	4.4	89.2%	89.2%
D5-2	34	<4	<4	88.2%	88.2%
D6-1	37	<4	4.6	89.2%	87.6%
D6-2	53.6	4.8	7.6	91.0%	85.8%
D7-1	19.2	6.8	13.6	64.6%	29.2%
D7-2	21.3	<4	<4	81.2%	81.2%
D8-1	13.6	<4	<4	70.6%	70.6%
D8-2	133	<4	<4	97.0%	97.0%
D9-1	206	<4	<4	98.1%	98.1%
D9-2	48	<4	16.8	91.7%	65.0%
D10-1	47.2	<4	<4	91.5%	91.5%
D10-2	51.2	<4	<4	92.2%	92.2%
Average	56.8	8.5	6.3	81.3%	80.9%
Minimum	13.6	<4	<4	8.7%	29.2%
Maximum	206	76.3	16.8	98.1%	98.1%
Median	40.8	4.0	4.0	89.2%	85.8%
N	19	20	18		
N <RL	0	13	10		
% N<RL	0%	65%	56%		

Notes: Laboratory Reportable Limit (RL) = 4 mg/L; Shaded cells represent values removed in the calculation of summary statistics; DAF is Dissolved Air Flotation; Ozone is Ozonation; (-) = no data; NA = Not Applicable; [1] calculation not possible as influent concentration was below RL in influent and effluent samples

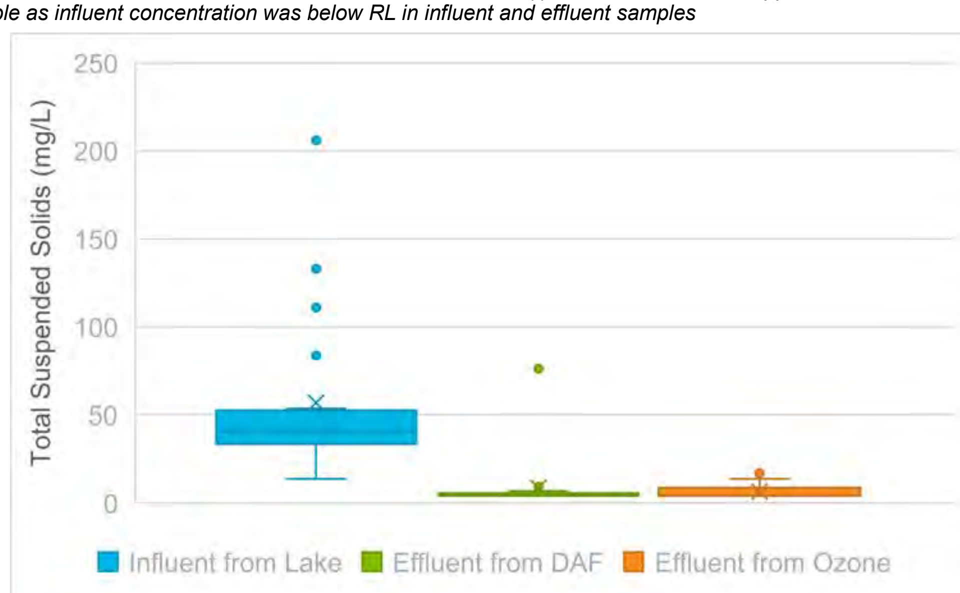


Figure 4: Box Plots of Total Suspended Solids Concentrations Before and After Treatment

5.3.3 Total Microcystins and Nodularins

Treatment significantly removed the cyanobacteria toxins, total microcystins and nodularins, from Lake Agawam water (**Table 7, Figure 5**). Influent water from the lake to the DAF unit had elevated concentrations ranging from 8 μg/L to 170 μg/L (average = 46 μg/L). With removal of the cyanobacteria by the DAF harvester, concentrations of total microcystins and nodularins were reduced by an average of 93% to 2.0 μg/L (range = 1.4 to 3.6 μg/L). Additional treatment by ozonation further reduced concentrations to below the laboratory reportable limit (RL) of 0.3 μg/L in every sample. Therefore, the final treated water returned to Lake Agawam met New York State Department of Health (NYSDOH) drinking water standards for total microcystins of <0.3 μg/L.

Total microcytins and nodularins concentrations were similar in samples from Lake Agawam Source Water (SP-1; 49.7 μg/L), Influent to DAF (SP-3; 45.8 μg/L) and Overflow from Receiving Tank (SP-2; 45.0 μg/L) indicating that there was no appreciable change in concentrations with travel time from the lake to the treatment system.

Analytical test results indicated that the grinder pump did not cause the rupture of cyanobacteria cells and thereby the release of microcystins and nodularins contained in the cells into the water entering the DAF. This is supported by equivalent concentrations of dissolved total microcystins and nodularins detected in filtered samples from the Lake Agawam Source Water upstream of the grinder pump and in Overflow from Receiving Tank downstream of the grinder pump. Concentration at both sites were 1.2 μg/L on Day 9 and 1.4 μg/L on Day 10.

Table 7: Influent and Effluent Total Microcystins and Nodularins

	Total Microcystins and Nodularins (µg/L)			% Removal by:	
Day-Event	**Influent from Lake**	**Effluent from DAF**	**Effluent from Ozone**	**DAF**	**DAF + Ozone**
2-1	46	2.3	<0.3	95%	99%
2-2	50	3.4	<0.3	93%	99%
3-1	53	3.6	<0.3	93%	99%
3-2	47	3.2	<0.3	93%	99%
4-1	47	1.5	<0.3	97%	99%
4-2	41	1.4	<0.3	97%	99%
5-1	37	1.4	<0.3	96%	99%
5-2	51	1.5	<0.3	97%	99%
6-1	28	1.5	<0.3	95%	99%
6-2	21	1.4	<0.3	93%	99%
7-1	24	1.7	<0.3	93%	99%
7-2	28	1.7	<0.3	94%	99%
8-1	8	1.8	<0.3	78%	96%
8-2	10	1.9	<0.3	81%	97%
9-1	170	1.9	<0.3	99%	100%
9-2	29	1.7	<0.3	94%	99%
10-1	57	1.7	<0.3	97%	99%
10-2	83	1.9	<0.3	98%	100%
Average	46	2.0	<0.3	93%	99%
Minimum	8	1.4	<0.3	78%	96%
Maximum	170	3.6	<0.3	99%	100%
Median	43	1.7	<0.3	94%	99%
N<RL	0	0	18	0%	100%

Notes: Laboratory Reportable Limit (RL) = 0.3 µg/L; values for final effluent from the Ozone treatment were <RL; DAF = Dissolved Air Flotation.

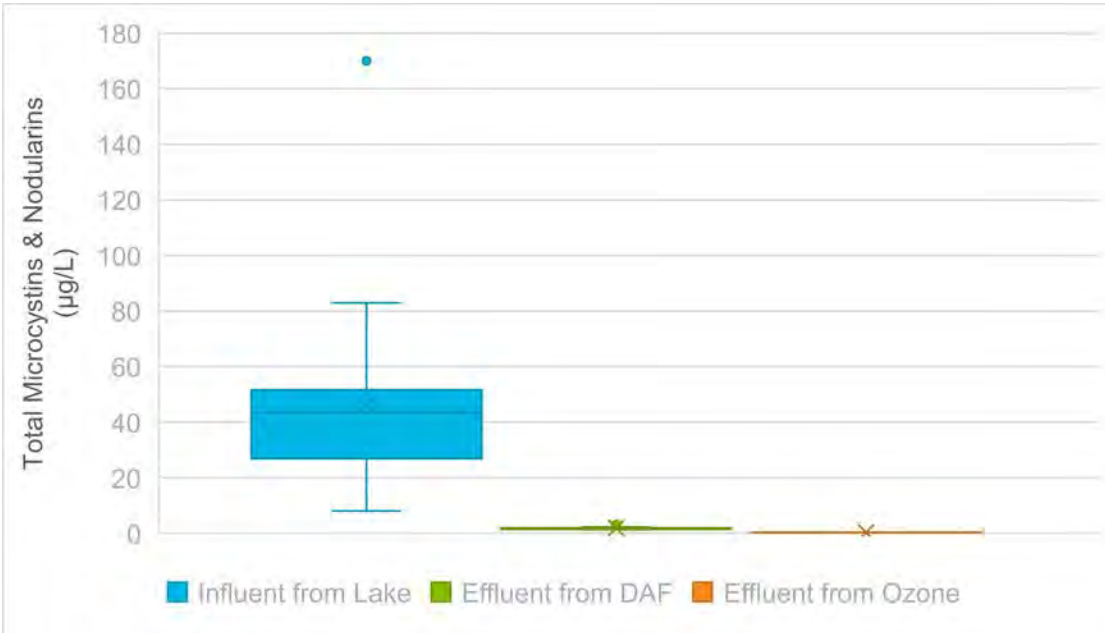


Figure 5: Box Plots of Total Microcystins and Nodularins Concentrations Before and After Treatment

5.3.4 Nutrients

Algal production is controlled by several factors, including water temperature, the presence of light, nutrient availability, and consumption by other organisms. When there is sufficient light for photosynthesis to occur, nutrient availability often represents the controlling factor in algal growth. Nutrient enrichment, therefore, is typically the key factor driving algal blooms. In freshwater systems, phosphorus is most often the least available nutrient and is the primary limiting factor in algal production. Nitrogen, needed for protein synthesis, is also an important nutrient for algal production. By removing algal biomass that contains high levels of phosphorus and nitrogen, treatment by DAF significantly reduced concentrations of these nutrients in water from Lake Agawam.

5.3.4.1 Phosphorus

Total phosphorus concentrations in the influent water from Lake Agawam were reduced by an average of 94% from 0.22 mg/L to 0.01 mg/L (**Table 8, Figure 6**). Dissolved phosphorus concentrations[1], by contrast were generally low in the influent water to the DAF and did not change significantly following DAF treatment with average concentrations of 0.014 mg/L in the influent and 0.013 mg/L in the effluent (**Table 8, Figure 7**). The low dissolved phosphorus relative to very high total phosphorus in the influent water demonstrates that at the time of treatment most of the phosphorus was contained in particulate matter such as algal cells. Therefore, a portion of particulate phosphorus can be effectively removed along with the intact algal cells and other suspended solids by the DAF. Treatment of the DAF effluent by ozone did not significantly change average total or dissolved phosphorus concentrations. Differences between concentrations in the DAF effluent and oxidation unit effluent most likely represent variability in phosphorus measurements as values were near laboratory RLs.

[1] AECOM has determined that samples analyzed for dissolved parameters were not field filtered on Day1 or on Day 2 (early sample, D1-2 only). Values therefore do not represent dissolved concentrations on these days.

Table 8: Influent and Effluent Total and Dissolved Phosphorus

Day-Event	Total Phosphorus (mg/L)					Dissolved Phosphorus (mg/L)				
	Influent from Lake	Effluent from DAF	Effluent from Ozone	% Removal by: DAF	% Removal by: DAF + Ozone	Influent from Lake	Effluent from DAF	Effluent from Ozone	% Removal by: DAF	% Removal by: DAF + Ozone
D1-1	0.18	<0.01	-	94%	NA	-	-	-	NA	NA
D1-2	0.17	<0.01	-	94%	NA	-	-	-	NA	NA
D2-1	0.16	<0.01	<0.01	94%	94%	-	-	-	NA	NA
D2-2	0.17	<0.01	0.11[3]	94%	NA	<0.01	0.0068[2]	0.0068[2]	32%	32%
D3-1	0.25	<0.01	<0.01	96%	96%	<0.01	<0.01	<0.01	0%	0%
D3-2	0.27	0.031	<0.01	89%	96%	<0.01	<0.01	<0.01	0%	0%
D4-1	0.20	<0.01	<0.01	95%	95%	<0.01	<0.01	<0.01	0%	0%
D4-2	0.21	<0.01	<0.01	95%	95%	<0.01	<0.01	<0.01	0%	0%
D5-1	0.18	<0.01	0.016	94%	91%	<0.01	<0.01	<0.01	0%	0%
D5-2	0.21	<0.01	<0.01	95%	95%	0.016	<0.01	<0.01	38%	38%
D6-1	0.13	<0.01	<0.01	92%	92%	<0.01	<0.01	0.04	0%	-300%
D6-2	0.13	<0.01	<0.01	92%	92%	<0.01	<0.01	<0.01	0%	0%
D7-1	0.13	<0.01	<0.01	92%	92%	<0.01	<0.01	<0.01	0%	0%
D7-2	<0.01[1]	<0.01	<0.01	NA	NA	0.018	0.033	0.023	-83%	-28%
D8-1	0.023[1]	<0.01	<0.01	NA	NA	0.061	0.038	0.0068	38%	89%
D8-2	0.48	0.0086[2]	<0.01	98%	98%	0.009[2]	<0.01	0.029[3]	-16%	-237%
D9-1	0.49	<0.01	<0.01	98%	98%	<0.01	<0.01	<0.01	0%	0%
D9-2	0.18	<0.01	<0.01	94%	94%	<0.01	<0.01	<0.01	0%	0%
D10-1	0.16	<0.01	<0.01	94%	94%	<0.01	<0.01	<0.01	0%	0%
D10-2	<0.01[1]	<0.01	0.04	NA	NA	0.018	<0.01	<0.01	44%	44%
Average	0.22	0.01	0.01	94%	95%	0.014	0.013	0.013	3%	-21%
Minimum	0.13	0.0086	<0.01	89%	91%	0.009	0.0068	0.0068	-83%	-300%
Maximum	0.49	0.031	0.04	98%	98%	0.061	0.038	0.04	44%	89%
Median	0.2	<0.01	<0.01	94%	95%	<0.01	<0.01	<0.01	0%	0%
N	17	20	17			17	17	17		
N <RL	0	20	16			16	16	15		
% N<RL	0%	100%	94%			94%	94%	88%		

Notes: Laboratory Reportable Limit (RL) = <0.01 mg/L; Shaded cells represent suspect values removed in the calculation of summary statistics; DAF is Dissolved Air Flotation; (-) = no data; NA = Not Applicable; [1]Low values are suspect as concentrations of algae (as indicated by chlorophyll a, see Table 7) and total suspended solids (Table 8) that would be expected to contribute phosphorus remained elevated during these sampling events. Moreover, these total phosphorus concentrations are lower than the dissolved phosphorus concentration measured in the same samples, which is not possible. [2]Value below the RL but above the Method Detection Limit and is an estimate. [3]High value is suspect as the concentration is greater than that measured in Effluent from DAF, but no phosphorus is added following DAF treatment. Further, for the total phosphorus value (D2-2), dissolved phosphorus concentration was low (below RL) in this sample suggesting that the high total phosphorus was due to particulate phosphorus, yet chlorophyll a and total suspended solids concentrations (as indicators of algae and other particulate matter) were low and in the range of other samples in Effluent from Ozone that had low total phosphorus.

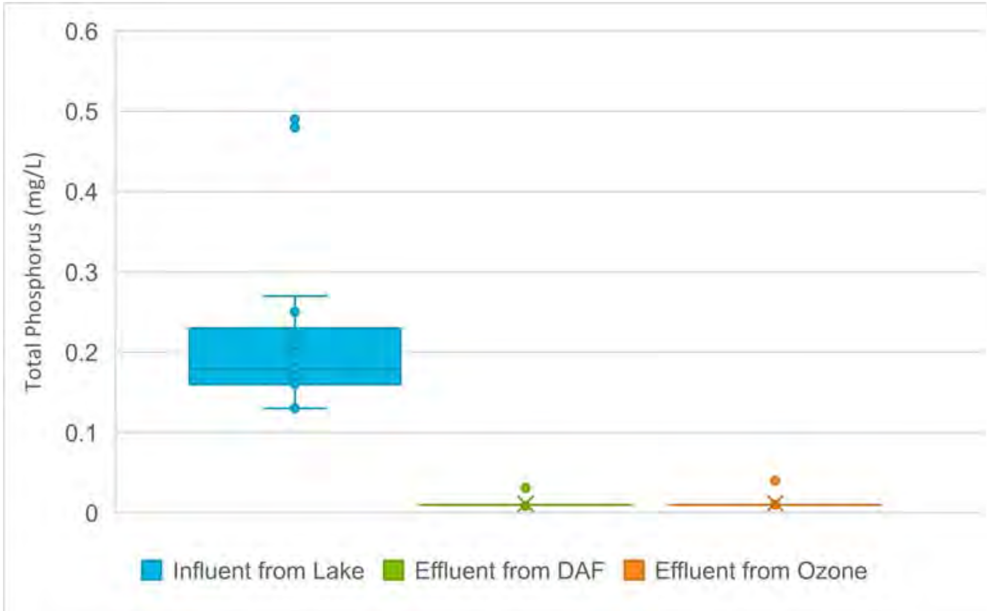


Figure 6: Box Plots of Total Phosphorus Concentrations Before and After Treatment

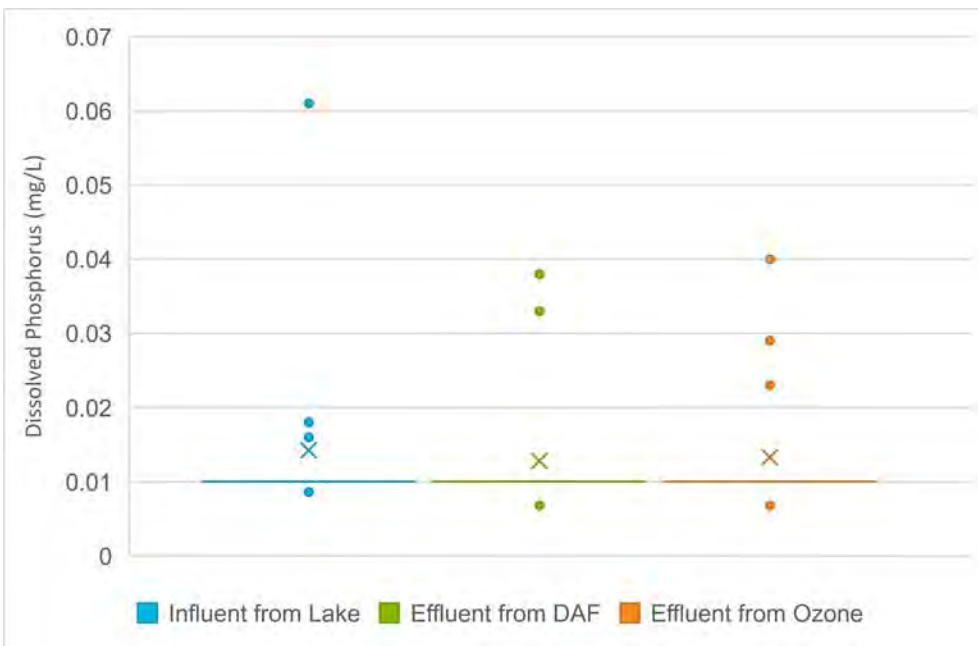


Figure 7: Box Plots of Dissolved Phosphorus Concentrations Before and After Treatment

5.3.4.2 Nitrogen

Total nitrogen is the sum of nitrate-nitrogen, nitrite-nitrogen, ammonia-nitrogen and organically bonded nitrogen. Total nitrogen should not be confused with Total Kjeldahl Nitrogen, which is the sum of ammonia nitrogen plus organically bound nitrogen but does not include nitrate-nitrogen or nitrite nitrogen.

Total nitrogen concentrations in the influent water from Lake Agawam were reduced by an average of 81% by the DAF treatment, from 3.6 mg/L to 0.62 mg/L (**Table 9, Figure 8**).

As with phosphorus, most of the nitrogen present in the influent water was in particulate form, with dissolved nitrogen representing an average of approximately 20% of the nitrogen in the samples. Unlike phosphorus, however, treatment by DAF significantly reduced dissolved total nitrogen, albeit by a moderate amount (30% removal) (**Table 9**, **Figure 9**). It is possible that some dissolved nitrogen species (most likely nitrate) were adsorbed to the surface of the algal cells or other particulates that were removed by the DAF process. Treatment of the DAF effluent by ozone did not significantly change average total or dissolved nitrogen concentrations (T Tests, $p>0.05$).

Table 9: Influent and Effluent Total and Dissolved Nitrogen

	Total Nitrogen (mg/L)					Dissolved Nitrogen (mg/L)				
				% Removal by:					% Removal by:	
Day-Event	**Influent from Lake**	**Effluent from DAF**	**Effluent from Ozone**	**DAF**	**DAF + Ozone**	**Influent from Lake**	**Effluent from DAF**	**Effluent from Ozone**	**DAF**	**DAF + Ozone**
D1-1	3.9	0.76	-	81%	NA	-	-	-	-	-
D1-2	3.7	0.49	-	87%	NA	-	-	-	-	-
D2-1	2.5	0.33	0.31	87%	88%	-	-	-	-	-
D2-2	2.6	0.2	0.37	92%	86%	0.49	0.38	0.39	22%	20%
D3-1	2.7	0.38	0.39	86%	86%	2.7	0.68	0.66	75%	76%
D3-2	2.4	0.46	0.44	81%	82%	2.8	0.57	0.49	80%	83%
D4-1	3.4	1.3	0.56	62%	84%	0.78	0.65	0.53	17%	32%
D4-2	3.6	0.53	0.56	85%	84%	0.55	0.51	0.53	7%	4%
D5-1	4.3	0.76	0.71	82%	83%	0.98	0.65	0.73	34%	26%
D5-2	3.4	1.6	0.77	53%	77%	0.98	0.76	1.2	22%	-22%
D6-1	2.4	0.65	0.75	73%	69%	1.1	0.61	0.74	45%	33%
D6-2	3.2	0.64	0.70	80%	78%	0.96	0.61	0.76	36%	21%
D7-1	2.4	0.78	0.82	68%	66%	1	0.79	0.86	21%	14%
D7-2	2.2	0.61	0.59	72%	73%	0.77	0.99	0.96	-29%	-25%
D8-1	2.3	0.63	0.75	73%	67%	0.79	0.6	0.62	24%	22%
D8-2	8.9	0.64	0.52	93%	94%	0.97	0.6	0.61	38%	37%
D9-1	7.8	0.45	0.48	94%	94%	0.74	0.48	0.5	35%	32%
D9-2	3.0	0.46	0.48	85%	84%	0.65	0.43	0.57	34%	12%
D10-1	3.4	0.4	0.35	88%	90%	0.6	0.48	0.4	20%	33%
D10-2	4.7	0.36	0.34	92%	93%	0.47	0.34	0.34	28%	28%
Average	3.6	0.62	0.55	81%	82%	1.02	0.60	0.64	30%	25%
Minimum	2.2	0.2	0.31	53%	66%	0.47	0.34	0.34	-29%	-25%
Maximum	8.9	1.6	0.82	94%	94%	2.8	0.99	1.2	80%	83%
Median	3.3	0.6	0.5	83%	84%	0.8	0.6	0.6	28%	26%
N	20	20	18			20	20	18		
N <RL	0	1	0			0	0	0		
% N<RL	0%	5%	0%			0%	0%	0%		

Notes: Laboratory Reportable Limit (RL) = 0.02 mg/L. Shaded cells represent suspect values removed in the calculation of summary statistics (see text). DAF is Dissolved Air Flotation. (-) = no data; NA = Not Applicable.

