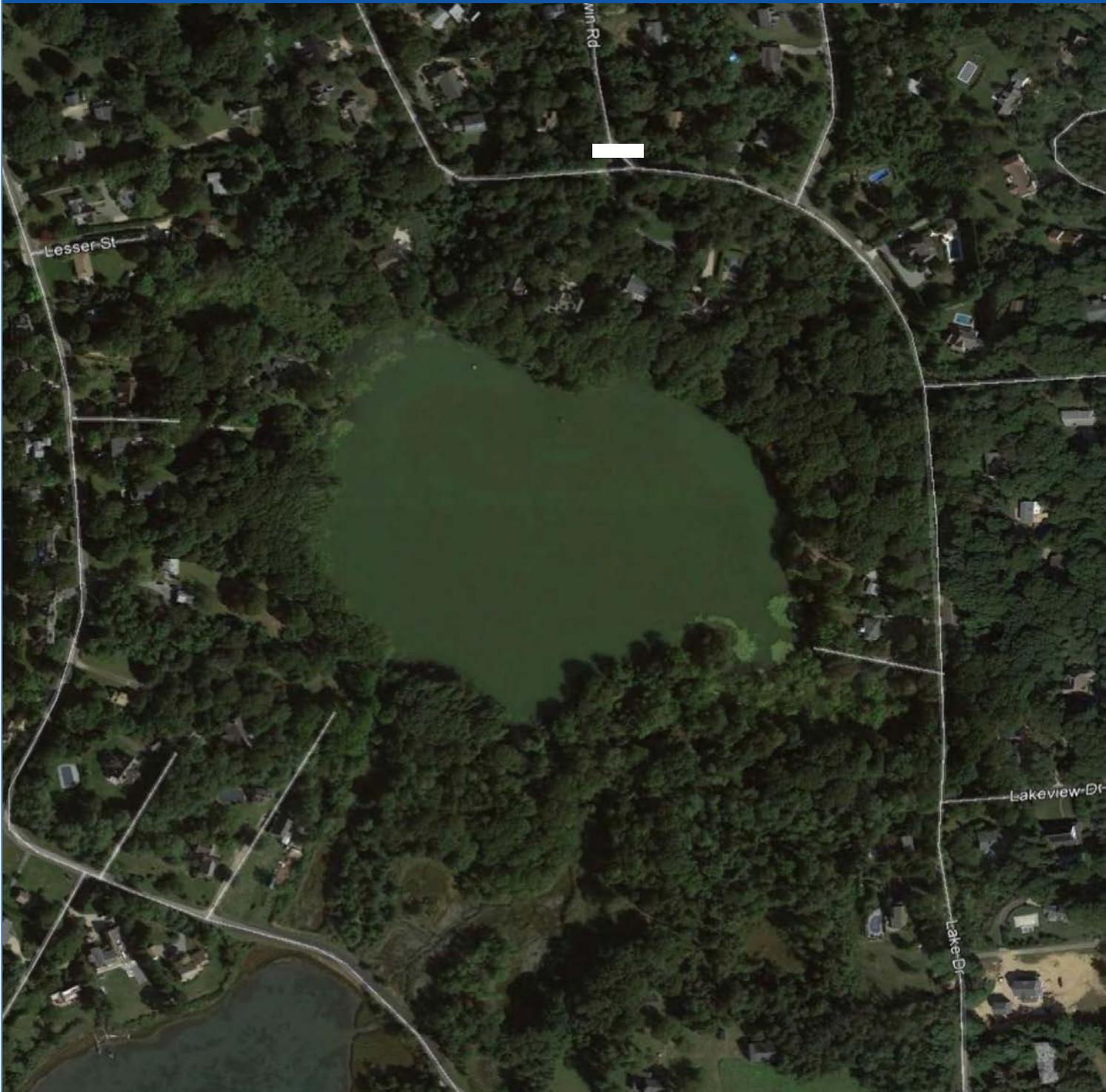


FRESH POND IN-WATERBODY NUTRIENT CONTROL FEASIBILITY STUDY / ENGINEERING REPORT



Prepared for:
Town of Shelter Island
38 North Ferry Road
Shelter Island, NY 11964-0907

July 25, 2022

Environmental Engineers/Consultants

LOMBARDO ASSOCIATES, INC.