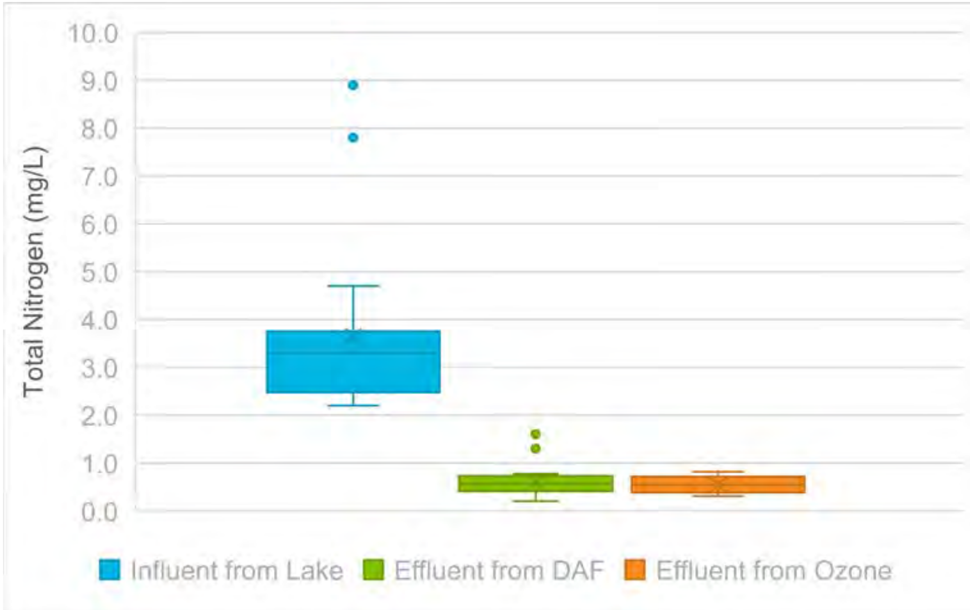


Figure 8: Box Plots of Total Nitrogen Concentrations Before and After Treatment

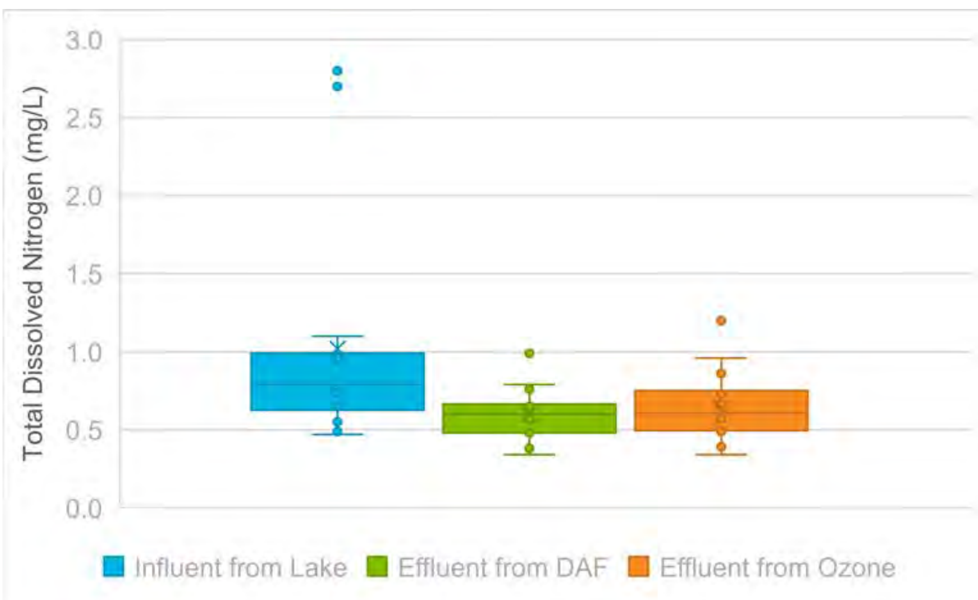


Figure 9: Box Plots of Dissolved Nitrogen Concentrations Before and After Treatment

5.3.5 Potentially Toxigenic (PTOX) Cyanobacteria Screen

Potentially Toxigenic (PTOX) cyanobacteria screens identified a diversity of potentially toxic species (**Table 10**). Water from Lake Agawam, including water samples collected directly from the lake, in influent to the DAF and overflow from the DAF receiving tank contained the most diverse assemblages of PTOX species, and samples were consistently dominated by *Microcystis viridis*. Following DAF treatment and oxidation treatment, water samples contained either low densities of similar species (Day 2 and Day 3), or no PTOX species (Day 4). Following oxidation treatment, colonies were observed to be in a state of deterioration.

Table 10: Summary of PTOX Observations

Lake Agawam/Overflow from DAF	Influent from Lake Agawam	Effluent from DAF	Effluent from Oxidation System
Dominated by: *Microcystis viridis* Other species observed: *Microcystis spp.* *Cuspidothrix issatschenkoi* *Pseudanbaena mucicola* *Dolichospermum sp.*	Dominated by: *Microcystis viridis* Other species observed: *Microcystis spp.* *Cuspidothrix issatschenkoi* *Pseudanbaena mucicola* *Dolichospermum sp.* *Planktothrix sp.*	Contained or contained in low densities: *Microcystis viridis* *Cuspidothrix issatschenkoi* *Planktothrix sp.* *Pseudanabeana mucicola* **No PTOX species in Day 4 samples.	Contained: *Microcystis viridis* *Dolichospermum sp.* *Colonies appeared to be in a state of deterioration **No PTOX species in Day 4 samples.

The PTOX species observed have the potential to produce several toxins including microcystins, saxitoxins, anatoxin-a and cylindrospermopsin (**Table 11**).

Table 11: Potential Toxin Producing Cyanobacteria Genera in Influent and Effluent

Microcystins	Saxitoxins	Anatoxin-a	Cylindrospermopsin
Microcystis	*Cuspidothrix*	*Cuspidothrix*	*Dolichospermum*
Pseudanabaena	*Dolichospermum*	*Dolichospermum*	
Dolichospermum		*Planktothrix*	
Planktothrix			

The PTOX screening reports including photomicrographs of observed species are provided in **Appendix F**.

5.3.6 pH

The addition of ACH [$Al_2(OH)_5Cl$] as a coagulant in the DAF process can cause a depression in pH as hydrogen ions (H^+) are produced when the ACH is hydrolyzed:

$$Al_2(OH)_5Cl \rightarrow Al_2(OH)_5^+ + Cl^- + H_2O \rightarrow 2Al(OH)_3 + H^+ + Cl^-$$

A lowering of pH can also occur with the removal of algae by the DAF as photosynthesis causes pH to rise as the algae take up carbon dioxide, which forms a weak acid (carbonic acid) in water.

A statistically significant depression in pH was observed following coagulation by ACH and with the removal of algae biomass by the DAF treatment (T Test, $df = 38$, $p = 0.016$, t Critical = 2.02). pH was reduced by a maximum of 0.93 pH units and by an average of 0.31 pH units in the DAF effluent over the period of operation (**Table 12**, **Figure 10**). Ozone treatment had no significant effect on pH (T Test, $df = 34$, $p = 0.45$, t Critical = 2.03).

The pH of the effluent following the DAF and Ozone treatments was well within the New York State water quality standards (6 CRR-NY 703.3; pH range of 6.5 to 8.5) on each sampling event and therefore posed no risk to water quality for the protection of aquatic life.

Table 12: Influent and Effluent pH

Day-Event	pH			pH Change by:	
	Influent from Lake	Effluent from DAF	Effluent from Ozone	DAF	DAF + Ozone
D1-1	8.62	8.01	-	0.61	-
D1-2	8.25	7.32	-	0.93	-
D2-1	8.16	7.82	7.49	0.34	0.67
D2-2	7.54	7.54	7.51	0	0.03
D3-1	7.90	7.09	6.96	0.81	0.94
D3-2	7.74	7.02	7.14	0.72	0.6
D4-1	7.71	7.01	7.23	0.7	0.48
D4-2	7.34	7.24	7.45	0.1	-0.11
D5-1	7.71	7.48	7.56	0.23	0.15
D5-2	7.34	7.36	7.69	-0.02	-0.35
D6-1	7.39	7.36	7.42	0.03	-0.03
D6-2	7.45	7.49	7.58	-0.04	-0.13
D7-1	7.78	7.64	7.22	0.14	0.56
D7-2	8.10	8.20	7.33	-0.1	0.77
D8-1	8.11	7.88	7.56	0.23	0.55
D8-2	8.06	7.78	7.60	0.28	0.46
D9-1	8.38	7.66	7.60	0.72	0.78
D9-2	8.23	8.16	7.96	0.07	0.27
D10-1	8.30	8.15	8.00	0.15	0.3
D10-2	8.46	8.10	8.10	0.36	0.36
Average	7.93	7.62	7.52	0.31	0.35
Minimum	7.34	7.01	6.96	-0.10	-0.35
Maximum	8.62	8.20	8.10	0.93	0.94
Median	7.98	7.59	7.54	0.23	0.41
N	20	20	18	20	18

Notes: DAF is Dissolved Air Flotation. Values in highlighted cells are outside the range of New York water quality standard for pH of 6.5 – 8.5 (6 CRR-NY 703.3). (-) = no data.

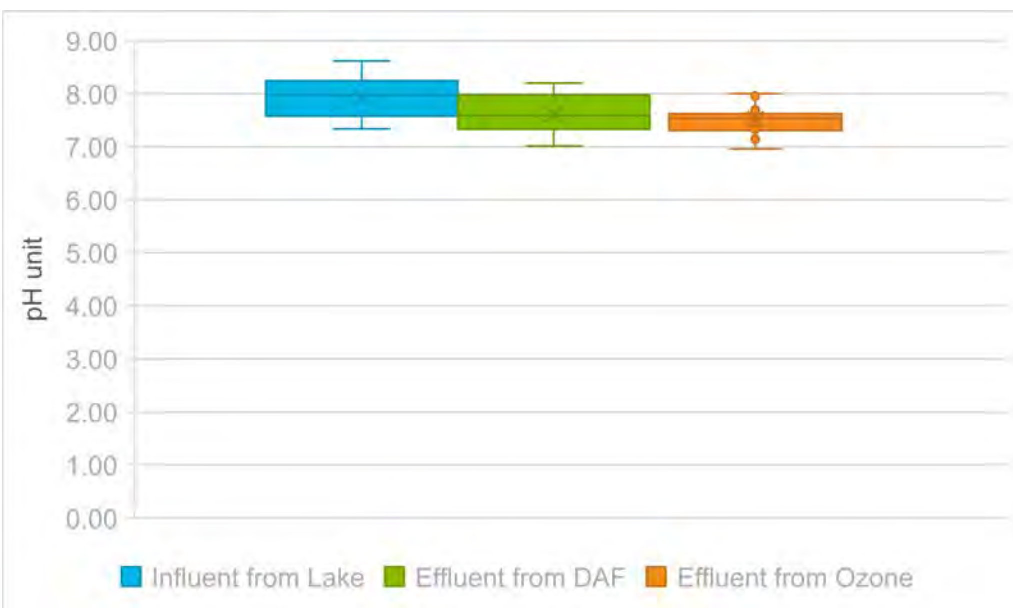


Figure 10: Box Plots of pH Before and After Treatment

5.3.7 Aluminum

Aluminum is a naturally-occurring heavy metal that can be toxic to aquatic life. The New York State water quality standard for ionic aluminum, which occurs in the dissolved aluminum fraction, is 0.100 mg/L. The US EPA recently developed criteria for total aluminum that consider site-specific pH, dissolved organic carbon and total hardness of water that moderate the bioavailability and toxicity of aluminum to aquatic life (US EPA 2018).

Aluminum is added in small doses in the DAF treatment process with the use of ACH as a coagulant. In the first three days of operation (until 12:15 pm on Day 3), an ACH dosage of 130 mg/L was used (**Section 4.3.1**). An error in the bench to full scale dilution calculations was discovered and corrected, resulting in the use of lower dosages of 12 to 25 mg/L (average dosage = 16 mg/L) for the remainder of the operation (**Section 4.3.1**).

Aluminum concentrations measured over the course of operations are presented in **Table 13** and **Figure 11** and US EPA water quality criteria are provided for acute and chronic toxicity for total aluminum in **Table 14**. The criteria were calculated using measured pH and carbonate alkalinity (as an estimate of total hardness) specific to each sample. Dissolved organic carbon concentration was not analyzed, therefore a conservative estimate of 1 mg/L was used in the calculation.

Total aluminum concentration in the influent water from Lake Agawam was low (average = 0.22 mg/L) and below the laboratory reportable limit (RL) of 0.2 mg/L in 60% of the samples. Concentrations were well below the US EPA criteria for chronic (1.000 mg/L) and acute toxicity (see **Table 14**). Dissolved aluminum was also low with all samples less than the RL. The New York standard for ionic aluminum of 0.100 mg/L cannot be used to evaluate dissolved aluminum concentrations because the laboratory reportable limit (RL) for aluminum of 0.2 mg/L exceeds the standard.

A significant increase in total aluminum concentration occurred in DAF effluent samples relative to influent samples in the first three days of operation (D1-1, D1-2, D2-1, D2-2, D3-1) when higher ACH dosages were used. Total aluminum concentrations, however, remained below the calculated sample-specific US EPA standards for acute toxicity (**Table 14**) over this period and therefore posed no risk to water quality for the protection of aquatic life.

Following correction of the ACH dosage, total and dissolved aluminum concentrations in the DAF effluent were all below the laboratory RL and all samples were well below the US EPA criteria for chronic (0.720 mg/L) and acute toxicity (see **Table 14**). These results confirm that aluminum from the ACH addition is efficiently used in the floc formation and subsequently removed with the floc. Additional removal of aluminum present in the source water occurs as aluminum contained within algae or other suspended particles is also removed in the process. Ozone treatment had no significant effect on aluminum concentrations (T Tests, $p>0.05$) as no additional aluminum is added following DAF.

Table 13: Influent and Effluent Total and Dissolved Aluminum

Day-Event	Total Aluminum (mg/L)					Dissolved Aluminum (mg/L)				
	Influent from Lake	Effluent from DAF	Effluent from Ozone	% Removal by: DAF	% Removal by: DAF + Ozone	Influent from Lake	Effluent from DAF	Effluent from Ozone	% Removal by: DAF	% Removal by: DAF + Ozone
D1-1	<0.2	0.76	NA	-280%	NA	-	-	-	-	-
D1-2	0.21	0.68	NA	-224%	NA	-	-	-	-	-
D2-1	0.21	1.4	1.4	-567%	-567%	-	-	-	-	-
D2-2	<0.2	1.3	1.3	-550%	-550%	<0.2	<0.2	<0.2	0%	0%
D3-1	0.28	<0.2	0.99	29%	NA	<0.2	<0.2	<0.2	0%	0%
D3-2	0.33	<0.2	<0.2	39%	39%	<0.2	<0.2	<0.2	0%	0%
D4-1	0.31	<0.2	<0.2	35%	35%	<0.2	<0.2	<0.2	0%	0%
D4-2	0.32	<0.2	<0.2	38%	38%	<0.2	<0.2	<0.2	0%	0%
D5-1	<0.2	<0.2	<0.2	0%	0%	<0.2	<0.2	<0.2	0%	0%
D5-2	0.33	<0.2	<0.2	39%	39%	<0.2	<0.2	<0.2	0%	0%
D6-1	0.27	<0.2	<0.2	26%	26%	<0.2	<0.2	<0.2	0%	0%
D6-2	<0.2	<0.2	<0.2	0%	0%	<0.2	<0.2	<0.2	0%	0%
D7-1	<0.2	<0.2	<0.2	0%	0%	<0.2	<0.2	<0.2	0%	0%
D7-2	<0.2	<0.2	<0.2	0%	0%	<0.2	<0.2	<0.2	0%	0%
D8-1	<0.2	<0.2	<0.2	0%	0%	<0.2	<0.2	<0.2	0%	0%
D8-2	<0.2	<0.2	<0.2	0%	0%	<0.2	<0.2	<0.2	0%	0%
D9-1	<0.2	<0.2	<0.2	0%	0%	<0.2	<0.2	<0.2	0%	0%
D9-2	<0.2	<0.2	<0.2	0%	0%	<0.2	<0.2	<0.2	0%	0%
D10-1	<0.2	<0.2	<0.2	0%	0%	<0.2	<0.2	<0.2	0%	0%
D10-2	<0.2	<0.2	<0.2	0%	0%	<0.2	<0.2	<0.2	0%	0%
Average	0.23	0.37	0.34	-71%	-55.2%	<0.2	<0.2	<0.2	0%	0%
Minimum	<0.2	<0.2	<0.2	-567%	-567%	<0.2	<0.2	<0.2	0%	0%
Maximum	0.33	1.4	1.4	39%	39%	<0.2	<0.2	<0.2	0%	0%
Median	<0.2	<0.2	<0.2	0%	0%	<0.2	<0.2	<0.2	0%	0%
N	20	20	17			17	17	17		
N <RL	12	16	15			17	17	17		
% N<RL	60%	80%	88%			100%	100%	100%		

Notes: Laboratory Reportable Limit (RL) = 0.2 mg/L; Shaded cell represents a suspect value (statistical outlier and value is significantly greater than that for DAF effluent on the same sampling event despite no addition of aluminum) removed in the calculation of summary statistics; DAF is Dissolved Air Flotation. All values meet the US EPA 2018 water quality criterion for total aluminum for acute (based on sample-specific pH and hardness (as carbonate alkalinity) and dissolved organic carbon concentration of 1 mg/L as a conservative estimate). Average total aluminum concentrations meet the US EPA 2018 water quality criterion for chronic toxicity (based on average measured pH and hardness (as carbonate alkalinity) and dissolved organic carbon concentration of 1 mg/L as a conservative estimate).

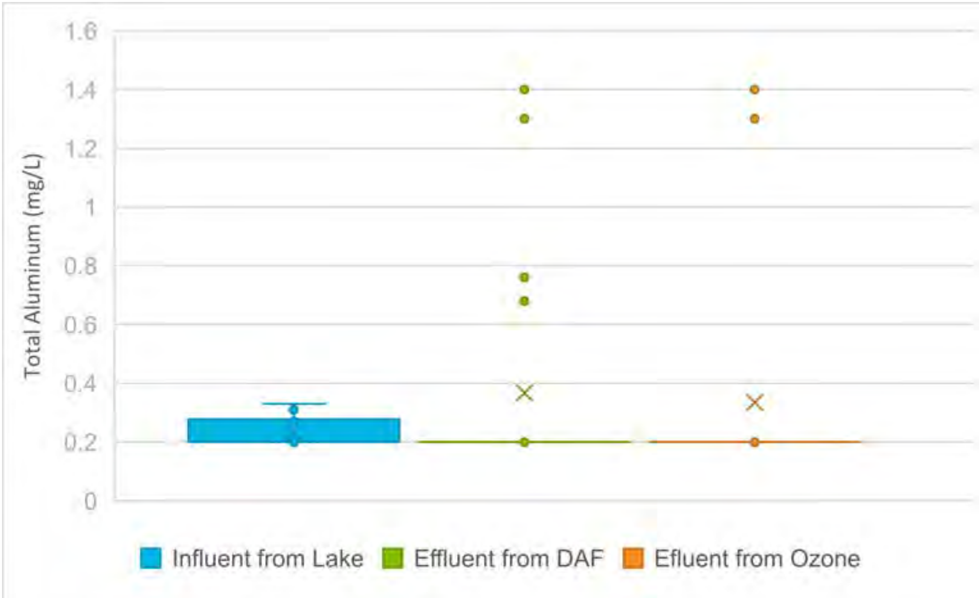


Figure 11: Box Plots of Total Aluminum Concentrations Before and After Treatment

Table 14: US EPA Total Aluminum (Al) Criteria

Day-Event	SP-3				SP-4				SP-5			
	Total Hardness (mg/L as $CaCO_3$)	pH	Criteria (µg-Al/L)		Total Hardness (mg/L as CaCO3)	pH	Criteria (µg-Al/L)		Total Hardness (mg/L as CaCO3)	pH	Criteria (µg-Al/L)	
			Acute	Chronic			Acute	Chronic			Acute	Chronic
D1-1	55.8	8.62	1500		42	8.01	1600					
D1-2	54.8	8.25	1700		40.7	7.32	1000					
D2-1	56.0	8.16	1800		45.1	7.82	1500		44.6	7.49	1500	
D2-2	55.8	7.54	1400		44.2	7.54	1300		45.7	7.51	1700	
D3-1	56.1	7.90	1700		45.8	7.09	840		45.5	6.96	1800	
D3-2	53.1	7.74	1500		50.4	7.02	810		49.6	7.14	1400	
D4-1	52.2	7.71	1500		59.9	7.01	840		58.5	7.23	1700	
D4-2	63.6	7.34	1200		60.4	7.24	1100		50.8	7.45	1500	
D5-1	53.0	7.71	1500		53.7	7.48	1300		52.7	7.56	1500	
D5-2	54.4	7.34	1100		63.7	7.36	1200		63.0	7.69	1200	
D6-1	66.9	7.39	1300		60.8	7.36	1200		62.2	7.42	1500	
D6-2	65.9	7.45	1300		64.1	7.49	1300		63.1	7.58	1100	
D7-1	68.1	7.78	1700		55.5	7.64	1500		61.0	7.22	1300	
D7-2	54.9	8.10	1700		52	8.2	1700		54.7	7.33	1300	
D8-1	54.9	8.11	1700		52.9	7.88	1600		51.1	7.56	1700	
D8-2	53.8	8.06	1700		52.6	7.78	1600		53.6	7.60	1700	
D9-1	55.7	8.38	1700		54	7.66	1500		51.9	7.60	1700	
D9-2	55.1	8.23	1700		51	8.16	1700		54.7	7.96	1700	
D10-1	54.2	8.30	1700		53.7	8.15	1700		51.8	8.00	1700	
D10-2	54.2	8.46	1600		50.1	8.1	1700		51.7	8.10	1700	
Minimum	52.2	7.34	1100		40.7	7.01	810		44.6	6.96	1100	
Average	56.9	7.93		**1000**	52.6	7.62		**720**	53.7	7.52		**640**

Notes: Carbonate alkalinity was used as an estimate of total hardness. Dissolved organic carbon was not analyzed, therefore a conservative estimate of 1 mg/L was used to derive the criteria. Chronic criteria are derived using the site-specific average pH and total hardness using EPA's Aluminum Criteria Calculator V2.0 (Excel) available online at https://www.epa.gov/wqc/aquatic-life-criteria-aluminum. The recommended acute criteria duration is a one-hour average and the recommended chronic criteria duration is a four-day average. These criteria should not be exceeded more than once every three years.

5.3.8 Volatile Organic Compounds

In the presence of dissolved organic carbon, oxidants such as chlorine and ozone can produce toxic disinfection by-products (DBPs) such as trihalomethanes (THMs) and haloacetic acids, collectively known as volatile organic compounds.

THMs were only detected on Day 10 of the operation in the effluent from the DAF and oxidation units. Haloacetic acids were detected on four days (Days 3, 5, 8 and 9) in the DAF effluent and on all days in the oxidation system effluent. In all cases, concentrations were low and below applicable guidelines (refer to **Appendix E**) such that production of DBPs with the use of ACH (source of chlorine) for coagulation and ozonation for disinfection was negligible and did not impair water quality for aquatic life.

5.4 Air Quality

The maximum airborne endotoxin concentration measured as an area sample was 0.187 nanograms per cubic meter (ng/m^3). Due to the lack of a regulatory exposure standard for endotoxin, a recommended limit value of 50 Endotoxin Units/m^3 (4.5 ng/m^3) has been proposed[2], which is an 8-hour health-based exposure guideline that was developed in the Netherlands. The results of the area sample analyses were below the referenced guideline. Refer to **Table 15** for the endotoxin data.

The maximum airborne microcystin toxin concentration measured as an area sample was <0.5 ng/m^3. Due to the lack of a regulatory exposure standard or voluntary industry guideline for microcystin, AECOM retained Dr. Christopher Teaf, a toxicologist with Hazardous Substance & Waste Management Research, Inc. to develop exposure criteria. A “Protective Air Concentration (PAC)” of between 250 and 2,500 ng/m^3 was recommended for chronic and acute exposures, respectively (Teaf 2018). Given the limited amount of toxicological data associated with the inhalation route of microcystin exposure, AECOM recommends using the more protective PAC of 250 ng/m^3 for both acute and chronic exposures. The results of the area sample analyses were below both recommended PACs. Refer to **Table 16** for microcystin data.

VOCs were not detected in the personal samples. VOCs were detected in the area samples but were in the ppb range and below applicable regulatory standards and voluntary guidelines (e.g., ACGIH 2019) by one or more orders of magnitude. The following VOCs were detected:

- Propylene, n-Butane, Acetone, Pentane, Vinyl Acetate, Hexane, Cyclohexane, Heptane, Toluene, Isobutane, Benzene, Acetonitrile, Acetone, 2,2,4-Trimethylpentane, and Toluene.

Refer to **Table 17** for VOC air sampling data and **Table 18** for applicable occupational exposure limits.

In conclusion, the concentration of airborne microcystin, endotoxin, and VOCs were below applicable exposure standards and guidelines at the time of sampling.

[2] The Dutch Expert Committee on Occupational Standards (DECOS) of the National Health Council recommended limit value of 50 Endotoxin Units/m^3 (4.5 ng/m^3) over an 8-hour period.

Table 15: Endotoxin Air Sample Data

Sample #	Sample Date	Sample Type Sample Location Sample Duration	Result (EU/m³)	Result (ng/m³)
ALE-1	10/05/19	Background Area Sample Upwind – north dock 100 minutes	0.097	0.012
ALE-2	10/05/19	Background Area Sample Downwind – WNW bank 100 minutes	0.089	0.011
ALE-3	10/07/19	Algae Harvesting Area Sample Upwind – north dock 100 minutes	0.2	0.025
ALE-4	10/07/19	Algae Harvesting Area Sample Downwind – WNW bank 100 minutes	1.5	0.187
ALE-5	10/07/19	Blank	<0.025	N/A

Notes:
EU/m³ = Endotoxin Unit per cubic meter
ng/m³ = Nanograms per cubic meter of air
1 EU conversion = 0.125 ng
EMLab P&K Report ID: 2272123

Endotoxin Exposure Guidelines:
50 Endotoxin Units/m³ (4.5 ng/m³) over an 8-hour exposure period - Dutch Expert Committee on Occupational Standards (DECOS) of the National Health Council recommended limit value

Table 16: Microcystins/Nodularins Air Sample Data

Sample #	Sample Date	Sample Type Sample Location Sample Duration	Concentration (ng/mg³)
ALM-1	10/05/19	Background Area Sample Upwind – north dock 264 minutes	<0.5
ALM-2	10/05/19	Background Area Sample Downwind – WNW bank 269 minutes	<0.5
ALM-3	10/07/19	Algae Harvesting Area Sample Upwind – north dock 261 minutes	<0.5
ALM-4	10/07/19	Algae Harvesting Area Sample Downwind – WNW bank 257 minutes	<0.5
ALM-5	10/07/19	Blank	-

Notes:
ND = Not detected
ng/m³ = nanograms per cubic meter of air
Detection Limit 0.3 ng/m³
Green Water Lab report #: 191005-191007 (amended)

*Microcystin Protective Air Concentration**:*
2,470 ng/m³ acute exposure
247 ng/m³ chronic exposure
***Teaf, CM. HSWMR 2018*

Table 17: VOCs Air Sample Data

Sample #	Sample Date	Sample Type Sample Location Sample Duration	VOC	Results (ppbv)
ALV-1	10/5/19	Background Area Sample Downwind – WNW bank 240 minutes	Propylene	89
			n-Butane	120
			Acetone	25
			Pentane	29
			Vinyl Acetate	5.3
			Hexane	8.9
			Cyclohexane	2.9
			Heptane	2.7
			Toluene	0.90
			Isobutane *	43
ALV-2	10/5/19	Background Area Sample Upwind – North Dock 240 minutes	Benzene	0.90
ALPV-1	10/7/19	Personal Sample – David Pinelli, Supervisor During Algae Harvesting 406 minutes	None Detected	None Detected
ALPV-2	10/7/19	Personal Sample – Mike Powell, Technician During Algae Harvesting 407 minutes	None Detected	None Detected
ALPV-3	10/7/19	Personal Blank During Algae Harvesting	None Detected	None Detected
ALV-3	10/08/19	Algae Harvesting Area Sample Upwind – North Dock 480 minutes	Acetonitrile	5.1
			Acetone	5.4
			2,2,4-Trimethylpentane	1.1
			Toluene	1.0
ALV-4	10/08/19	Algae Harvesting Area Sample Downwind – WNW bank 480 minutes	Acetonitrile	6.5
			Acetone	5.3
			2,2,4-Trimethylpentane	1.0
			Toluene	0.9

Notes:
ppbv: parts per billion by volume
VOC: volatile organic compound
** Tentatively Identified Compound*
SGS report #: L494740 & L494902

Table 18. Occupational Exposure Limits for Detected VOCs

Chemical Name	CAS Number	Federal OSHA PEL (ppm)	NIOSH RELs (ppm)	ACGIH TLVs (ppm)
Propylene	115-07-1	None	None	500
N-Butane	106-97-8	None	800	1,000
Acetone	67-64-1	1,000	250	250
Pentane	109-66-0	1,000	120	1,000; 610 C
VinylAcetate	108-05-4	None	4 C	10
Hexane	110-54-3	500	50	50
Cyclohexane	110-82-7	300	300	300
Heptane	142-82-5	500	85	400
Toluene	108-88-3	200	100	20
Isobutane	75-28-5	None	800	1000 C
Benzene	71-43-2	1; 5 C	0.1	0.5
Acetonitrile	75-05-8	40	20	20
Acetone	67-64-1	1,000	250	250
2,2,4-Trimethylpentane	540-84-1	500	75	300

Notes:
OSHA: Occupational Safety and Health Administration (Regulatory Standards)
ACGIH: American Conference of Governmental Industrial Hygienists (Voluntary Guidelines)
NIOSH: National Institute of Occupational Safety and Health (Voluntary Guidelines)
C: Ceiling Limit, may not be exceeded at any time
PPM: Parts per Million
PEL: Permissible Exposure Limit (OSHA)
REL: Recommended Exposure Limit (NIOSH)
TLV: Threshold Limit Value (ACGIH)

6. Conclusions and Recommendations

The Lake Agawam ten-day demonstration project was successful and provided site-specific data and supporting evidence that the use of DAF technology was safe and effective in removing algal biomass, microcystins and nutrients (phosphorus and nitrogen) from Lake Agawam source water.

The DAF treatment met or exceeded project objectives for all measured parameters with average removal efficiencies of:

- Chlorophyll *a* >99%;
- Total suspended solids >80%;
- Total microcystins and nodularins >90%;
- Total phosphorus >90%; and
- Total nitrogen >80%.

Lake Agawam is presently hypereutrophic with elevated algal biomass and nutrients. The water returned to Lake Agawam following treatment had low algal biomass (average chlorophyll *a* = 0.501 µg/L) and nutrient levels (average total phosphorus = 0.01 mg/L; average total nitrogen = 0.55 mg/L) that are characteristic of low productivity (oligotrophic) to moderate productivity (mesotrophic) lakes. DAF treatment also resulted in relatively low concentrations of microcystins (average = 2.0 µg/L) and additional treatment by ozonation further reduced microcystins, such that water returned to Lake Agawam met Federal and State drinking water guidelines for this toxin.

There were no significant treatment effects due to the use of coagulants and ozonation with respect to pH, aluminum and VOCs on the aquatic environment. While higher ACH dosages were inadvertently used in the first two and a half days of operation, potential parameters of concern remained below applicable standards and guidelines in effluent discharged to the lake on all sampling events, and there was no effect of the higher dosage on the efficiency of the DAF to remove chlorophyll *a*, microcystins, phosphorus and nitrogen from Lake Agawam source water.

No health and safety issues due to air quality were experienced over the duration of the project. Monitored airborne contaminants (i.e., microcystins, endotoxins and VOCs) were below relevant guidelines and standards.

The DAF system used for the project was operated at a nominal flow rate of approximately 60 gpm, which is about 30% of its rated capacity, for demonstrating treatment efficiency. Estimated energy consumption to operate the DAF was 0.0096 kW/gallon. The system can be scaled up to operate at substantially higher flow rates with significantly lower energy consumption per gallon of water treated. For example, the estimated energy consumption rate for a 700 gallon per minute (1 MGD) harvester operated at 100% capacity would be nearly five-fold less than that observed for the demonstration project.

Results of the Lake Agawam demonstration project are consistent with other similar projects that have documented high algal removal efficiency by DAF treatment and the significant reduction of associated microcystins and nutrients from water (Page *et al.* 2020). Application of full-scale DAF treatment could therefore be applied to Lake Agawam as well as other waterbodies affected by HABs in New York and elsewhere as part of a comprehensive approach to lake restoration. Operation of the DAF system at a hydraulic rate that removes algal nutrients at a greater rate than loadings from external human sources would result in lower nutrient concentrations in the treated water body and hence reduce the potential for algal production and the risk of HABs. In addition, removal of oxygen-demanding algal biomass can reduce the potential for the release of nutrients from sediments due to anoxia, thereby reducing this bioavailable supply of nutrients for algal production.

Long-term restoration and HAB control ultimately require continued efforts to reduce human sources of nutrients to affected water bodies. Even with effective nutrient source control in the watershed, it can take decades for improved water quality to be realized in lakes due several factors such as long water retention times, continued nutrient loading from sediments, and the inherent resistance of some lakes to changing from a turbid, algae-dominated state to a clear water state with low algae levels. Algae harvesting provides a means to accelerate restoration by removing algae, toxins and nutrients from the water column in a comparatively short period of time.

Treatment needs to effect significant changes in water quality of Lake Agawam or other HAB impacted water bodies can be numerically modeled allowing resource managers to weigh the costs and benefits of using DAF treatment as a part of a complete restoration project.

Research is ongoing to evaluate the use of organic-based coagulants and flocculants in the algae recovery process, and to advance the potential use of recovered algal biomass as a feedstock for biocrude production (Page *et al.* 2020). Results to date have indicated that dewatered algal biomass can yield biocrude and that algae harvesting could be net energy positive at ambient algae concentrations above 100 mg/L (Page *et al.* 2020). These potential advancements could make algae harvesting even more attractive as an effective, safe and energy conscious approach for mitigating HABs.

It is recommended that algae harvesting be further considered for full scale application at Lake Agawam or another HAB impaired water body. Water quality modeling should be conducted to determine treatment needs and to predict lake response to treatment in consideration of nutrient and water loads to the subject water body, as well as an understanding of algal and nutrient dynamics.

7. References

American Conference of Governmental Industrial Hygienists (ACGIH), 2019. Guide to Occupational Exposure Values.

Chorus, I., and Bartram, J. (Eds.), 1999. Toxic Cyanobacteria in Water – A Guide to Their Public Health Consequences, Monitoring and Management. E & FN Spon for the World Health Organization, New York, NY.

Davis, T.W., Berry, D.L., Boyer, G.L., Gobler, C.J., 2009. The effects of temperature and nutrients on the growth and dynamics of toxic and non-toxic strains of Microcystis during cyanobacteria blooms. *Harmful Algae* 8, 715-725.

Didi, Y., Naiyun, G., Kejia, Z., Lei, L., and D. Yang, 2015. Microcystin-RR degradation by ozonation. *Desalination and Water Treatment* 55:4, 1060-1067.

Gobler, C.J., 2017. Quantifying Nitrogen Loading from Southampton Village to Surrounding Water Bodies and Their Mitigation by Creating a Sewer District, Stony Brook University, School of Marine and Atmospheric Sciences, February 2017.

Gobler, C.J., Davis, T.W., Coyne, K.J., and Boyer, G.L., 2007. Interactive influences of nutrient loading, zooplankton grazing, and microcystin synthetase gene expression on cyanobacterial bloom dynamics in a eutrophic New York lake. *Harmful Algae* 6, 119-133.

Hoeger, S.J., Hitzfeld, B.C., and Dietrich, D.R., 2005. Occurrence and elimination of cyanobacterial toxins in drinking water treatment plants. *Toxicology and Applied Pharmacology* 203:3, 231-242.

Page, M.A. Page, MacAllister, B., Urban, A., Veinotte, C., MacAllister, I., Pokrzywinski, K., Martinez, E., White, C., Grasso, C., Kennedy, A., Thomas, K., and Riley, J., 2020. Harmful Algal Bloom Interception, Treatment, and Transformation System "HABITATS" Pilot Research Study Phase 1, Summer 2019. US Army Corps of Engineers, Environmental Research & Development Center (ERDC), ERDC TR 20-1, January 2020.

Nelson, Pope & Voorhis, LLC (NP&V), 2009. Comprehensive Management Plan for Lake Agawam. Report prepared for Village of Southampton, Village Board of Trustees, June 2009.

New York State Department of Environmental Conservation (NYSDEC), 2013. Fisheries Index Numbers (FINs) - Statewide Streams and Ponds - New York State (NYSDEC).

New York State Department of Environmental Conservation (NYSDEC), 2018. Archived HABs Notices. Access online at: https://www.dec.ny.gov/chemical/83332.html

Rositano, J., Nicholson, B.C., and Pieronne, P., 1998. Destruction of cyanobacterial toxins by ozone. *Ozone: Science & Engineering*, 20:3, 223-238, DOI: 10.1080/01919519808547273

Shawwa, A.R. and Smith, D.W., 2001. Kinetics of microcystin-LR oxidation by ozone. *Ozone: Science & Engineering*, 23:2, 161-170, DOI: 10.1080/01919510108961998

Teaf, C.M., 2018. Development of a Proposed Protective Air Concentration for Microcystin; Hazardous Substance & Waste Management Research, Inc.

US Environmental Protection Agency (US EPA), 2001. Requirements for Quality Assurance Project Plans (QA/R-5) - March 2001 (Reissued May 2006), EPA/240/B-01/003.

United States Environmental Protection Agency (US EPA), 2018. 2018 Final Aquatic Life Criteria for Aluminum in Freshwater. Available at: https://www.epa.gov/wqc/aquatic-life-criteria-aluminum.

Appendix A
Photolog of Project Activities

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
New York Department of Environmental Conservation New York Office of General Services	Southampton, NY	60615739

Photo No. 1

Date: 10/4/2019

Mobilization

Description:

Project site upon arrival at 8am.

Photo No. 2

Date: 10/4/2019

Mobilization

Description:

HIPOx unit upon placement on site.

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
New York Department of Environmental Conservation New York Office of General Services	Southampton, NY	60615739

Photo No. 3

Date: 10/4/2019

Mobilization

Description:

Mobile office in place on site.

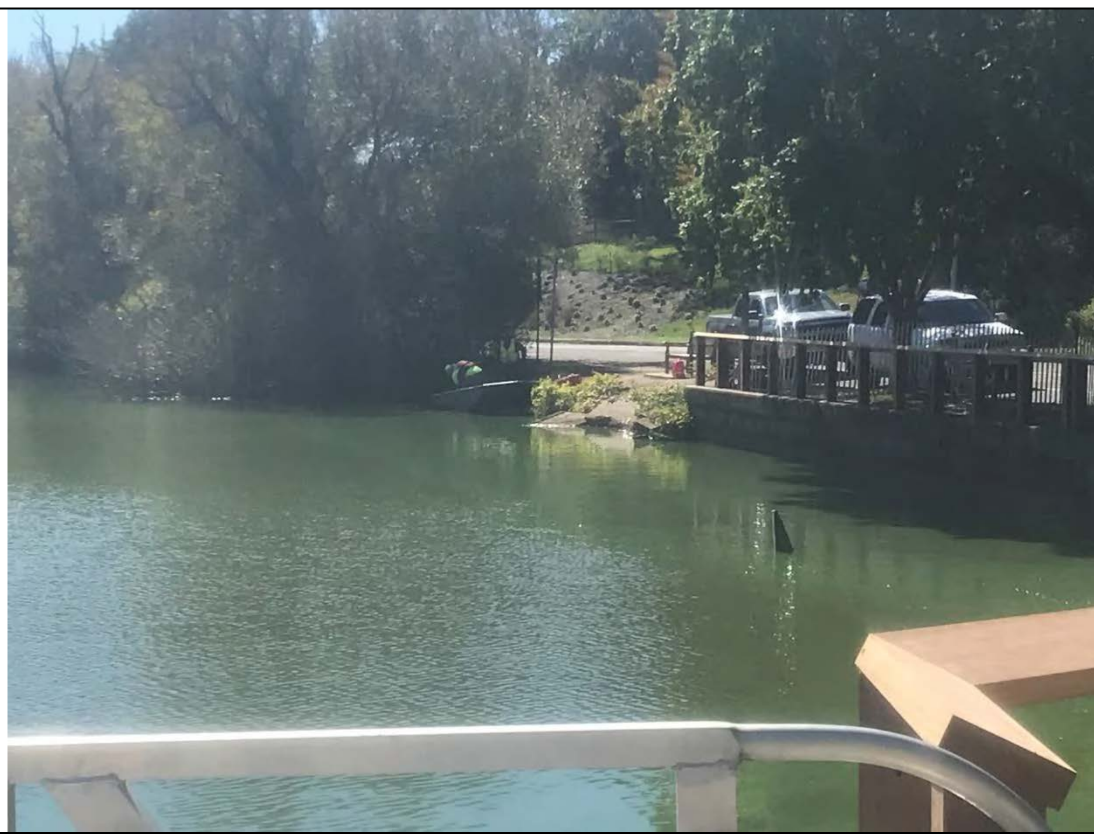
Photo No. 4

Date: 10/5/2019

Mobilization

Description:

Sevenson employees fixing the motor on the boat



PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
New York Department of Environmental Conservation New York Office of General Services	Southampton, NY	60615739

Photo No. 5	Date: 10/5/2019
Mobilization	
Description: Upwind air sampling station	

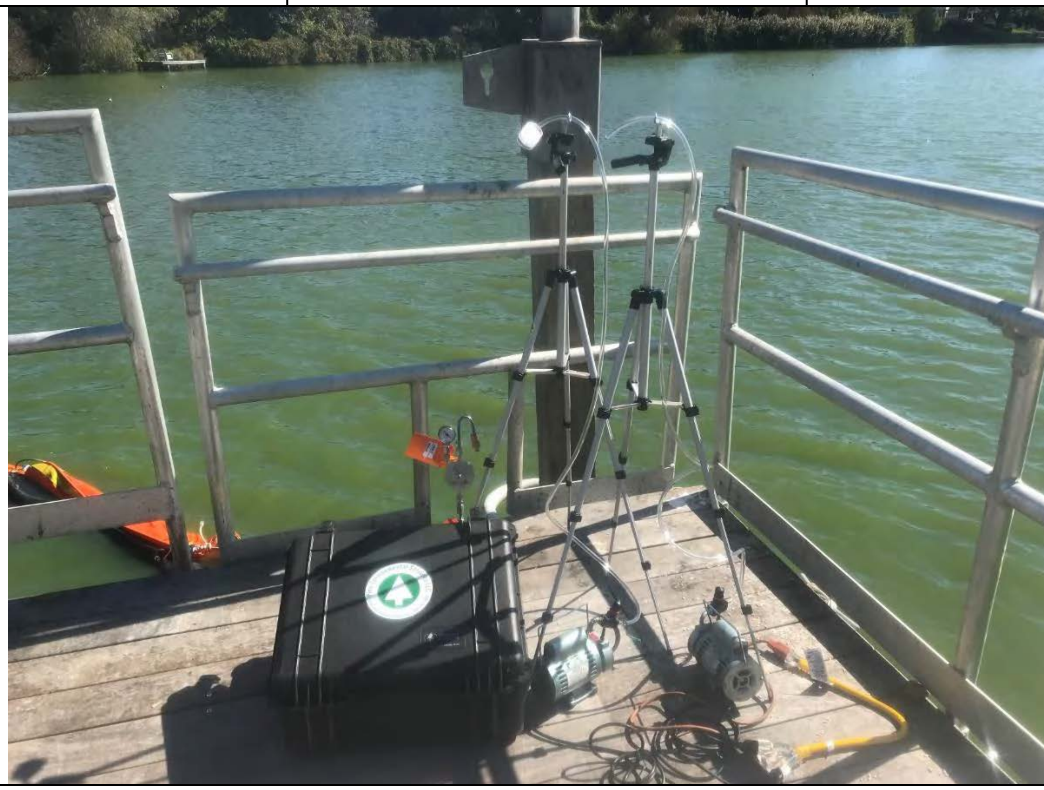


Photo No. 6	Date: 10/5/2019
Mobilization	
Description: Downwind air sampling station	

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
New York Department of Environmental Conservation New York Office of General Services	Southampton, NY	60615739

Photo No. 7	Date: 10/5/2019
Mobilization	
Description: Sevenson employees setting the scimmer up on the lake	

Photo No. 8	Date: 10/6/2019
Mobilization	
Description: PVC effluent piping section 2	

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
New York Department of Environmental Conservation New York Office of General Services	Southampton, NY	60615739

Photo No.	Date:
9	10/6/2019

Mobilization

Description:

PVC effluent piping section 1

Photo No.	Date:
10	10/6/2019

Mobilization

Description:

Water samples from the system test

PHOTOGRAPHIC LOG

Client Name: New York Department of Environmental Conservation New York Office of General Services	Site Location: Southampton, NY	Project No. 60615739

Photo No.	Date:
11	10/7/2019

Operation Day 1

Description:

Full system at the start of Run Day 1

Photo No.	Date:
12	10/7/2019

Operation Day 1

Description:

Upwind air sampling station

PHOTOGRAPHIC LOG		
Client Name: New York Department of Environmental Conservation New York Office of General Services	**Site Location:** Southampton, NY	**Project No.** 60615739

Photo No. 13	**Date:** 10/7/2019
Operation Day 1	
Description: Downstream air sampling station	

Photo No. 14	**Date:** 10/7/2019
Operation Day 1	
Description: Samples of raw lake water, treated lake water, and blue green algae	

PHOTOGRAPHIC LOG	

Client Name: New York Department of Environmental Conservation New York Office of General Services	**Site Location:** Southampton, NY	**Project No.** 60615739

Photo No. 15	**Date:** 10/8/2019
Operation Day 2	
Description: Downwind VOCs air sampling station	

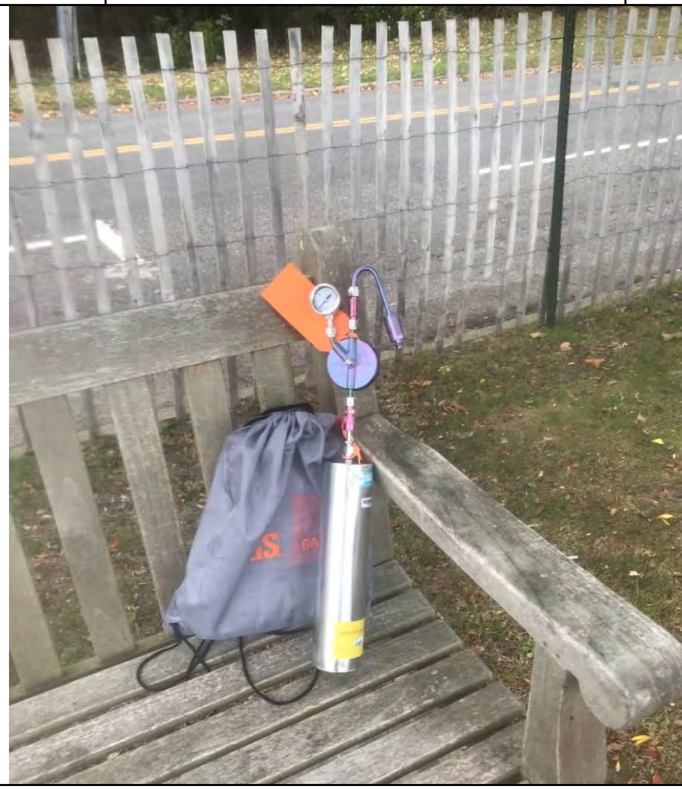


Photo No. 16	**Date:** 10/8/2019
Operation Day 2	
Description: Upwind VOCs air sampling station	

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
New York Department of Environmental Conservation New York Office of General Services	Southampton, NY	60615739

Photo No. 17

Date: 10/8/2019

Operation Day 2

Description:

AECOM drone and Lake Agawam on DAF operation day 2, cloudy day

Photo No. 18

Date: 10/9/2019

Operation Day 3

Description:

Microcystin test strips unopened

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
New York Department of Environmental Conservation New York Office of General Services	Southampton, NY	60615739

Photo No.	Date:
19	10/9/2019

Operation Day 3

Description:

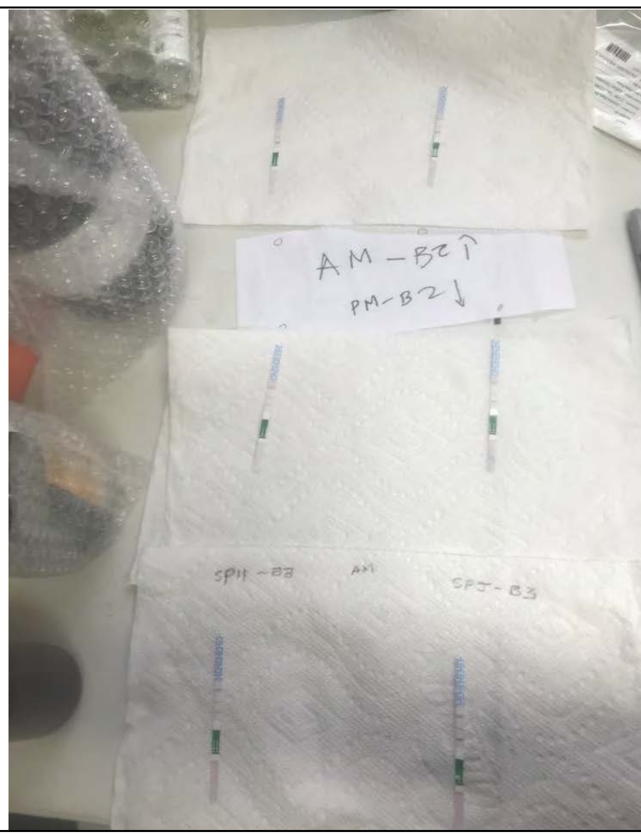
AECOM employee testing day 2 and day 3 AM samples for microcystin, using the test strips

Photo No.	Date:
20	10/9/2019

Operation Day 3

Description:

Results of the day 2 and day 3 AM microcystin test strips – all 0 ppb



PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
New York Department of Environmental Conservation New York Office of General Services	Southampton, NY	60615739

Photo No. 21

Date: 10/10/2019

Operation Day 4

Description:

AECOM employee working with the microcystins test strip kit

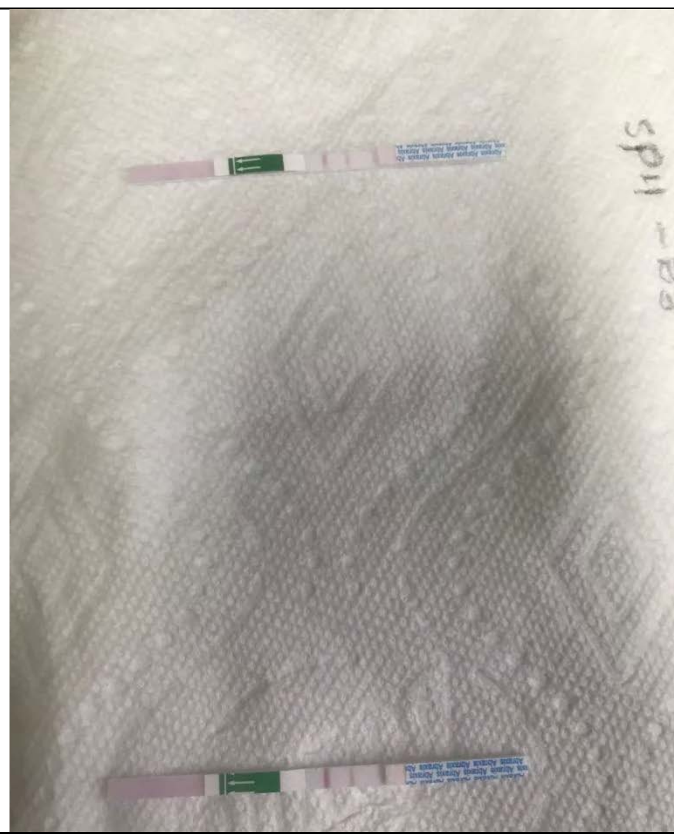
Photo No. 22

Date: 10/10/2019

Operation Day 4

Description:

Microcystin test strip results for 19-SP4-B4, 0 ppb



PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
New York Department of Environmental Conservation New York Office of General Services	Southampton, NY	60615739

Photo No.	Date:
23	10/11/2019

Operation Day 5

Description:

AECOM supervising EPS on-site for the slurry transfer

Photo No.	Date:
24	10/11/2019

Operation Day 5

Description:

Slurry sample extracted from SP-6 (sample ID 19-SP6-B5)

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
New York Department of Environmental Conservation New York Office of General Services	Southampton, NY	60615739

Photo No. 25

Date: 10/12/2019

Operation Day 6

Description:

AECOM using algae torch to obtain chlorophyll and cyanobacteria measurements at SP-3.

Photo No. 26

Date: 10/12/2019

Operation Day 6

Description:

AECOM using algae torch to obtain chlorophyll and cyanobacteria measurements at SP-3.

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
New York Department of Environmental Conservation New York Office of General Services	Southampton, NY	60615739

Photo No.	Date:
27	10/12/2019

Operation Day 6

Description:

Results of microsystin test strips from SP-4 and SP-5

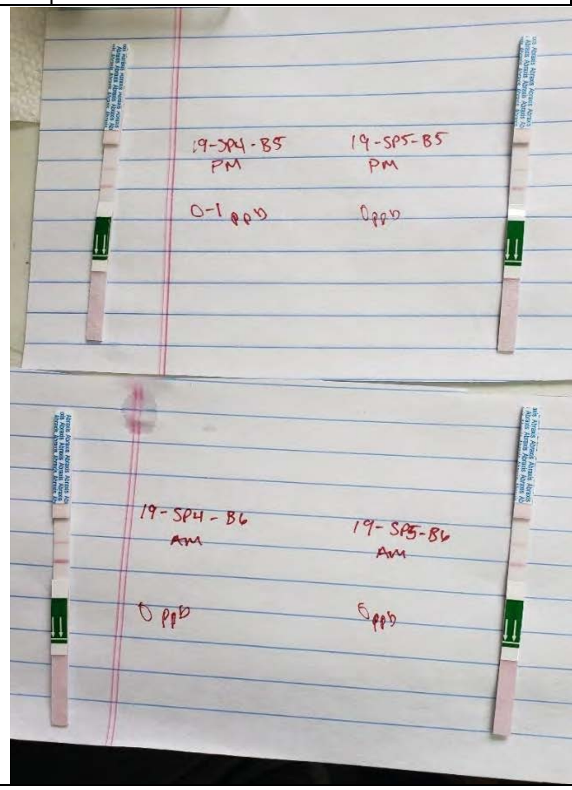


Photo No.	Date:
28	10/13/2019

Operation Day 7

Description:

Algal slurry discharge section of the DAF

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
New York Department of Environmental Conservation New York Office of General Services	Southampton, NY	60615739

Photo No.	Date:
29	10/13/2019

Operation Day 7

Description:

Influent water to the DAF on 10/13/19 displayed lower turbidity then past sampling days

Photo No.	Date:
30	10/14/2019

Operation Day 8

Description:

Slurry post harvesting

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
New York Department of Environmental Conservation New York Office of General Services	Southampton, NY	60615739

Photo No.	Date:
31	10/14/2019

Operation Day 8

Description:

Water post DAF, heading to HIPOx

Photo No.	Date:
32	10/14/2019

Operation Day 8

Description:

Slurry container to be packaged and sent to the laboratory

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
New York Department of Environmental Conservation New York Office of General Services	Southampton, NY	60615739

Photo No. 33

Date: 10/15/2019

Operation Day 9

Description:

Algae in Lake Agawam on sunny day 9

Photo No. 34

Date: 10/15/2019

Operation Day 9

Description:

AECOM employee sampling SP-1 for the microcystin test

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
New York Department of Environmental Conservation New York Office of General Services	Southampton, NY	60615739

Photo No. 35

Date: 10/15/2019

Operation Day 9

Description:

AECOM employee sampling SP-2 for the microcystin test

Photo No. 36

Date: 10/16/2019

Operation Day 10

Description:

Crews begin to place sand on site for heavy equipment operation tomorrow

PHOTOGRAPHIC LOG

Client Name:

New York Department of Environmental Conservation
New York Office of General Services

Site Location:

Southampton, NY

Project No.

60615739

Photo No. 37

Date: 10/16/2019

Operation Day 10

Description:

Sand fill completed on site

Photo No. 36

Date: 10/16/2019

Operation Day 10

Description:

Algae in the DAF system prior to being skimmed into the slurry pit

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
New York Department of Environmental Conservation New York Office of General Services	Southampton, NY	60615739

Photo No. 37	Date: 10/17/2019
Demobilization	
Description: DAF system cleaned out for demobilization	

Photo No. 38	Date: 10/17/2019
Demobilization	
Description: Lake influent piping taken apart for demobilization	

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
New York Department of Environmental Conservation New York Office of General Services	Southampton, NY	60615739

Photo No. 39

Date: 10/17/2019

Demobilization

Description:

U-Haul begins to be packed for demobilization

Photo No. 40

Date: 10/18/2019

Demobilization

Description:

Consolidated Fence dismantles and retrieves fence from site

PHOTOGRAPHIC LOG

Client Name: New York Department of Environmental Conservation New York Office of General Services	Site Location: Southampton, NY	Project No. 60615739

Photo No. 41	Date: 10/18/2019
Demobilization	
Description: Sevenson (2) retrieves skimmer and boom from Lake Agawam	

Photo No. 42	Date: 10/18/2019
Demobilization	
Description: Lake Agawam- all equipment removed from lake	

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
New York Department of Environmental Conservation New York Office of General Services	Southampton, NY	60615739

Photo No. 43

Date: 10/18/2019

Demobilization

Description:

ATP Water equipment removed from site by subcontractor

Photo No. 44

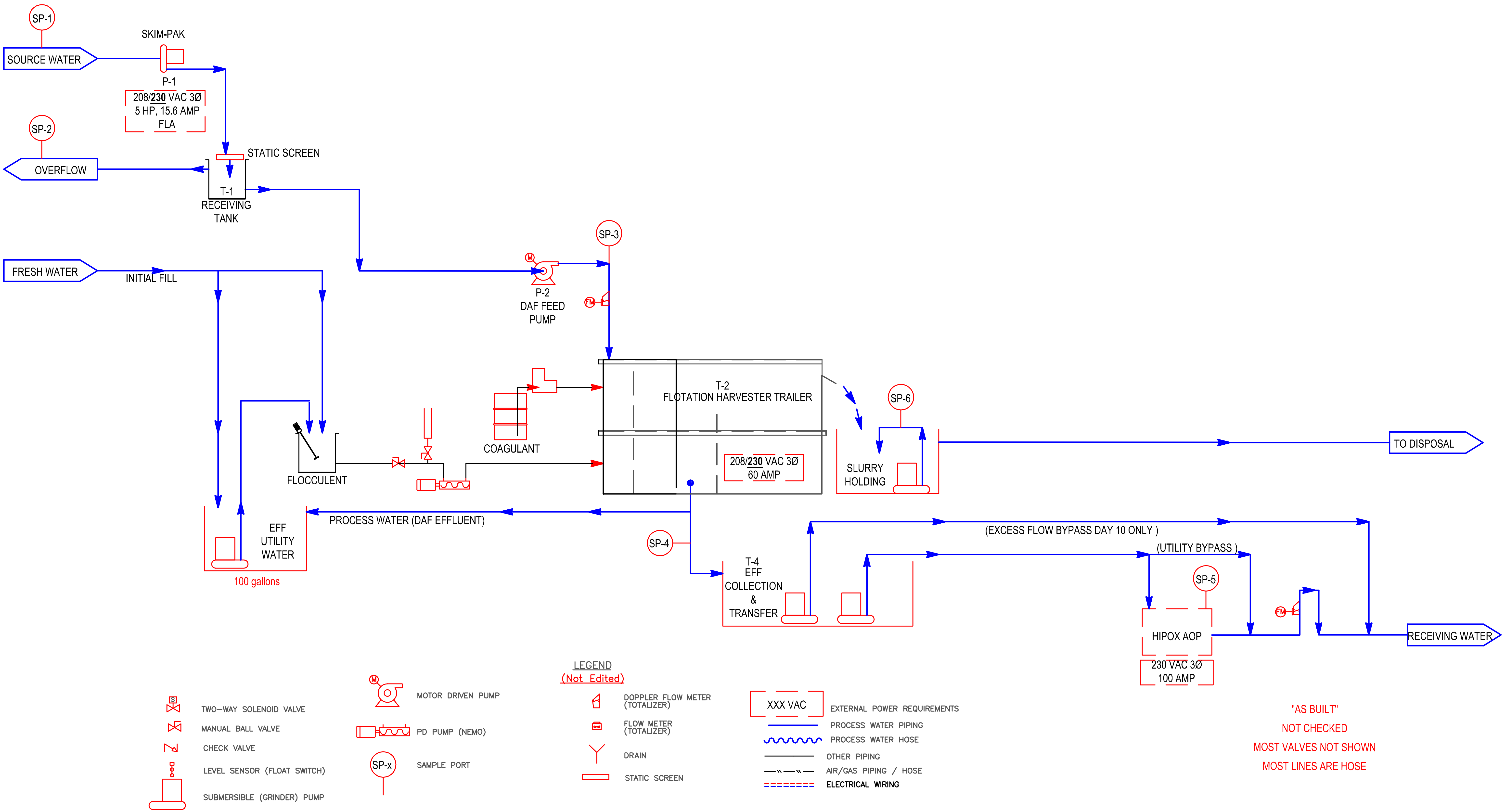
Date: 10/18/2019

Demobilization

Description:

Eastern Environmental Solutions moving slurry from DAF to PortaTank

Appendix B
As-Built Process Configuration



PROPRIETARY and CONFIDENTIAL

AECOM Imagine it Delivered

Algae Recovery Process Flow Diagram
NYS-OGS
Lake Agawam, South Hampton, NY

REV	BY	DESCRIPTION	DATE				
REV				PLOT DATE:			
4				DRAWN BY:	D. PINELLI	DATE:	9-27-19
3				CHECKED BY:		DATE:	
2	DJP	Configure to "AS BUILT"	11-13-19	PROJECT ENG.		DATE:	
1	DJP	Add SP-6 and Slurry Mix Pump	9-29-19	APPROVED BY:		DATE:	
				CUSTOMER		DATE:	

SCALE: NTS
DRAWING NO.: B-101 PFD
REVISION: 2
DRAWING NAME.: NYS-OGS

Southampton Village 159

Appendix C
Daily Operating Logs

Daily DAF Operating Log

			H7 Operating Parameters					Chemical Application Data							Skimming Data			
Date (YYYY-MM-DD)	Day	Time	Influent Flow (Q) (gpm)	Recycle Flow (gpm)	Recycle Rate (%)	Pressure (psi / psi)	Air Flow (SCFH)	Coagulant Pump (S / F)	Coagulant Flow (ml/min)	Coagulant Dose (ppm)	Polymer Pump (%)	Polymer Flow (ml/min)	Polymer Concentration (%)	Polymer Dose (ppm)	Skim Cycle (Auto or Manual)	No. of Skims	Estimated Slurry Volume (Gal.)	Notes
2019-10-07	D-1	11:40																DAF only, no oxidation, ACH & Polytech 2160 Cationic, weather not noted
		11:46	60	11	18	86 / 88	10	100 / 50	44	194					Auto			Water over weir, Skim Cycle: 6 skims per hour, ACH dose high - See note D-3
		13:10	60	11	18				44		30	350	0.05	0.77				
		15:15	60	13	22	76 / 88	10											
		17:00	60	12	20	80 / 88												Sample
		17:10	60	12	20	80 / 88	10											Shutdown
																	147	Weather not noted
2019-10-08	D-2	10:41	56												Auto			Today: oxidation, ACH & Polytech 2160 Cationic
		11:15	60					100 / 50	44	194	34	400	0.05	0.88				(ACH dose high - See note D-3)
		12:10																Water to oxidation unit - Ozone Only (D-2 through D-10)
		14:00	60	13	22	78 / 78	10								Auto			Sample SP-1 through SP-5 (UVA)
		16:00																Sample SP-3 through SP-5 (UVA)
		16:30	60	12	20	80 / 89	10				34	350	0.05	0.77	Auto			Poly flow down - low head in tank
		17:30																Shut Down
																		Weather: Windy from northeast, Cool and Overcast most of the day, partly cloudy at end.
																	120	Fine Carryover all day, Bench work points to Anionic Polymer. See note on D-3
2019-10-09	D-3	9:25																DAF Begin (Technical Difficulty) Flopam 934 (Anionic)
		9:55	60	12.5	21	78 / 89	10	100 / 50	44	194	34	450	0.05	1.1				Oxidation Unit On-Line - Ozone Only
		11:00																Sample Note: Sampling takes 30 to 45 minutes. Filled D-1 and D-2 Spreadsheet Calcs. Discovered ACH dosage was high due to bench to full scale dilution error. That explains why it looked like Anionic was more effective. Subsequently lowered ACH dose.
		12:15	60	12.5	21			No Noted	8.5	37								
		15:00																Sample - Note: Polymer ran out prior completion of sampling. During SP-4. Should have no effect.
		16:05																Shutdown
																	122	Steady rain all day

Daily DAF Operating Log

			H7 Operating Parameters					Chemical Application Data							Skimming Data			
Date (YYYY-MM-DD)	Day	Time	Influent Flow (Q) (gpm)	Recycle Flow (gpm)	Recycle Rate (%)	Pressure (psi / psi)	Air Flow (SCFH)	Coagulant Pump (S / F)	Coagulant Flow (ml/min)	Coagulant Dose (ppm)	Polymer Pump (%)	Polymer Flow (ml/min)	Polymer Concentration (%)	Polymer Dose (ppm)	Skim Cycle (Auto or Manual)	No. of Skims	Estimated Slurry Volume (Gal.)	Notes
2019-10-10	D-4	9:33	60															Start-up back to 2160 Cationic Polymer
		9:45	60	13	22	78 / 89	10	30 / 30	7	31	34	400	0.05	0.88				Oxidation Unit On-line - Ozone only
		10:45	60												Manual			Sample Note: With system in AUTO and skimmer in Manual, Skimmer cycles as if in Auto - interval was 10 min. Now system in Manual. Sampling aborted. Chemical feed circuit had tripped.
		11:20																Discovered compressor not running in "Manual" switched to Auto.
		11:50														1210-1		Sample - Harvester in Manual all components operational
		15:00														1310-1		Sample - Harvester running very well. Sludge Judge Slurry Tank ~1 ft. of matt above ~2.5 ft. of clear water - will be very dilute when homogenized. Will be coming off heavier with 60-minute skim cycle time.
		16:10														1610-1		
		16:18																Oxidation unit bypassed
		16:20																Shutdown, 15 Gallons remaining in Polymer Tank
																	69	Overcast all day, rain at 16:00
2019-10-11	D-5	9:20	60												Auto			Harvester on. Skim Cycle: once per hour, reduced ACH dose
		9:30																HiPOx on - ozone only
		9:50	60	13	22	78 / 89	10	22 / 30	4.5	20								Now using 6 GPD Coag pump, was 10 GPD
2019-10-11	D-5	10:14																Oxidation unit short bypass and shutdown to clear vent to O3 destruct unit. Harvester remaining in operation.
		10:20														1020-1		System in auto, skim every 60 minutes
		10:30																Oxidation unit back on line
		11:00																Sample – SP-3 to SP-5, ~35 minutes to complete
		11:35														1.6%		Slurry homogenized and sampled (SP-6), 11:40 pumping out. Moisture will be run on Saturday. Top layer so slurry grab came in at 4.4% solids.
		14:50	60								36	303	0.05	0.67				
		15:05																Sample (40 minutes)
		15:20														2.3%		Skim grab 2.3% solids
		16:30																Oxidation unit off
		16:32																DAF off
																	38	Overcast all day, brief glimmer of sun, misting at times

Daily DAF Operating Log

Date (YYYY-MM-DD)	Day	Time	H7 Operating Parameters					Chemical Application Data							Skimming Data			Notes
			Influent Flow (Q) (gpm)	Recycle Flow (gpm)	Recycle Rate (%)	Pressure (psi / psi)	Air Flow (SCFH)	Coagulant Pump (S / F)	Coagulant Flow (ml/min)	Coagulant Dose (ppm)	Polymer Pump (%)	Polymer Flow (ml/min)	Polymer Concentration (%)	Polymer Dose (ppm)	Skim Cycle (Auto or Manual)	No. of Skims	Estimated Slurry Volume (Gal.)	
2019-10-12	D-6	9:15	61	12	20	89 / 75	10								Auto			Start-up 2160 target 0.5 ppm or half of yesterday, polymer concentration now at 0.025%, overcast
		9:25	61															Oxidation unit on-line - ozone only
		9:35	61					22 / 50	4.175	18								
		9:45	61								35-36	225	0.025	*0.24*				Higher polymer recorded yesterday at the 34% setting.
		11:00	61															Sample - overcast
		11:55	61								35-36	420	0.025	0.45				Polymer calibration cylinder does not agree with measured outfall. 420 ml/min. is measured outfall.
		12:30																Collected Sample for UVA
		14:00																Sample - Overcast, glimmer of sunlight at ~12:45
		14:45	61								35-35	373	0.025	0.40				Table value is outfall, cylinder says 254 ml/min.
		15:00	61					22 / 50	4.6	20								
		15:48																Oxidation unit bypassed
		15:49													1 M			DAF off
																		Cleaned polymer system calibration cylinder and piping
																	75	Note: D-1 through D-6, Coag Mixer 1 at 98%, Coag mixer 2 adjusted to 50% on about D-3 (Look for note later)
2019-10-13	D-7	8:20	61												Auto			Start-up no flocculant, will run more than 1 hour until sampling to assure displacement of harvester water volume. Clear, visible sunshine.
		9:00	61	12	20	88 / 76	10				Off	Off	Off	Off	20 min. after			
		9:35	61					30 / 30	4.175	18								
		10:07																Oxidation unit on-line - ozone only
		10:25	61					22 / 50	4.2	18								
		10:30																Sample, mostly sunny, fine carryover in effluent, influent appears much lighter
		11:15																Targeting 30 ppm ACH (~6.8 ml/min)
		11:25	61					22 / 68	6.8	29								
		13:00																All systems working well
		14:20													2.1%			Skim sample
		15:00																Sample, low sun (~45 deg. angle)
		15:45	61					22 / 68	7.1	31								
		16:10																FM 2 Reported to be working fine now that no entrained air
		16:25																Shutdown
2019-10-13	D-7	16:45															66	100 GPM Flow Exp. Draws down receiving tank. Must change to 3" Hose.

Daily DAF Operating Log

			H7 Operating Parameters					Chemical Application Data								Skimming Data			
Date (YYYY-MM-DD)	Day	Time	Influent Flow (Q) (gpm)	Recycle Flow (gpm)	Recycle Rate (%)	Pressure (psi / psi)	Air Flow (SCFH)	Coagulant Pump (S / F)	Coagulant Flow (ml/min)	Coagulant Dose (ppm)	Polymer Pump (%)	Polymer Flow (ml/min)	Polymer Concentration (%)	Polymer Dose (ppm)	Skim Cycle (Auto or Manual)	No. of Skims	Estimated Slurry Volume (Gal.)	Notes
2019-10-14	D-8	9:00	61	18	30	100 / 80	~14								Auto (60-min interval)			Today target 30% Recycle, Prestart-up to adjust recycle rate. Better differential pressure now. 20 ppm ACH w/ 0.5 ppm 2160 Cationic Polymer
		9:30	61															Start-up DAF
		10:00	61					32 / 50	4.6	20								(Oxidation unit start-up time not specifically noted - Ozone only)
		10:10	61								34	410	0.025	0.44				Polymer: recorded value measured at outfall. Cylinder measured 225 mls/min. Discontinuing use of cylinder
		10:30	61								36	480	0.025	0.52				Polymer flow adjustment, measured at outfall.
		11:00																Sample - Calm, overcast, misting
		12:00														1.8%		Slurry sampled for PNNL, sun trying to break through
		12:45																Sun breakthrough
		14:45	61					32 / 50	5	22	36	440	0.025	0.48				Chem flow measurement at outfall
		15:00																Sample - nearly full sun, southerly breeze (toward Weir skimmer), surface algae streaming into weir skimmer (photo and video)
		16:00														1-M	75	Shutdown
2019-10-15	D-9	9:00	61	18	30	100 / 80	~14								Auto			Target conditions same as D-8, 20 ppm ACH w/ 0.5 ppm 2160 Cationic Polymer
		9:15																Start-up
		9:20																Oxidation unit on line - ozone only
		10:30	61	18	30	100 / 80	~14	32 / 50	4.6	19.9	36	470	0.025	0.51				Sample - full sun, light southerly breeze
		14:30																Sample - full sun, about 45 deg. angle. Light southerly breeze. Missed chem flow data because of Georgica Pond Demo.
		15:38																Oxidation unit off
		15:40													M-1			DAF off
		16:00															66	Replaced weir skimmer discharge hose with 3", installed second sump pump in ECT - tomorrow trying for 100 gpm through DAF.
2019-10-16	D-10														Auto			Target conditions 100 gpm through Harvester (if weir skimmer delivers) 20 ppm ACH w/ 0.5 ppm 2160
		9:30																Start-up
		9:45																Oxidation unit On Line - ozone only
		10:00	88	18	20	100 / 80	12	32 / 74	6.8	20	38	680	0.0025	0.51				Only able to get 88 gpm from weir skimmer with 3" Lay flat Hose
		11:00																Sample - high clouds, heavily filtered sunshine
		14:00														1.9%		Slurry Homogenized and Sampled for Microcystin
		14:45	88	18	20	100 / 80	10	32 / 74	9.0	27	38	570	0.0025	0.43				Coag flow crept up
		15:00																Sample - full overcast
		15:35	88						9.0	27								Double checking Coag Flow- yes it has crept up.
		15:50	88								100	2100	0.0025	1.58				Boost polymer to exhaust inventory
		17:00														1-M	91	Shut down DAF and Oxidation unit
																	869	Cumulative Total
																	>977	Liquid Volume with DeMob skims and Rinse Water

Daily Oxidation Operating Log

Reading Input									APT Tests			
Date	Time	Total Flow (gpm)	O2 flow SLM	wt % O3	Gen. Power LED	O3 (mg/L)	Gallons R1/R2 Run Time	Gallons Total / gpm	O3 (mg/L) Residual	H2O2 (mg/L) Residual	pH	Alkalinity (mg/L)
8-Oct	14:30	56.0	10.0	4.00	5/5	2.5	0	0 / 0	1.1/0.5*	NA	7.2	70
9-Oct	10:30	57.0	10.0	3.80	5/5	2.3	0	0 / 0	1.1/0.6*	NA	7.2	70
9-Oct	14:30	57.0	10.0	3.55	5/5	2.2	0	0 / 0	1.1/0.6*	NA	7.2<pH<7.6	70
10-Oct	10:30	56-57	10.0	3.50	10	2.2	0	NA	1.0/0.5*	NA	7.2<pH<7.6	70
10-Oct	15:30	56-57	10.0	3.40	10	2.1	0	NA	1.0/0.5*	NA	7.6	70
11-Oct	11:00	55-56	10.0	3.40	10	2.1	0	NA	1.1/0.6	NA	7.2<pH< 7.6	80
11-Oct	15:15	55-56	10.0	3.35	10	2.1	11375/11843 RT = 405 min	23281 / 57.3	1.1/0.6	NA	7.2<pH< 7.6	70
12-Oct	10:30	55-56	10.0	3.35	10/10.9	2.1	0	0 / 0	1.1/0.6	NA	7.2	80
12-Oct	14:00	55-56	10.0	3.30	10/10.9	2.1	10509/10950 RT = 388 min	21459 / 55.3	1.1/0.6	NA	7.4	80
13-Oct	10:30	55-56	10.0	3.45	10/10.9	2.2	0	0 / 0	1.1/0.6	NA	7.2<pH<7.6	70
13-Oct	15:00	55-56	10.0	3.35	10/10.9	2.1	10428/10774 RT = 380 min	21202 / 55.8	1.1/0.6	NA	7.2<pH<7.6	70
14-Oct	11:00	55-56	10.0	3.35	10/10.9	2.1	0	0 / 0	1.1/0.6	NA	7.2<pH<7.6	70
14-Oct	15:00	55-56	10.0	3.33	10/10.9	2.1	10623/10980 RT = 385 min	21603 / 56.1	1.1/0.6	NA	7.6	70
15-Oct	10:00	55-56	10.0	3.45	10/10.9	2.2	1200/1140 RT = 42 mins	2340 / 56	1.1/0.6	NA	7.2	70
15-Oct	14:00	56-57	10.0	3.35	10/10.9	2.1	10412/10773 RT = 377 min	21185 / 56.2	1.0/0.5	NA	7.2<pH<7.6	80
16-Oct	10:30	56-57	10.0	3.40	10/10.9	2.1	1573/1595 RT = 57 min	3168 / 55.6	1.1/0.6	NA	7.6	70
16-Oct	14:45	56-57	10.0	3.33	10/10.9	2.0	12150/12514 RT = 435 min	24664 / 56.7	1.0/0.5	NA	7.8<pH<8.2	70

Comments

Date	Time	Description
7-Oct		Day 1 was DAF ONLY, while oxidation system prep was completed
8-Oct		* 1.0 = neat sample. 0.5 = 50% Dilution RESIDUAL O3
		Oxidation system running very stably for 2 hours, without any adjustment, before sampling
		Day #2 - Cationic Floc. #2160 Dose = 0.77 ppm
		Was unable to record totalizers for 10/8.
9-Oct		15 degrees colder with steady rain.
		Day #3 - Anionic Floc. Flopam #934 Dose = 1.1 ppm
		14:30 readings - noticed an increase in pH from 7.2 to 7.6. Report to Dave. No explanation for this.
10-Oct		Day #4 -Repeat Cationic Floc. #2160 at 0.88 ppm
11-Oct	10:17	Identified H20 lock on both Vent Valves discharge PFA. Stop oxidation unit, clear lines, restart, retest O3 Residual. No change in residual.
		Day #5 - Cationic Floc. #2160 Dose = 0.88 ppm + ACH -20 ppm
	15:15	Day #5 - Afternoon sampling. Adding ACH Coagulant - 20ppm
12-Oct	10:00	The only difference today is the #2160 Cat. Floc. Dose is reduced to 0.5 ppm target, while the ACH Coagulant is maintained at 20 ppm.
		Day #6 - Cationic Floc. #2160 Dose = 0.70 ppm + ACH -20 ppm
	11:00	The water being tested has dropped about 2 degrees C due to colder air (~45F)
	16:30	Added the totalizer readings for R1 and R2
13-Oct	08:00	Though it is still cool out, the winds are calm. There is more appearance of algae on the lake surface. (Take Pictures)
	11:00	Today's test is without any Polymer (flocculant). The ACH coagulant is still being dosed at 20 ppm.
	14:00	The Non-Detect (ND) of the MC is solely the result of the Dip Strips. No Lab results have been made available up to this point.
	16:00	Flowmeter. Checked clear tubing, found and cleared air bubbles.
		Closer review found Separator discharge gulping air. Correct Vent Valve positions until condition cleared. Meter now working.
	16:25	Shutdown oxidation unit. Calculate total flows

Daily Oxidation Operating Log

Date	Time	Description
14-Oct	**10:30**	**The only change is the Flocculant 2160 dose is dropped to 0.5 ppm. Very slight improvement on H2O gpm + psi from Vent Valve adjustment.**
		Day #8 - Dose #2160 at 0.5 ppm and ACH @ 20 ppm
	16:00	Shutdown oxidation unit. Calculate total flows
15-Oct	9:00	Today is a repeat of yesterday's targets.
		Day #9 - Dose #2160 at 0.5 ppm and ACH @ 20 ppm. Repeat day 8
	14:00	The total gallons and flow rates are determined at the time the oxidation unit is shut off, not at the time of the data readings
16-Oct	8:00	Plan is to start asap as afternoon rains are expected to be heavy. It's only 42F here now.
	8:30	Before leaving on 10/9, we set up skimmer to bring 100 gpm on shore. This will initially require more oxidation unit Feed monitoring.
		Day #10 - Same dosing as Day 9. Water flow to DAF ^ 100 gpm.
	10:30	Startup at 09:41, Running at 09:47. Working with local DPW on site work in prep for demobilization activities. Take readings at 10:30
	14:45	Take Final readings Final Sampling. Only time pH read so high
	16:00	Shutdown delayed due to need to process DAF fluids required for demobilization
	17:15	Take Total Flows from +GF+ Meters

Appendix D
Field Monitoring Data

Table 1 - SP1 Field Measured Parameters
Agawam Lake - Southampton, NY
NYSDEC Project No. SD089

Sample Date	**Unit**	**NY WQS**	**Day 2 10/8/2019**
Sample Time	24 hour		**1400**
Parameters			
Turbidity (+/- 10%)	NTU		69.8
Dissolved Oxygen (+/- 10%)	%		61.40
Dissolved Oxygen (+/- 10%)	mg/L	≥5 (daily), ≥4 (instantaneous)	7.63
Total Dissolved Solids	mg/L	500	-
Specific Conductivity (+/- 3%)	mS/cm		495
Conductivity (+/- 3%)	mS/cm		0.433
pH (+/- 0.1)	pH unit	6.5-8.5	8.18
Temperature (+/- 0.5)	˚C		18.40
Color	Visual		Murky
Odor	Olfactory		None

Notes:

(-) = Parameter not collected
% = Percent
˚C = Degrees Celcius
mg/L = Miligrams per Liter
NTU = Nephelometric Turdbidity Unit
mS/cm = Microsiemens per centimeter
Sample collection method = Grab directly from Lake water
NY WQS = New York Water Quality Standard (6 CRR-NY 703.3), Class C
Values in highlighted cells do not meet NY WQS

Table 2 - SP2 Field Measured Parameters
Agawam Lake - Southampton, NY
NYSDEC Project No. SD089

Sample Date	Unit	NY WQS	Day 2 10/8/2019
Sample Time	24 hour		**1405**
Parameters			
Turbidity (+/- 10%)	NTU		37.5
Dissolved Oxygen (+/- 10%)	%		83.10
Dissolved Oxygen (+/- 10%)	mg/L	≥5 (daily), ≥4 (instantaneous)	7.79
Total Dissolved Solids	mg/L	500	-
Specific Conductivity (+/- 3%)	mS/cm		509.9
Conductivity (+/- 3%)	mS/cm		0.422
pH (+/- 0.1)	pH unit	6.5-8.5	8.69
Temperature (+/- 0.5)	˚C		18.20
Color	Visual		Clear
Odor	Olfactory		None

Notes:
(-) = Parameter not collected
% = Percent
˚C = Degrees Celcius
mg/L = Miligrams per Liter
NTU = Nephelometric Turdbidity Unit
mS/cm = Microsiemens per centimeter
Sample collection method = Grab from sample port, unless specified otherwise
NY WQS = New York Water Quality Standard (6 CRR-NY 703.3), Class C
Values in highlighted cells do not meet NY WQS

Table 3 - SP3 Field Measured Parameters
Agawam Lake - Southampton, NY
NYSDEC Project No. SD089

Sample Date	Unit	NY WQS	Day 1 10/7/2019		Day 2 10/8/2019		Day 3 10/9/2019		Day 4 10/10/2019		Day 5 10/11/2019		Day 6 10/12/2019		Day 7 10/13/2019		Day 8 10/14/2019		Day 9 10/15/2019		Day 10 10/16/2019	
Sample Time	24 hour		**1407**	**1700**	**1410**	**1600**	**1100**	**1530**	**1150**	**1500**	**1150**	**1500**	**1100**	**1400**	**1030**	**1500**	**1100**	**1500**	**1030**	**1430**	**1100**	**1500**
Parameters																						
Turbidity (+/- 10%)	NTU		67.4	71.3	42.8	44.2	62.80	42.60	50.40	55.10	50.40	55.10	53.60	64.80	48.90	87.60	51.10	225.00	176.00	142.00	102.00	139.00
Dissolved Oxygen (+/- 10%)	%		110.50	83.30	87.50	91.60	87.50	108.70	112.20	294.30	112.20	294.30	78.60	77.50	76.70	87.20	90.50	164.00	123.00	117.80	139.60	156.10
Dissolved Oxygen (+/- 10%)	mg/L	≥5 (daily), ≥4 (instantaneous)	9.52	7.38	8.14	8.66	8.19	9.75	11.06	27.47	11.06	27.47	7.85	7.72	7.39	2.90	9.03	15.46	12.56	11.27	13.8	15.19
Total Dissolved Solids	mg/L	500	-	-	-	-	317.2	286	300.95	269.75	300.95	269.75	293.06	311.3	320.9	314.9	314.6	325	313.95	312	313.3	310.07
Specific Conductivity (+/- 3%)	mS/cm		870	427.70	487	482	487.9	440.3	963.1	414.9	463.1	414.9	476.5	474	456.4	496	484.1	480	483.1	480	481.7	478
Conductivity (+/- 3%)	mS/cm		0.54	0.44	0.418	0.414	0.41	0.367	0.384	0.365	0.384	0.365	0.335	0.332	0.41	0.345	0.395	0.417	0.329	0.41	0.395	0.401
pH (+/- 0.1)	pH unit	6.5-8.5	8.62	8.25	8.16	7.54	7.9	7.74	7.71	7.34	7.71	7.34	7.39	7.45	7.78	8.10	8.11	8.06	8.38	8.23	8.3	8.46
Temperature (+/- 0.5)	˚C		21.60	21.30	18.40	17.40	16.80	16.30	15.00	18.60	15.0	18.60	15.50	15.50	15.90	15.90	15.40	18.20	15.40	17.40	15.60	16.60
Color	Visual		Murky	Murky	Murky	Murky	L. Green	L. Green	Greenish	Greenish	L. Green	L. Green	Clear	Clear	L. Green	L. Green	Clear	Clear	Green	Green	Green	Green
Odor	Olfactory		None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None

Notes:
(-) = Parameter not collected
% = Percent
˚C = Degrees Celcius
mg/L = Miligrams per Litre
NTU = Nephelometric Turdbidity Unit
mS/cm = Microsiemens per centimeter
Sample collection method = Grab from sample port, unless specified otherwise
NY WQS = New York Water Quality Standard (6 CRR-NY 703.3), Class C

Table 4 - SP4 Field Measured Parameters
Agawam Lake - Southampton, NY
NYSDEC Project No. SD089

Sample Date	Unit	NY WQS	Day 1 10/7/2019		Day 2 10/8/2019		Day 3 10/9/2019		Day 4 10/10/2019		Day 5 10/11/2019		Day 6 10/12/2019		Day 7 10/13/2019		Day 8 10/14/2019		Day 9 10/15/2019		Day 10 10/16/2019	
Sample Time	24 hour		**1415**	**1710**	**1415**	**1605**	**1105**	**1535**	**1155**	**1505**	**1105**	**1505**	**1105**	**1405**	**1035**	**1610**	**1105**	**1505**	**1035**	**1435**	**1105**	**1505**
Parameters																						
Turbidity (+/- 10%)	NTU		1.6	5.9	1.55	1.5	2.20	3.92	9.16	2.37	0.78	1.99	3.02	7.37	3.71	1.31	5.60	1.15	1.82	4.15	1.82	3.65
Dissolved Oxygen (+/- 10%)	%		106.80	74.20	99.70	91.60	91.40	82.90	126.10	106.20	88.30	83.40	51.40	54.80	83.90	84.50	98.10	165.60	90.70	101.60	97.80	119.80
Dissolved Oxygen (+/- 10%)	mg/L	≥5 (daily), ≥4 (instantaneous)	9.17	6.54	9.15	8.66	9.12	8.46	12.62	10.75	9.05	8.58	5.18	5.47	8.89	7.96	9.85	15.64	9.21	9.43	9.72	11.82
Total Dissolved Solids	mg/L	500	-	-	-	-	312.65	289.25	289.25	296.04	290.70	287.10	308.75	311.75	317.85	318.80	311.35	322.20	308.75	310.05	300.95	308.10
Specific Conductivity (+/- 3%)	mS/cm		489	603.40	496	473	481.1	444.6	445.2	456.4	456.4	471.0	474.6	478.7	488.9	493	479.1	468	475.5	476.5	462.8	474.5
Conductivity (+/- 3%)	mS/cm		0.466	0.46	0.434	0.419	0.39	0.35	0.36	0.37	0.36	0.37	0.39	0.37	0.42	0.42	0.39	0.41	0.38	0.42	0.38	0.39
pH (+/- 0.1)	pH unit	6.5-8.5	8.01	7.32	7.82	7.54	7.09	7.02	7.01	7.24	7.48	7.36	7.36	7.49	7.64	8.2	7.88	7.78	7.66	8.16	8.15	8.1
Temperature (+/- 0.5)	˚C		22.30	20.70	18.60	17.40	14.50	14.10	13.30	14.80	13.90	14.00	15.10	15.40	16.70	16.90	15.10	18.10	14.60	18.90	15.60	16.00
Color	Visual		Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Odor	Olfactory		None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None

Notes:
(-) = Parameter not collected
% = Percent
˚C = Degrees Celcius
mg/L = Miligrams per Liter
NTU = Nephelometric Turdbidity Unit
mS/cm = Microsiemens per centimeter
Sample collection method = Grab from sample port, unless specified otherwise
NY WQS = New York Water Quality Standard (6 CRR-NY 703.3), Class C
Values in highlighted cells do not meet NY WQS

Table 5 - SP5 Field Measured Parameters
Agawam Lake - Southampton, NY
NYSDEC Project No. SD089

Sample Date	Unit	NY WQS	Day 2 10/8/2019		Day 3 10/9/2019		Day 4 10/10/2019		Day 5 10/11/2019		Day 6 10/12/2019		Day 7 10/13/2019		Day 8 10/14/2019		Day 9 10/15/2019		Day 10 10/16/2019	
Sample Time	24 hour		**1420**	**1610**	**1110**	**1610**	**1200**	**1510**	**1110**	**1510**	**1110**	**1410**	**1040**	**1610**	**1110**	**1510**	**1040**	**1440**	**1110**	**1510**
Parameters																				
Turbidity (+/- 10%)	NTU		2.08	2.49	2.48	5.32	1.83	0.81	2.69	3.87	3.47	2.69	4.41	4.15	2.50	1.15	1.06	3.82	1.12	1.56
Dissolved Oxygen (+/- 10%)	%		311.10	218.20	243.60	236.10	243.80	244.50	249.00	215.80	215.30	214.60	265.90	213.10	286.00	312.30	221.40	316.60	228.10	267.50
Dissolved Oxygen (+/- 10%)	mg/L	≥5 (daily), ≥4 (instantaneous)	25.21	20.56	23.34	23.13	24.10	24.20	26.21	21.74	21.67	21.31	26.35	20.31	28.5	28.64	22.02	30.28	22.63	26.18
Total Dissolved Solids	mg/L	500	-	-	316.55	283.4	300.3	302.25	305.5	307.45	310.05	309.4	315.9	316.25	307.45	308.1	235.95	313.36	309.4	304.2
Specific Conductivity (+/- 3%)	mS/cm		496	492	485.7	436.3	461.8	465.4	470	472.5	476.8	476.7	456.4	435	473	478	362.8	482	475.8	475
Conductivity (+/- 3%)	mS/cm		0.431	0.427	0.409	0.363	0.381	0.384	0.377	0.382	0.386	0.391	0.48	0.477	0.387	0.425	0.298	0.412	0.391	0.39
pH (+/- 0.1)	pH unit	6.5-8.5	7.49	7.51	6.96	7.14	7.23	7.45	7.56	7.69	7.42	7.58	7.22	7.33	7.56	7.60	7.60	7.96	8.00	8.10
Temperature (+/- 0.5)	˚C		20.00	18.10	16.80	16.30	15.90	15.80	14.80	15.00	15.00	15.70	15.70	17.60	15.50	18.10	15.60	17.40	15.60	16.00
Color	Visual		Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Odor	Olfactory		None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None

Notes:
(-) = Parameter not collected
% = Percent
˚C = Degrees Celcius
mg/L = Miligrams per Liter
NTU = Nephelometric Turdbidity Unit
mS/cm = Microsiemens per centimeter
Sample collection method = Grab from sample port, unless specified otherwise
NY WQS = New York Water Quality Standard (6 CRR-NY 703.3), Class C
Values in highlighted cells do not meet NY WQS

Appendix E
Laboratory Monitoring Data

Table 1 - SP1 Sampling Results
Agawam Lake - Southampton, NY
NYSDEC Project No. SD089

Date and Time of Sampling	**Unit**	**RL**	**Day 2 - 10/8/19**	**Day 9 - 10/15/19**	**Day 10 - 10/16/19**
Analyte			**14:00**	**10:20**	**10:50**
Adda MCs/NODs	ng/mL	0.30	**49.7**	-	-
Total Microcystins & Nodularins	µg/L	0.3	-	**1.2**	**1.4**

Table 2 - SP2 Sampling Results Agawam Lake - Southampton, NY NYSDEC Project No. SD089					
Date and Time of Sampling	**Unit**	**RL**	**Day 2 - 10/8/19**	**Day 9 - 10/15/19**	**Day 10 - 10/16/19**
Analyte			**14:05**	**10:25**	**10:55**
Adda MCs/NODs	ng/mL	0.30	**45.0**	**-**	**-**
Total Microcystins & Nodularins	μg/L	0.3	**-**	**1.2**	**1.4**

Table 3 - SP3 Water Sampling Results
Agawam Lake - Southampton, NY
NYSDEC Project No. SD089

Date and Time of Sampling	Unit	RL	**Day 1 - 10/7/19**		**Day 2 - 10/8/19**		**Day 3 - 10/9/19**		**Day 4 - 10/10/19**		**Day 5 - 10/11/19**		**Day 6 - 10/12/19**		**Day 7 - 10/13/19**		**Day 8 - 10/14/19**		**Day 9 - 10/15/19**		**Day 10 - 10/16/19**	
Analyte			**14:07**	**17:00**	**14:10**	**16:00**	**11:00**	**15:00**	**11:50**	**15:00**	**11:00**	**15:00**	**11:00**	**14:00**	**10:30**	**15:00**	**11:00**	**15:00**	**10:30**	**14:30**	**11:00**	**15:00**
Bromoform	mg/L	0.00050	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorodibromomethane	mg/L	0.00050	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	mg/L	0.00050	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dichlorobromomethane	mg/L	0.00050	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trihalomethanes, Total	mg/L	0.00050	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Monochloroacetic acid	mg/L	0.0010	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Monobromoacetic acid	mg/L	0.0010	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**0.00087 J p**	ND	ND	ND	ND	ND
Dichloroacetic acid	mg/L	0.0010	ND	ND	ND	ND	**0.0033**	ND	ND	ND	ND	**0.013**	ND	ND	ND	ND	ND	**0.0013**	ND	ND	ND	ND
Dibromoacetic acid	mg/L	0.0010	ND	ND	ND	ND	**0.00068 J**	ND	ND	ND	ND	ND	ND	ND	ND	ND	**0.00092 J**	**0.0014 p**	ND	ND	ND	ND
Trichloroacetic acid	mg/L	0.0010	ND	ND	ND	ND	**0.0044**	ND	ND	ND	ND	**0.0057**	ND	ND	ND	ND	**0.00040 J p**	ND	**0.00044 J**	**0.00050 J**	ND	ND
Total Haloacetic Acids 5	μg/L	1.0	ND	ND	ND	ND	**8.4**	ND	ND	ND	ND	**19**	ND	ND	ND	ND	**2.2**	**2.7**	**0.44 J**	**0.50 J**	ND	ND
Aluminum	mg/L	0.20	**0.20**	**0.21**	**0.21**	**0.20**	**0.28**	**0.33**	**0.31**	**0.32**	**0.16 J**	**0.33**	**0.27**	**0.17 J**	**0.18 J**	**0.19 J**	**0.17 J**	**0.12 J**	**0.19 J**	**0.20**	**0.20**	**0.18 J**
Iron	mg/L	0.050	**1.5**	**1.3**	**1.1**	**1.2**	**1.5**	**1.6**	**1.6**	**1.6**	**1.3**	**1.7**	**1.4**	**1.2**	**1.5**	**1.2**	**0.97**	**0.86**	**1.5**	**1.2**	**1.2**	**1.1**
Aluminum - Dissolved	mg/L	0.20	**0.24**	**0.25**	**0.19 J**	ND	ND	ND	ND	ND	ND	ND	ND	**0.069 J**	ND	ND	ND	ND	ND	ND	ND	ND
Iron - Dissolved	mg/L	0.050	**1.4**	**1.3**	**1.2**	**0.23**	**0.038 J**	ND	**0.25**	**0.18**	**0.096**	**0.27**	**0.22**	**0.20**	**0.33**	**0.19**	**0.27**	**0.18**	**0.30**	**0.23**	**0.23**	**0.21**
Ammonia	mg/L	0.020	**0.022 B**	ND	**0.047 B**	**0.041 B**	**0.11**	**0.14**	**0.19**	**0.16**	**0.25**	**0.22**	**0.35 F1**	**0.33**	**0.50**	**0.26**	**0.29**	**0.22**	**0.20 B**	**0.094 B**	**0.18**	**0.14**
Ammonia as NH3	mg/L	0.024	**0.027 B**	ND	**0.057 B**	**0.050 B**	**0.14**	**0.17**	**0.23**	**0.20**	**0.30**	**0.27**	**0.43 F1**	**0.40**	**0.61**	**0.32**	**0.35**	**0.27**	**0.25 B**	**0.11 B**	**0.22**	**0.17**
Total Kjeldahl Nitrogen	mg/L	0.20	**3.9**	**3.6**	**2.4**	**2.5**	**2.6**	**2.3**	**3.3**	**3.5**	**4.1**	**3.2**	**2.2**	**3.0**	**2.2**	**2.1**	**2.2**	**8.8**	**7.7**	**2.8**	**3.2**	**4.6**
Nitrate Nitrite as N	mg/L	0.050	**0.048 J**	**0.081**	**0.096**	**0.10**	**0.093 F1**	**0.088**	**0.12 F1**	**0.12**	**0.15**	**0.15**	**0.19 F1**	**0.18**	**0.17**	**0.091**	**0.13**	**0.14**	**0.14**	**0.17**	**0.17 B**	**0.14 B**
Alkalinity, Total	mg/L	5.0	**55.8**	**54.8**	**56.0**	**55.8**	**56.1**	**53.1**	**52.2**	**63.6**	**53.0**	**54.4**	**66.9**	**65.9**	**68.1**	**54.9**	**54.9**	**53.8**	**55.7**	**55.1**	**54.2**	**54.2**
Alkalinity, Bicarbonate	mg/L	5.0	**55.8**	**54.8**	**56.0**	**55.8**	**56.1**	**53.1**	**52.2**	**63.6**	**53.0**	**54.4**	**66.9**	**65.9**	**68.1**	**54.9**	**54.9**	**53.8**	**55.7**	**55.1**	**54.2**	**54.2**
Alkalinity, Carbonate	mg/L	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hydroxide Alkalinity	mg/L	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ortho-Phosphate	mg/L	0.020	ND	**0.021**	**0.019 J**	**0.017 J**	ND	ND	**0.051**	**0.060**	**0.053**	**0.074**	**0.033 H**	**0.036 H**	**0.029 H**	**0.040**	**0.033**	**0.037**	**0.032**	**0.047**	ND	ND
Phosphorus	mg/L	0.010	**0.18**	**0.17**	**0.16**	**0.17**	**0.25**	**0.27**	**0.20**	**0.21**	**0.18**	**0.21**	**0.13**	**0.13**	**0.13**	ND	**0.023**	**0.48**	**0.49 ^**	**0.18**	**0.16**	ND
Phosphorus as PO4	mg/L	0.031	**0.57**	**0.52**	**0.49**	**0.51**	**0.78**	**0.82**	**0.62**	**0.64**	**0.56**	**0.65**	**0.40**	**0.41**	**0.41**	ND	**0.072**	**1.5**	**1.5**	**0.56**	**0.49**	ND
Total Suspended Solids	mg/L	4.0	**83.6**	**111**	ND	**33.2**	**18.8**	**39.5**	**37.2**	**50.8**	**40.8**	**34.0**	**37.0**	**53.6**	**19.2**	**21.3**	**13.6**	**133**	**206**	**48.0**	**47.2**	**51.2**
Nitrogen, Total	mg/L	0.20	**3.9**	**3.7**	**2.5**	**2.6**	**2.7**	**2.4**	**3.4**	**3.6**	**4.3**	**3.4**	**2.4**	**3.2**	**2.4**	**2.2**	**2.3**	**8.9**	**7.8**	**3.0**	**3.4**	**4.7**
Total Kjeldahl Nitrogen - Dissolved	mg/L	0.20	**3.3**	**3.6**	**2.2**	**0.39**	**2.6**	**2.7**	**0.65 F1**	**0.45**	**0.82 F1**	**0.82**	**0.93**	**0.76**	**0.86 F1**	**0.67**	**0.67**	**0.82**	**0.60 F1**	**0.47**	**0.44**	**0.33**
Nitrate Nitrite as N - Dissolved	mg/L	0.050	**0.051**	**0.11**	**0.10**	**0.099**	**0.090**	**0.094**	**0.13**	**0.1**	**0.16**	**0.16**	**0.20**	**0.20**	**0.17**	**0.096**	**0.12**	**0.15**	**0.14**	**0.18**	**0.16 B**	**0.14 B**
Phosphorus - Dissolved	mg/L	0.010	**0.19**	**0.20**	**0.18**	ND	ND	ND	ND	ND	ND	**0.016**	ND	ND	ND	**0.018**	**0.061**	**0.0086 J**	ND	ND	ND	**0.018**
Phosphorus as PO4 - Dissolved	mg/L	0.031	**0.58**	**0.60**	**0.54**	ND	ND	ND	ND	ND	ND	**0.049**	ND	ND	ND	**0.055**	**0.19**	**0.026 J**	ND	ND	ND	**0.055**
Nitrogen, Total - Dissolved	mg/L	0.20	**3.4**	**3.7**	**2.3**	**0.49**	**2.7**	**2.8**	**0.78**	**0.55**	**0.98**	**0.98**	**1.1**	**0.96**	**1.0**	**0.77**	**0.19**	**0.97**	**0.74**	**0.65**	**0.60**	**0.47**
Chlorophyll A	μg/L	0.40	**253**	**192**	**200**	**57.1**	-	-	**14.3**	**80.5**	**68.9**	**132**	**126**	**166**	**130**	**138**	**109**	**628**	**662**	**119**	**248**	**222**
Adda MCs/NODs	ng/mL	0.30	-	-	**45.8**	**50.0**	**53.4**	**46.6**	**47.2**	**40.9**	-	-	-	-	-	-	-	-	-	-	-	-
Total Microcystins & Nodularins	μg/L	0.3	-	-	-	-	-	-	-	-	**37**	**51**	**28**	**21**	**24**	**28**	**8.0**	**10**	**170**	**29**	**57**	**83**

Notes:
*^ - ICV, CCV, ICB, CCB, ISA, ISB, CRI, CRA, DLCK or MRL standard: Instrument related QC is outside acceptance limits
*B - Compound was found in the blank and sample
*F1 - MS and/or MSD Recovery is outside acceptance limits
*H - Sample was prepped or analyzed beyond the specified holding time
*J - Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value
*ND - Not detected at the reporting limit (or MDL or EDL if shown)
*p - The %RPD between the primary and confirmation column/detector is >40%. The lower value has been reported

Table 4 - SP4 Water Sampling Results
Agawam Lake - Southampton, NY
NYSDEC Project No. SD089

Date and Time of Sampling	Unit	RL	Day 1 - 10/7/19		Day 2 - 10/8/19		Day 3 - 10/9/19		Day 4 - 10/10/19		Day 5 - 10/11/19		Day 6 - 10/12/19		Day 7 - 10/13/19		Day 8 - 10/14/19		Day 9 - 10/15/19			Day 10 - 10/16/19	
Analyte			14:15	17:10	14:15	16:05	11:05	15:05	11:55	15:05	11:05	15:05	11:05	14:05	10:35	15:05	11:05	15:05	10:35	DUP-2 - 10:35	14:35	11:05	15:05
Bromoform	mg/L	0.00050	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorodibromomethane	mg/L	0.00050	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0019
Chloroform	mg/L	0.00050	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0074
Dichlorobromomethane	mg/L	0.00050	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0031
Trihalomethanes, Total	mg/L	0.00050	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.012
Monochloroacetic acid	mg/L	0.0010	ND	ND	ND	ND	ND F1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Monobromoacetic acid	mg/L	0.0010	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dichloroacetic acid	mg/L	0.0010	ND	ND	ND	ND	0.0021	ND	ND	ND	0.0030	0.013	ND	ND	ND	ND	0.0044	0.0012	ND	ND	ND	ND	ND
Dibromoacetic acid	mg/L	0.0010	ND	ND	ND	ND	0.00048 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00042 J p	0.0016	ND	ND	ND	ND	ND
Trichloroacetic acid	mg/L	0.0010	ND	ND	ND	ND	0.00085 J	ND	ND	ND	0.0016	0.0058	ND	ND	ND	ND	0.0042	ND	ND	0.00040 J	0.00049 J	ND	ND
Total Haloacetic Acids 5	µg/L	1.0	ND	ND	ND	ND	3.4	ND	ND	ND	4.6	19	ND	ND	ND	ND	9.0	2.8	ND	0.40 J	0.49 J	ND	ND
Aluminum	mg/L	0.20	0.76	0.68	1.4	1.3	ND	0.15 J	0.11 J	0.13 J	0.079 J	0.10 J	ND	0.099 J	0.11 J	0.15 J	0.095 J	0.10 J	0.085 J	0.092 J	0.10 J	0.099 J	0.11 J
Iron	mg/L	0.050	0.026 J	ND	0.036 J	0.035 J	ND	0.022 J	0.026 J	0.062	0.029 J	0.024 J	0.028 J	0.026 J	0.045 J	ND	ND	ND	0.023 J	0.022 J	ND	0.019 J	0.023 J
Aluminum - Dissolved	mg/L	0.20	0.74	0.66	1.4	ND	ND	ND	ND	ND	ND	0.083 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron - Dissolved	mg/L	0.050	ND	ND	0.036 J	ND	ND	ND	ND	ND	ND	ND	ND	0.023 J	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ammonia	mg/L	0.020	ND	ND	0.032 B	0.028 B	0.10	0.12	0.17	0.17	0.27	0.21	0.32	0.29	0.49	0.28	0.31	0.25	0.11 B	0.11 B	0.066 B	0.16	0.11
Ammonia as NH3	mg/L	0.024	ND	ND	0.039 B	0.034 B	0.13	0.15	0.2	0.2	0.32	0.26	0.39	0.36	0.60	0.34	0.38	0.31	0.14 B	0.13 B	0.081 B	0.20	0.13
Total Kjeldahl Nitrogen	mg/L	0.20	0.69	0.41	0.22	ND	0.29	0.37	1.2	0.39	0.61	1.4	0.45	0.46	0.61	0.49	0.50	0.48	0.31	0.34	0.28	0.23	0.22
Nitrate Nitrite as N	mg/L	0.050	0.065	0.076	0.11	0.10	0.087	0.086	0.12	0.14	0.15	0.16	0.20	0.18	0.17	0.12	0.13	0.16	0.14	0.14	0.18	0.17 B	0.14 B
Alkalinity, Total	mg/L	5.0	42.0	40.7	45.1	44.2	45.8	50.4	59.9	60.4	53.7	63.7	60.8	64.1	55.5	52.0	52.9	52.6	54.3	54.0	51.0	53.7	50.1
Alkalinity, Bicarbonate	mg/L	5.0	42.0	40.7	45.1	44.2	45.8	50.4	59.9	60.4	53.7	63.7	60.8	64.1	55.5	52.0	52.9	52.6	54.3	54.0	51.0	53.7	50.1
Alkalinity, Carbonate	mg/L	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hydroxide Alkalinity	mg/L	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ortho-Phosphate	mg/L	0.020	ND	0.0071 J	ND	0.013 J	ND	0.0098 J	0.019 J	0.026	0.041	0.028	ND H	ND H	0.036 H	0.036	0.033	0.022	0.071	0.018 J	0.040	ND	ND
Phosphorus	mg/L	0.010	ND	ND	ND	ND	ND	0.031	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0086 J	ND	ND	ND	ND	ND
Phosphorus as PO4	mg/L	0.031	ND	ND	ND	ND	ND	0.095	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.026 J	ND	ND	ND	ND	ND
Total Suspended Solids	mg/L	4.0	76.3	5.6	ND	ND	9.2	ND	ND	10.8	4.4	ND	ND	4.8	6.8	ND	ND	ND	ND	ND	ND	ND	ND
Nitrogen, Total	mg/L	0.20	0.76	0.49	0.33	ND	0.38	0.46	1.3	0.53	0.76	1.6	0.65	0.64	0.78	0.61	0.63	0.64	0.45	0.48	0.46	0.40	0.36
Total Kjeldahl Nitrogen - Dissolved	mg/L	0.20	0.31	0.32	0.27	0.27	0.37	0.47	0.54	0.38	0.49	0.60	0.41	0.42	0.63	0.87	0.47	0.45	0.33	0.32	0.26	0.32	0.20
Nitrate Nitrite as N - Dissolved	mg/L	0.050	0.058	0.073 F1	0.11	0.11	0.31	0.096	0.11	0.13	0.16	0.16 B	0.20	0.19	0.16	0.12	0.13	0.15	0.15	0.15	0.17	0.16 B	0.14 B
Phosphorus - Dissolved	mg/L	0.010	0.016	ND	0.025	0.0068 J	0.010	ND	ND	ND	ND	ND	ND	ND	ND	0.033	0.038	ND	ND	ND	ND	ND	ND
Phosphorus as PO4 - Dissolved	mg/L	0.031	0.049	ND	0.078	0.021 J	0.032	ND	0.015 J	ND	ND	ND	ND	ND	ND	0.10	0.12	0.015 J	ND	ND	ND	ND	ND
Nitrogen, Total - Dissolved	mg/L	0.20	0.37	0.39	0.38	0.38	0.68	0.57	0.65	0.51	0.65	0.76	0.61	0.61	0.79	0.99	0.60	0.60	0.48	0.47	0.43	0.48	0.34
Chlorophyll A	µg/L	0.40	0.40 U	0.96	2.75	0.40 U	1.26	0.94	0.073	0.161	0.40 U	0.40 U	0.40 U	0.40 U	1.00	0.40 U	0.40 U	0.40 U	0.67	0.40 U	0.40 U	0.40 U	0.50
Adda MCs/NODs	ng/mL	0.30	-	-	2.30	3.37	3.55	3.16	1.52	1.36	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Microcystins & Nodularins	µg/L	0.3	-	-	-	-	-	-	-	-	1.4	1.5	1.5	1.4	1.7	1.7	1.8	1.9	1.9	1.8	1.7	1.7	1.9

Notes:
*B - Compound was found in the blank and sample
*F1 - MS and/or MSD Recovery is outside acceptance limits
*H - Sample was prepped or analyzed beyond the specified holding time
*J - Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value
*ND - Not detected at the reporting limit (or MDL or EDL if shown)
*p - The %RPD between the primary and confirmation column/detector is >40%. The lower value has been reported
*U - Analyte was analyzed for but not detected

Table 5 - SP5 Water Sampling Results
Agawam Lake - Southampton, NY
NYSDEC Project No. SD089

Date and Time of Sampling	Unit	RL	Day 1 - 10/7/19		Day 2 - 10/8/19		Day 3 - 10/9/19		Day 4 - 10/10/19		Day 5 - 10/11/19			Day 6 - 10/12/19		Day 7 - 10/13/19		Day 8 - 10/14/19		Day 9 - 10/15/19		Day 10 - 10/16/19	
Analyte			-	-	14:20	16:10	11:10	15:10	12:00	15:10	11:10	DUP-1 - 11:10	15:10	11:10	14:10	10:40	15:10	11:10	15:10	10:40	14:40	11:10	15:10
Bromoform	mg/L	0.00050	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorodibromomethane	mg/L	0.00050	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00082
Chloroform	mg/L	0.00050	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.035	0.037
Dichlorobromomethane	mg/L	0.00050	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0037	0.0053
Trihalomethanes, Total	mg/L	0.00050	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.039	0.043
Monochloroacetic acid	mg/L	0.0010	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Monobromoacetic acid	mg/L	0.0010	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00088 J p	0.00091 J p	0.00080 J p	0.0012	ND	ND	0.0012	0.0012	0.00085 J p	ND
Dichloroacetic acid	mg/L	0.0010	-	-	ND	ND	ND	ND	ND	ND	0.015	0.015	0.012	ND	ND	ND	ND	0.0014	0.0015	ND	ND	ND	ND
Dibromoacetic acid	mg/L	0.0010	-	-	0.00092 J	0.00073 J	0.00086 J	0.00069 J	0.00093 J	0.00070 J	ND	0.00061 J p	0.00069 J p	0.00088 J	0.00081 J	0.00083 J	0.00077 J	0.0021	0.0024	0.00081 J	0.00069 J	0.00084 J	0.00063 J
Trichloroacetic acid	mg/L	0.0010	-	-	ND	0.00038 J p	ND	ND	ND	ND	0.0070	0.0072	0.0044	0.00048 J p	0.00056 J p	ND	0.00049 J p	ND	ND	0.0014	0.0010	0.00041 J p	0.00053 J p
Total Haloacetic Acids 5	µg/L	1.0	-	-	0.92 J	1.1	0.86 J	0.69 J	0.93 J	0.70 J	22	23	17	2.2	2.3	1.6	2.5	3.5	3.9	3.4	2.9	2.1	1.2
Aluminum	mg/L	0.20	-	-	1.4	1.3	0.99	ND	0.10 J	0.12 J	0.079 J	0.087 J	0.14 J	0.099 J	0.062 J	0.095 J	0.12 J	0.12 J	0.10 J	0.079 J	0.080 J	0.088 J	0.067 J
Iron	mg/L	0.050	-	-	0.038 J	0.036 J	ND	ND	ND	ND	0.029 J	0.30	0.024 J	0.027 J	0.054	0.035 J	ND	ND	ND	0.025 J	ND	0.022 J	ND
Aluminum - Dissolved	mg/L	0.20	-	-	1.3	0.084 J	ND	0.11 J	0.062 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron - Dissolved	mg/L	0.050	-	-	0.037 J	ND	ND	0.030 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ammonia	mg/L	0.020	-	-	0.044 B	0.039 B	0.10	0.11	0.15	0.15	0.25	0.26	0.22	0.33	0.30	0.48	0.27	0.31	0.24	0.13 B	0.077 B	0.18	0.11
Ammonia as NH3	mg/L	0.024	-	-	0.054 B	0.047 B	0.12	0.13	0.18	0.19	0.31	0.31	0.27	0.40	0.36	0.59	0.33	0.38	0.29	0.15 B	0.093 B	0.21	0.14
Total Kjeldahl Nitrogen	mg/L	0.20	-	-	0.20	0.26	0.30	0.35	0.43	0.44	0.54	0.53	0.89	0.53	0.51	0.65	0.49	0.62	0.36	0.33	0.3	0.17 J	0.19 J
Nitrate Nitrite as N	mg/L	0.050	-	-	0.11	0.11	0.092	0.094	0.13	0.12	0.17	0.18 B	0.32 F1	0.22	0.19 F1	0.17	0.10	0.13	0.16	0.15	0.18	0.18 B	0.15 B
Alkalinity, Total	mg/L	5.0	-	-	44.6	45.7	45.5	49.6	58.5	50.8	52.7	63.0	62.2	63.1	61.0	54.7	51.1	53.6	51.9	54.7	51.8	51.7	49.9
Alkalinity, Bicarbonate	mg/L	5.0	-	-	44.6	45.7	45.5	49.6	58.5	50.8	52.7	63.0	62.2	63.1	61.0	54.7	51.1	53.6	51.9	54.7	51.8	51.7	49.9
Alkalinity, Carbonate	mg/L	5.0	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hydroxide Alkalinity	mg/L	5.0	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ortho-Phosphate	mg/L	0.020	-	-	ND	ND	ND	ND	0.040	0.026	0.033	0.028	0.019 J	ND H	ND H	ND H	ND	0.047	0.022	0.019 J	0.021	ND	ND
Phosphorus	mg/L	0.010	-	-	ND	0.11	0.010	ND	0.010	ND	0.016	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.040
Phosphorus as PO4	mg/L	0.031	-	-	ND	0.35	0.032	ND	0.032	ND	0.049	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.12
Total Suspended Solids	mg/L	4.0	-	-	ND	8.8	ND	ND	8.4	10	4.4	6.4	ND	5.2	7.6	13.6	ND	ND	ND	ND	16.8	ND	ND
Nitrogen, Total	mg/L	0.20	-	-	0.31	0.37	0.39	0.44	0.56	0.56	0.71	0.71	0.77	0.75	0.70	0.82	0.59	0.75	0.52	0.48	0.48	0.35	0.34
Total Kjeldahl Nitrogen - Dissolved	mg/L	0.20	-	-	0.27	0.28	0.58	0.39	0.41	0.41	0.57	0.86	0.89	0.54	0.57	0.70	0.84	0.49	0.45	0.35	0.37	0.23	0.17 J
Nitrate Nitrite as N - Dissolved	mg/L	0.050	-	-	0.11	0.11 F1	0.083	0.095	0.12	0.12	0.16 F1	0.18 B	0.32 B	0.20	0.19	0.16	0.12	0.13	0.16	0.15	0.20	0.17 B	0.14 B
Phosphorus - Dissolved	mg/L	0.010	-	-	ND	0.0068 J	ND	ND	ND	ND	ND	ND	ND	0.040	ND	ND	0.023	0.0068 J	0.029	ND	ND	ND	ND
Phosphorus as PO4 - Dissolved	mg/L	0.031	-	-	ND	0.021 J	0.015 J	ND	ND	ND	ND	ND	ND	0.12	ND	ND	0.072	0.021 J	0.089	ND	ND	0.015 J	ND
Nitrogen, Total - Dissolved	mg/L	0.20	-	-	0.38	0.39	0.66	0.49	0.53	0.53	0.73	1.0	1.2	0.74	0.76	0.86	0.96	0.62	0.61	0.50	0.57	0.40	0.34
Chlorophyll A	µg/L	0.40	-	-	0.69	0.40 U	0.814	1.59	0.545	0.116	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.46	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U
Adda MCs/NODs	ng/mL	0.30	-	-	ND	ND	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Microcystins & Nodularins	µg/L	0.3	-	-	-	-	-	-	-	-	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3

Notes:
Day 1 not sampled because HIPOx was not running on day 1
*B - Compound was found in the blank and sample
*F1 - MS and/or MSD Recovery is outside acceptance limits
*H - Sample was prepped or analyzed beyond the specified holding time
*J - Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value
*ND - Not detected at the reporting limit (or MDL or EDL if shown)
*p - The %RPD between the primary and confirmation column/detector is >40%. The lower value has been reported
*U - Analyte was analyzed for but not detected

Table 6 - Slurry Sampling Results Agawam Lake - Southampton, NY NYSDEC Project No. SD089						
Date and Time of Sampling	**Unit**	**RL**	**Day 5 - 10/11/19**	**Day 6 - 10/12/19**	**Day 9 - 10/15/19**	**Day 10 - 10/16/19**
Analyte			**11:35**	**12:00**	**13:45**	**14:00**
Adda MCs/NODs	μg/g	1.5	**8.9 ± 0.2**	**9.5**	-	-
Total Microcystins & Nodularins	μg/L	0.3	**6900**	-	**29000**	**19000**

Appendix F
PTOX Screen Reports

Potentially Toxigenic (PTOX) Cyanobacteria Screen

Project: AECOM

Received: October 10, 2019
Prepared: October 18, 2019
Analyst: Andrew Chapman

Sample ID	Site	Collected
19-SP1-B2-1400	Lake Agawam	10/8/19
19-SP2-B2-1405	Lake Agawam	10/8/19
19-SP3-B2-1410	Lake Agawam	10/8/19
19-SP4-B2-1415	Lake Agawam	10/8/19
19-SP5-B2-1420	Lake Agawam	10/8/19
19-SP3-B2-1600	Lake Agawam	10/8/19
19-SP4-B2-1605	Lake Agawam	10/8/19
19-SP5-B2-1610	Lake Agawam	10/8/19
19-SP3-B3-1100	Lake Agawam	10/8/19
19-SP4-B3-1105	Lake Agawam	10/8/19
19-SP5-B3-1110	Lake Agawam	10/8/19
19-SP3-B3-1500	Lake Agawam	10/8/19
19-SP4-B3-1505	Lake Agawam	10/8/19
19-SP5-B3-1510	Lake Agawam	10/8/19

Method

One mL aliquots of Lugol’s Iodine preserved sample were prepared using Utermöhl Chambers and scanned at 100X for the presence of potentially toxigenic (PTOX) cyanobacteria using a Nikon Eclipse T*i*-S Inverted Microscope equipped with phase contrast optics. Higher magnification was used as necessary.

Results

19-SP1-B2-1400

The sample was dominated by the potentially toxigenic cyanobacterium (PTOX Cyano) *Microcystis viridis* (Fig. 1). Other PTOX Cyano species observed included *Microcystis* spp. (Figs. 2-4), *Cuspidothrix issatschenkoi* (Fig. 5), *Pseudanbaena mucicola* (Fig. 6), *Planktothrix* sp. (Fig. 7) and *Dolichospermum* sp. (Fig. 8).

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19-SP2-B2-1405
The sample was dominated by the potentially toxigenic cyanobacterium (PTOX Cyano) *Microcystis viridis*. Other PTOX Cyano species observed included *Microcystis* spp., *Cuspidothrix issatschenkoi*, *Pseudanbaena mucicola*, *Planktothrix* sp. and *Dolichospermum* sp.

19-SP3-B2-1410
The sample was dominated by the potentially toxigenic cyanobacterium (PTOX Cyano) *Microcystis viridis*. Other PTOX Cyano species observed included *Microcystis* spp., *Cuspidothrix issatschenkoi*, *Pseudanbaena mucicola* and *Dolichospermum* sp.

19-SP4-B2-1415
The sample contained the potentially toxigenic cyanobacterium (PTOX Cyano) *Microcystis viridis*.

19-SP5-B2-1420
The sample was contained the potentially toxigenic cyanobacterium (PTOX Cyano) *Microcystis viridis*. Colonies appeared to be in a state of deterioration (Fig. 9).

19-SP3-B2-1600
The sample was dominated by the potentially toxigenic cyanobacterium (PTOX Cyano) *Microcystis viridis*. Other PTOX Cyano species observed included *Microcystis* spp., *Cuspidothrix issatschenkoi*, *Pseudanbaena mucicola*, *Planktothrix* sp., *Dolichospermum* sp. and *Dolichospermum* sp. (Fig. 10).

19-SP4-B2-1605
The sample contained the potentially toxigenic cyanobacteria (PTOX Cyano) *Microcystis viridis* and *Pseudanabeana mucicola*.

19-SP5-B2-1610
The sample was contained the potentially toxigenic cyanobacterium (PTOX Cyano) *Microcystis viridis*. Colonies appeared to be in a state of deterioration.

19-SP3-B3-1100
The sample was dominated by the potentially toxigenic cyanobacterium (PTOX Cyano) *Microcystis viridis*. Other PTOX Cyano species observed included *Microcystis* spp., *Cuspidothrix issatschenkoi*, *Pseudanbaena mucicola*, *Planktothrix* sp. and *Dolichospermum* sp.

19-SP4-B3-1105
The sample was dominated by the potentially toxigenic cyanobacterium (PTOX Cyano) *Microcystis viridis*. Other PTOX Cyano species observed included *Microcystis* sp., *Pseudanbaena mucicola* and *Cuspidothrix issatschenkoi*.

19-SP5-B3-1110
The sample contained the potentially toxigenic cyanobacteria (PTOX Cyano) *Microcystis viridis* and *Dolichospermum* sp.

19-SP3-B3-1500
The sample was dominated by the potentially toxigenic cyanobacterium (PTOX Cyano) *Microcystis viridis* (Fig. 14). Other PTOX Cyano species observed included *Microcystis* spp., *Cuspidothrix issatschenkoi*, *Pseudanbaena mucicola* and *Dolichospermum* sp.

19-SP4-B3-1505
The sample contained the potentially toxigenic cyanobacteria (PTOX Cyano) *Microcystis viridis*, *Cuspidothrix issatschenkoi* and *Planktothrix* sp.

19-SP5-B3-1510
The sample was contained the potentially toxigenic cyanobacterium (PTOX Cyano) *Microcystis viridis*. Colonies appeared to be in a state of deterioration (Fig. 15).

Potential toxin producing genera observed include:

Microcystins	Saxitoxins	Anatoxin-a	Cylindrospermopsin
Microcystis	*Cuspidothrix*	*Cuspidothrix*	*Dolichospermum*
Pseudanabaena	*Dolichospermum*	*Dolichospermum*	
Dolichospermum		*Planktothrix*	
Planktothrix			

Recommendations:
Based on these observations toxin analyses for microcystin, saxitoxin, anatoxin-a and cylindrospermopsin are recommended.

Micrographs

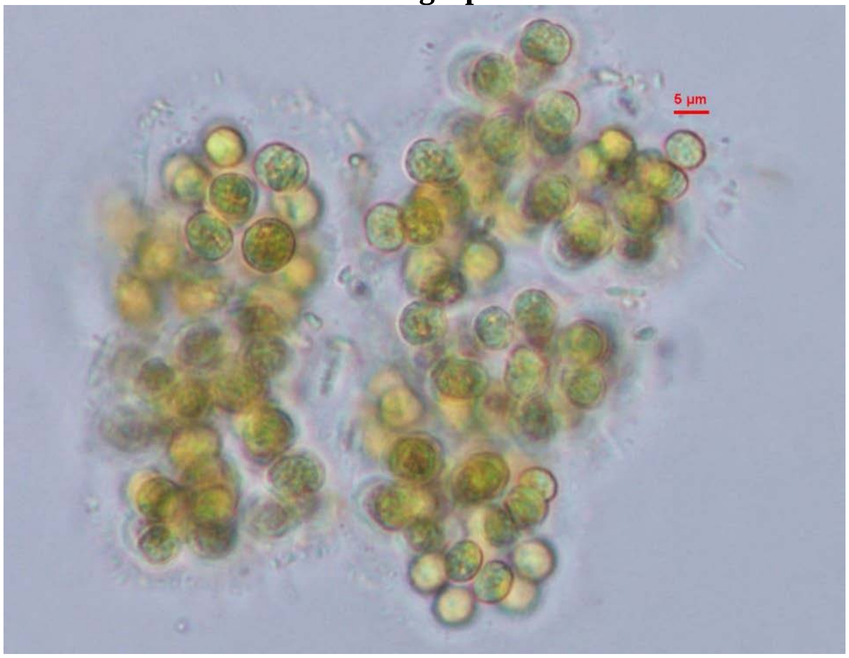

Fig. 1 *Microcystis viridis* (19-SP1-B2) 400X

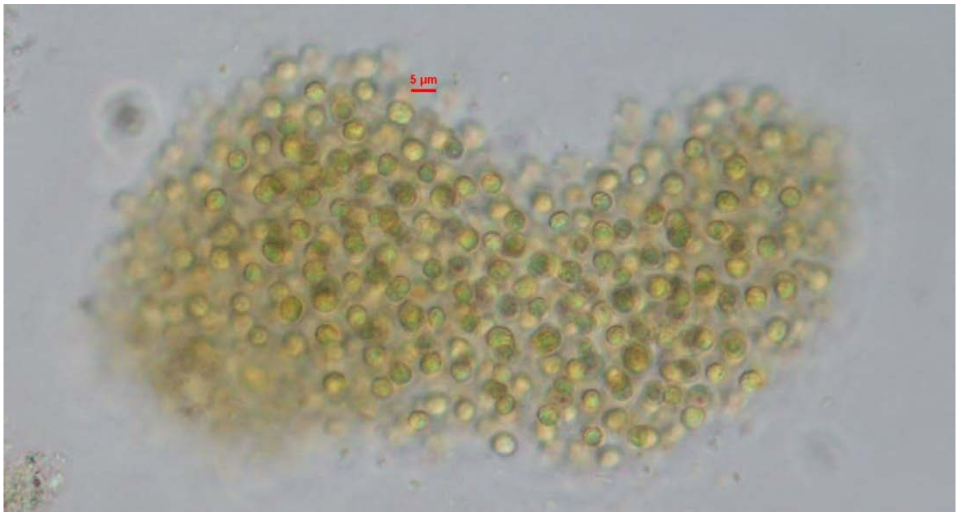

Fig. 2 *Microcystis* sp. (19-SP1-B2) 400X

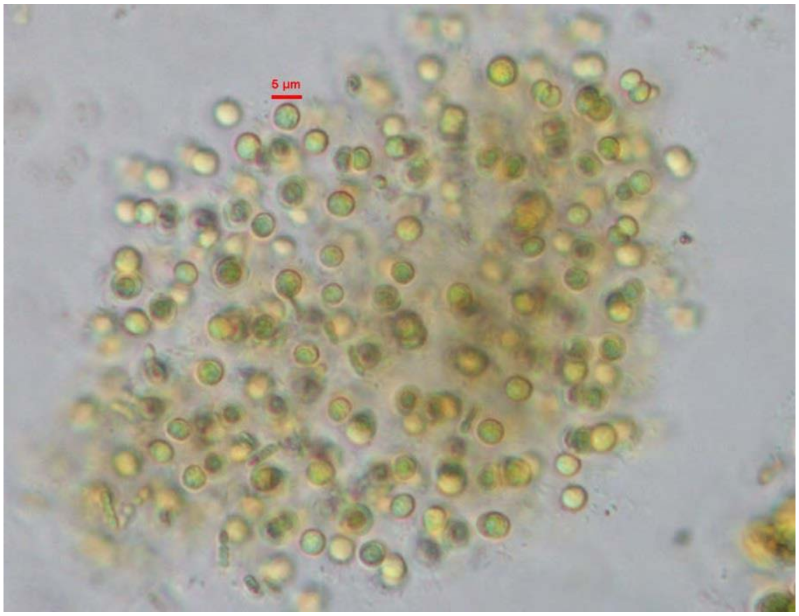

Fig. 3 *Microcystis* sp. (19-SP1-B2) 400X

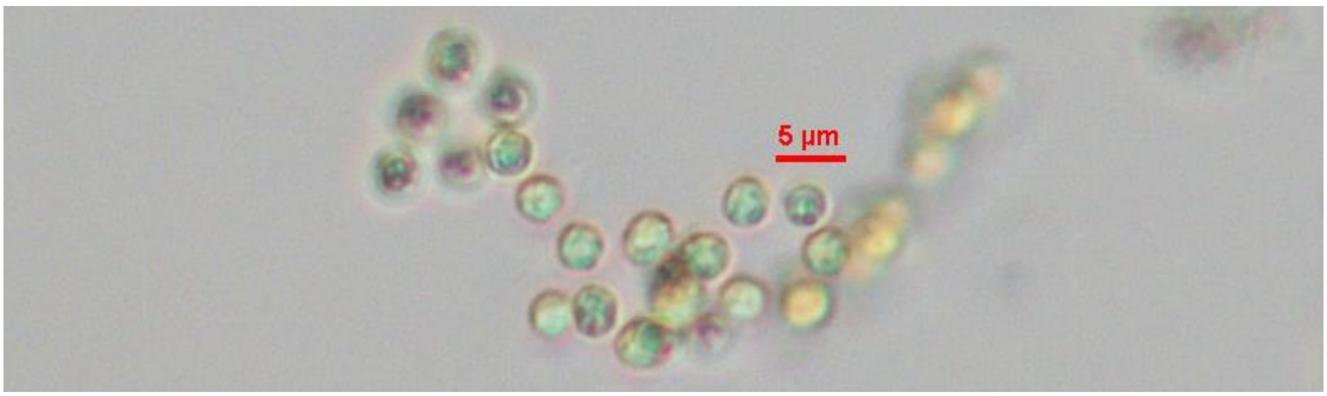

Fig. 4 *Microcystis* sp. (19-SP1-B2) 400X

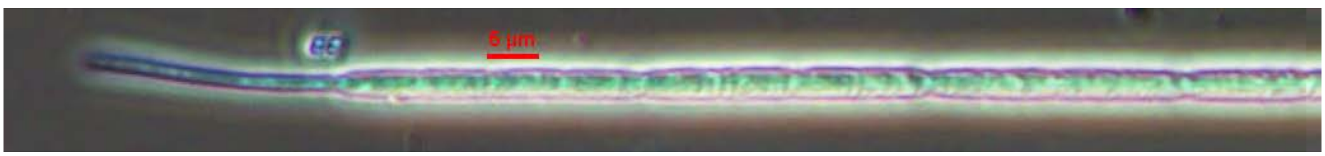

Fig. 5 *Cuspidothrix issatschenkoi* (19-SP1-B2) 400X

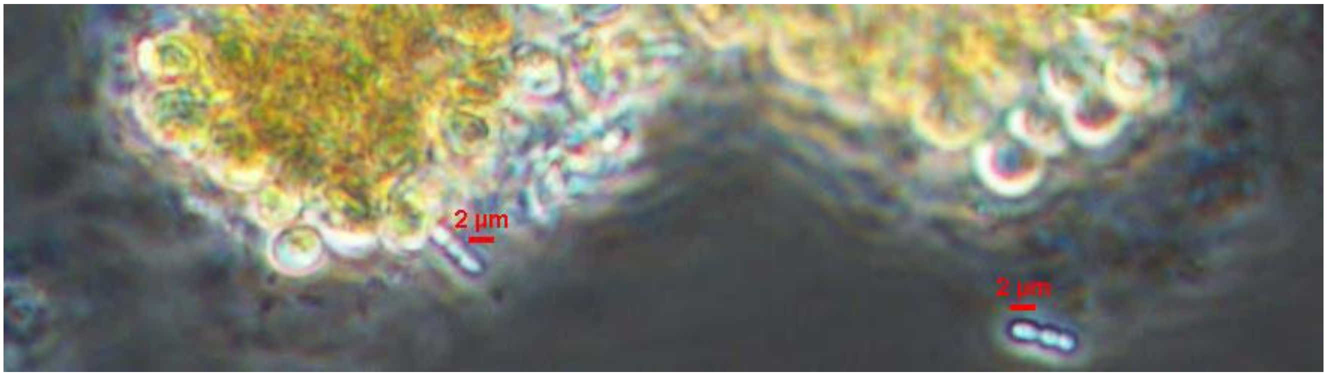

Fig. 6 *Pseudanabaena mucicola* (19-SP1-B2) 400X

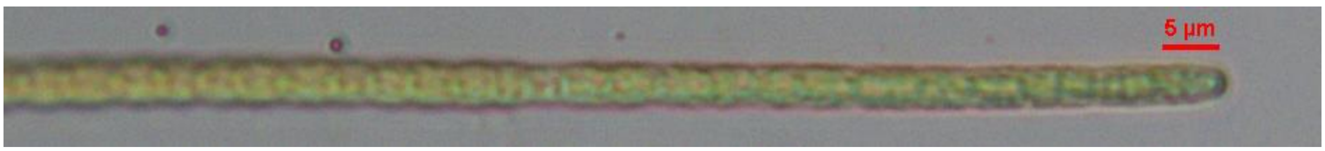

Fig. 7 *Planktothrix* sp. (19-SP1-B2) 400X

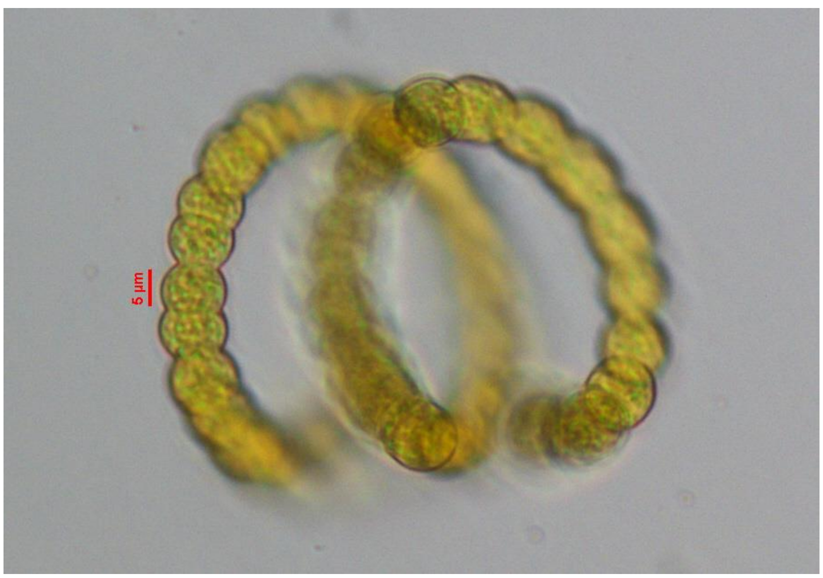

Fig. 8 *Dolichospermum* sp. (19-SP1-B2) 400X

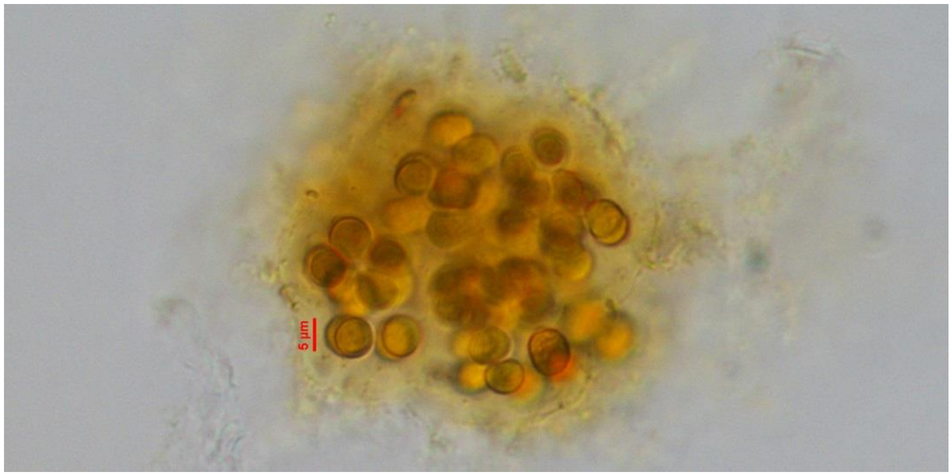

Fig. 9 *Microcystis viridis* (19-SP5-B2) 400X

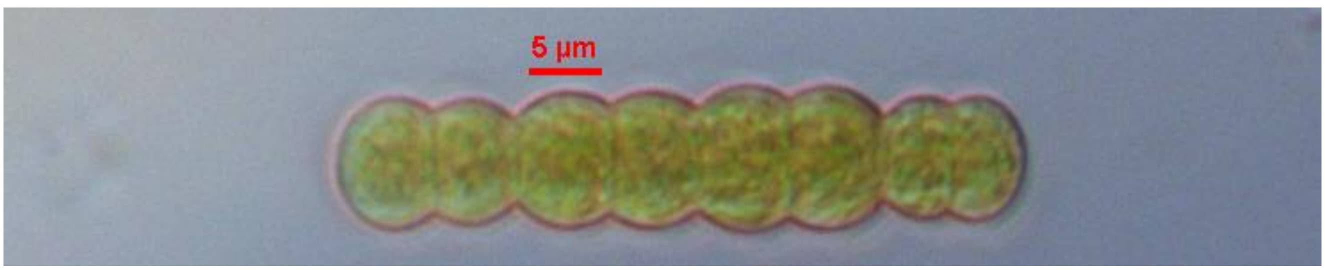

Fig. 10 *Dolichospermum* sp. (19-SP3-B2) 400X

Submitted by:

Amanda Foss, M.S.

Date: 10/18/19

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Potentially Toxigenic (PTOX) Cyanobacteria Screen

Project: AECOM

Received: October 11, 2019
Prepared: October 18, 2019
Analyst: Andrew Chapman

Sample ID	Site	Collected
19-SP3-B4-1150	Lake Agawam	10/10/19
19-SP4-B4-1155	Lake Agawam	10/10/19
19-SP5-B4-1200	Lake Agawam	10/10/19
19-SP3-B4-1500	Lake Agawam	10/10/19
19-SP4-B4-1505	Lake Agawam	10/10/19
19-SP5-B4-1510	Lake Agawam	10/10/19

Method

One mL aliquots of Lugol's Iodine preserved sample were prepared using Utermöhl Chambers and scanned at 100X for the presence of potentially toxigenic (PTOX) cyanobacteria using a Nikon Eclipse T*i*-S Inverted Microscope equipped with phase contrast optics. Higher magnification was used as necessary.

Results

19-SP3-B4-1150
The sample was dominated by the potentially toxigenic cyanobacterium (PTOX Cyano) *Microcystis viridis* (Fig. 1). Other PTOX Cyano species observed included *Microcystis* spp. (Fig. 2), *Cuspidothrix issatschenkoi* (Fig. 3), *Pseudanbaena mucicola* (Fig. 4), *Dolichospermum* sp. (Fig. 5) and *Planktothrix* sp.

19-SP4-B4-1155
The sample contained low densities of the potentially toxigenic cyanobacterium (PTOX Cyano) *Microcystis viridis*.

19-SP5-B4-1200
The sample contained low densities of the potentially toxigenic cyanobacterium (PTOX Cyano) *Microcystis viridis*.

19-SP3-B4-1500
The sample was dominated by the potentially toxigenic cyanobacterium (PTOX Cyano) *Microcystis viridis*. Other PTOX Cyano species observed included *Microcystis* spp. (Fig. 6), *Cuspidothrix issatschenkoi*, *Pseudanbaena mucicola* and *Dolichospermum* sp.

19-SP4-B4-1505
No potentially toxigenic cyanobacteria (PTOX Cyano) were observed in the sample.

19-SP5-B4-1510
No potentially toxigenic cyanobacteria (PTOX Cyano) were observed in the sample.

Potential toxin producing genera observed include:

Microcystins	Saxitoxins	Anatoxin-a	Cylindrospermopsin
Microcystis	*Cuspidothrix*	*Cuspidothrix*	*Dolichospermum*
Pseudanabaena	*Dolichospermum*	*Dolichospermum*	
Dolichospermum		*Planktothrix*	
Planktothrix			

Recommendations:
Based on these observations, toxin analyses for microcystin, saxitoxin, anatoxin-a and cylindrospermopsin are recommended.

Micrographs

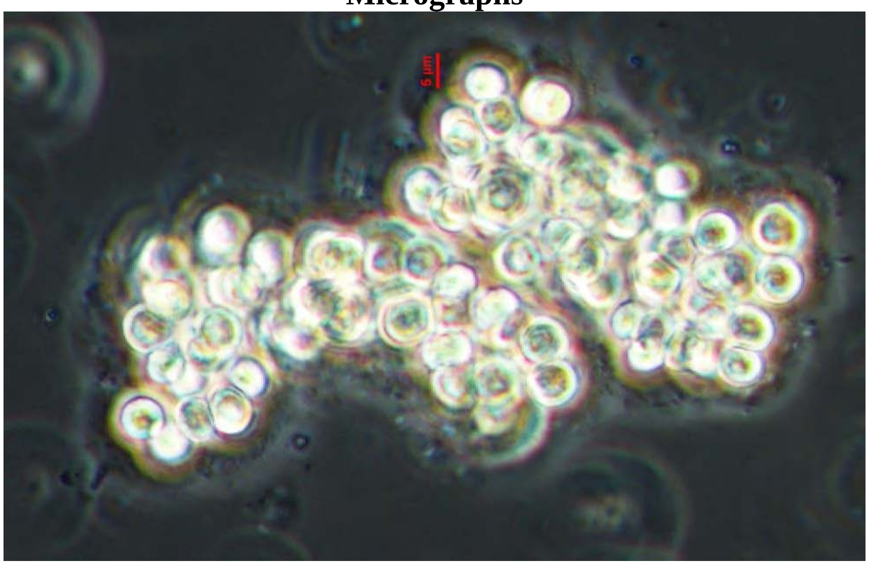

Fig. 1 *Microcystis viridis* (19-SP3-B4) 400X

Fig. 2 *Microcystis wesenbergii* (19-SP3-B4) 400X

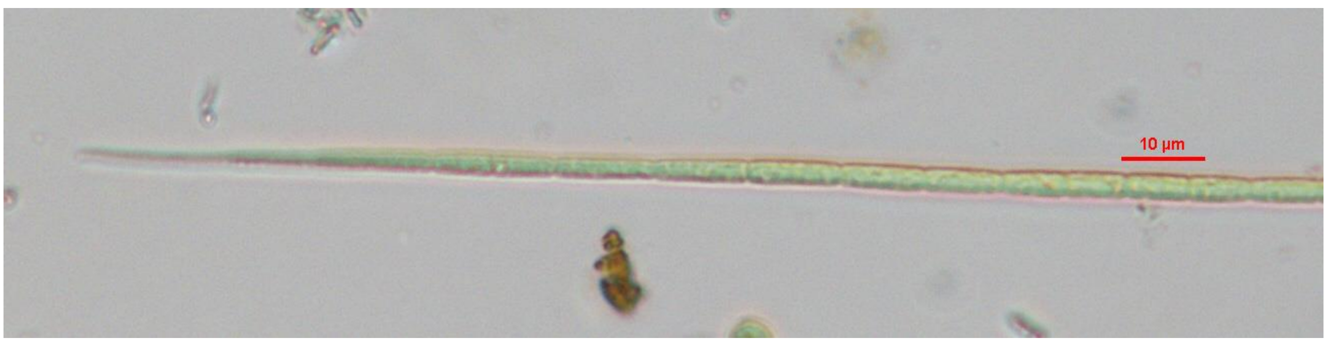

Fig. 3 *Cuspidothrix issatschenkoi* (19-SP3-B4) 400X

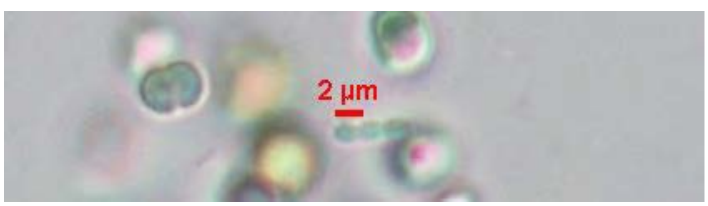

Fig. 4 *Pseudanabena mucicola* (19-SP3-B4) 400X

Fig. 5 *Dolichospermum* sp. (19-SP3-B4) 400X

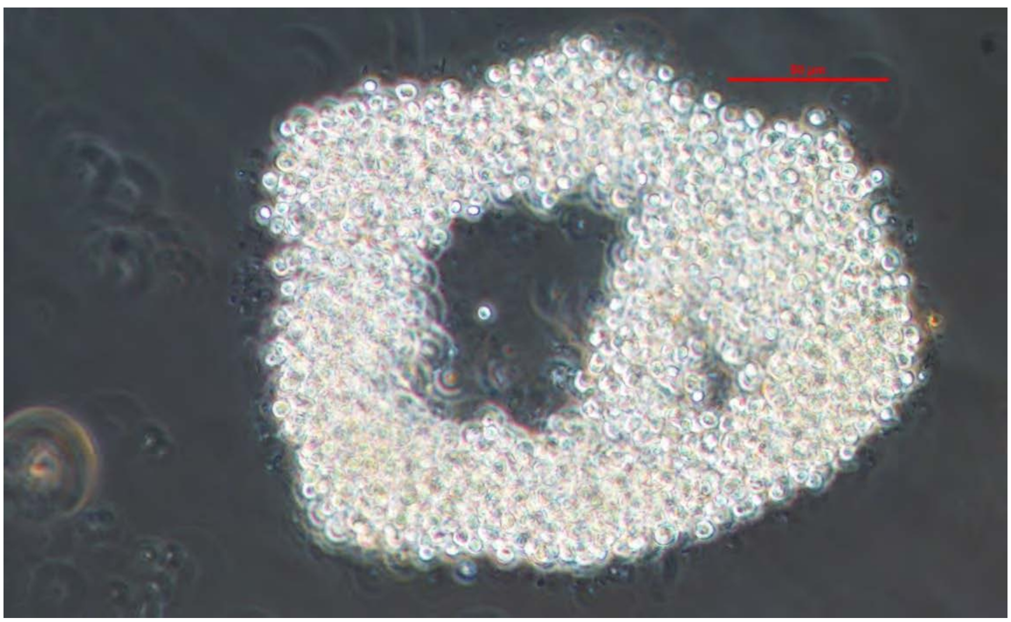

Fig. 6 *Microcystis aeruginosa* (19-SP3-B4) 400X

Submitted by:

Amanda Foss, M.S.

Date: 10/18/19

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Potentially Toxigenic (PTOX) Cyanobacteria Screen

Project: AECOM

Received: October 16, 2019
Prepared: October 23, 2019
Analyst: Amanda Foss/Alyssa Garvey

Sample ID	Site	Collected
19-SLURRY-B5	Lake Agawam	10/14/19
19-SLURRY-B6	Lake Agawam	10/12/19

Method

Subsets (100 mg) were transferred to glass vials and diluted with deionized water. Wet mounts were prepared and scanned at 100X for the presence of potentially toxigenic (PTOX) cyanobacteria using a Nikon Eclipse T*i*-S Inverted Microscope equipped with phase contrast optics. Higher magnification was used as necessary.

Results

19-SLURRY-B5
The sample was dominated by the potentially toxigenic (PTOX) cyanobacterium *Microcystis* spp.

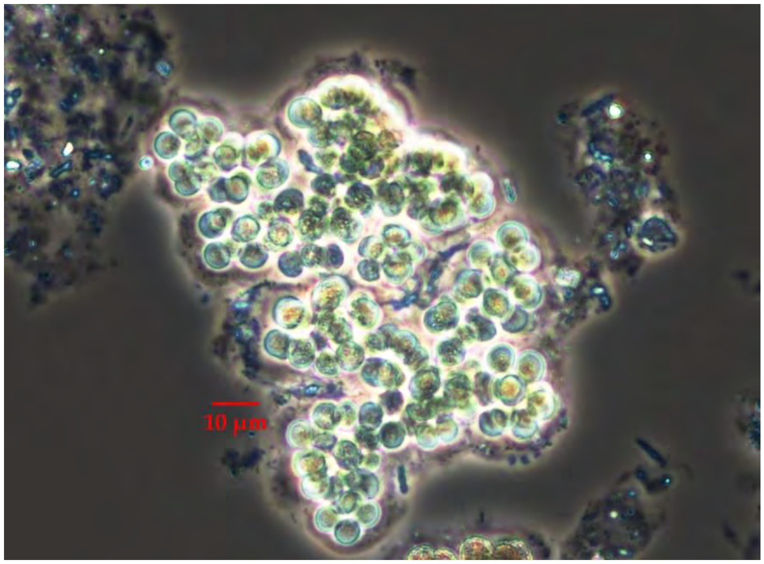
19-SLURRY-B6
The sample was dominated by the PTOX cyanobacterium *Microcystis* spp.

Potential toxin producing genera observed include:

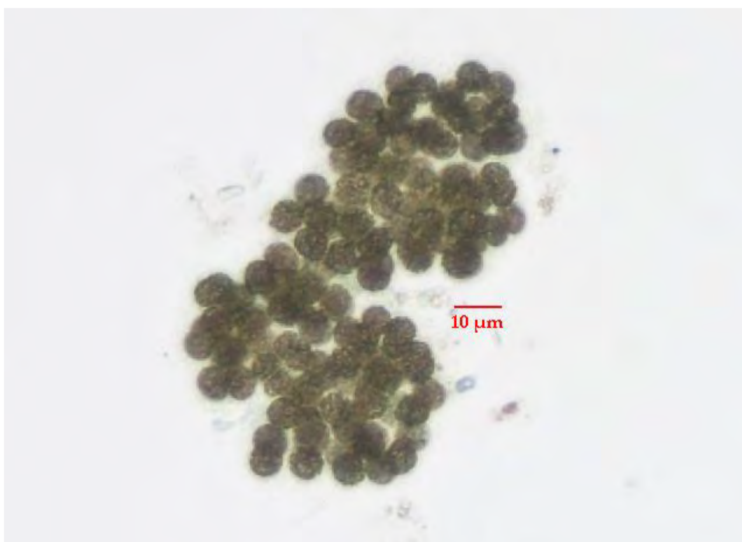
Microcystins	Saxitoxins	Anatoxin-a	Cylindrospermopsin
Microcystis			

Recommendations:
Based on these observations, toxin analysis for microcystins is recommended.

Micrographs



Microcystis viridis (19-SLURRY-B5) 400X



Microcystis sp. (19-SLURRY-B5) 400X

Submitted by: Amanda Foss

Amanda Foss, M.S.

Date: 10/23/19

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