188 Church Street, Newton, Massachusetts 02458

TABLE OF CONTENTS

1.	INTRODUCTION.....	6
2.	COVER PAGE	9
	EXECUTIVE SUMMARY	10
3.	SUMMARY	13
4.	PROJECT OBJECTIVES & SCOPE OF WORK OUTLINE	23
5.	EXISTING CONDITIONS.....	24
5.1	Fresh Pond Location, Bathymetry, Watershed Definition & Hydrogeology	24
5.2	Groundwater Quality	34
5.3	Watershed Soils.....	35
5.4	Stormwater.....	36
6.	WATER QUALITY CONDITIONS DEMONSTRATING OXYGEN DEFICIT	37
6.1	Temperature & Dissolved Oxygen	37
6.2	Hypolimnetic Oxygen Demand (HOD).....	47
6.3	Fresh Pond Nutrient Data	48
6.4	Assessment of Internal Loading Potential	49
6.5	Sediment Areal Extent, Quality and P Release	52
6.6	Data Collected by Fresh Pond Association & Others	56
6.7	Lyngbya Growth Issue	61
7.	TMDL PHOSPHORUS BUDGET	63
7.1	Introduction	63
7.2	Total P load to Fresh Pond	64
7.3	Pond Modeling Analysis.....	65
8.	OPTIONS FOR INTERNAL P LOAD CONTROL.....	67
8.1	Options Description.....	67
8.2	Candidate Remediation Sites	72
9.	SCREENED ALTERNATIVES PRELIMINARY ENGINEERING & COST ESTIMATES .	74
9.1	Oxygenation Alternative.....	74
9.2	Hypolimnetic withdrawal	78
9.3	Technology Selection.....	81
9.4	Caveats and Recommendations.....	81
10.	ENGINEERING PLAN OF PREFERRED REMEDIATION ALTERNATIVE	83
10.1	Equipment Sizing and Engineering Layout.....	83
10.2	CAPITAL & O&M COST ESTIMATES.....	90
10.3	PERMITTING REQUIREMENTS.....	91
10.4	IMPLEMENTATION PLAN, SCHEDULE & FUNDING	91
10.5	Long term Operations & Maintenance	92
10.6	Miscellaneous	92
10.7	Lyngbya Bloom Area Management	94
	APPENDIX A SHELTER ISLAND GROUNDWATER DATA	95
	APPENDIX B FRESH POND TEMPERATURE & DISSOLVED OXYGEN DATA.....	102
	April 6, 2021	102
	April 19, 2021 Data.....	109
	April 30, 2021 Data.....	115
	May 21, 2021 Data	120
	APPENDIX C SEDIMENT LAB ANALYSIS RESULTS.....	125
	APPENDIX D FRESH POND CSLAP REPORT WITH 2019 DATA	132

D.1 FRESH POND CSLAP REPORT WITH 2020 DATA	132
D.2 FRESH POND CSLAP REPORT WITH 2019 DATA	146
D.3 FRESH POND CSLAP 2018 DATA.....	153
APPENDIX E 2021 ALGAE SPECIES IDENTIFICATION	157
APPENDIX F REFERENCES	163
APPENDIX G 65 SOUTH MIDWAY ROAD SITE TEST PITS & BORING.....	165
APPENDIX H NEWS ARTICLES ON FRESH POND.....	170
EXHIBIT 1 POND WATER QUALITY CHEMISTRY DATA LAB REPORTS	176
EXHIBIT 2 QUALITY ASSURANCE PROJECT PLAN (QAPP).....	177

List of Figures

Figure S-1 Pond Seasonal Stratification – Turnover Illustration	13
Figure S-2 USGS Watersheds 191 & 193 – Flow Through Fresh Pond.....	14
Figure S-3 Dickerson Creek Contributing Watershed Area	14
Figure S-4 Menantic Creek Contributing Watershed Area.....	15
Figure S-5 Fresh Pond Contributing Watershed Area	15
Figure S-6 Grid Map + Temperature & DO Profiles – April 6, 2021	17
Figure S-7 Pond Elevation Gauge	19
Figure 5-1 Regional Location Map - Fresh Pond.....	24
Figure 5-2 Local Location Map - Fresh Pond.....	25
Figure 5-3 Bathymetric Map - Fresh Pond.....	26
Figure 5-4 Shelter Island Groundwater Elevations	28
Figure 5-5 USGS Watersheds 191 & 193.....	28
Figure 5-6 Dickerson Creek Contributing Area	29
Figure 5-7 Menantic Creek Contributing Area	30
Figure 5-8 Estimated Fresh Pond Watershed Boundary- on Aerial Photo	31
Figure 5-9 Wetlands Near Fresh Pond	32
Figure 5-10 USGS well and Pond Elevation Gauge Locations.....	33
Figure 5-11 Pond Elevation Gauge.....	34
Figure 5-12 Fresh Pond Watershed Soils.....	35
Figure 5-13 Stormwater Catch Basins within Watershed	36
Figure 6-1 Fresh Pond Sampling Location Grid Map.....	37
Figure 6-2 Temperature & DO Profiles Stations 16 & 23 – April 30, 2021.....	38
Figure 6-3A Temperature & DO Profiles Stations 16 – June 23 & Sept. 13, 2021	39
Figure 6-3B Temperature & DO Profiles Stations 16 – Oct. 8 & December 1, 2021	40
Figure 6-4 Temperature & DO Profiles All Stations – April 6, 2021	42
Figure 6-5 Temperature & DO Profiles All Stations – April 19, 2021	43
Figure 6-6 Temperature & DO Profiles All Stations – April 30, 2021	44
Figure 6-7 Temperature & DO Profiles All Stations – May 21, 2021	45
Figure 6-8 Station 16 Temperature – 9 Depths	46
Figure 6-9 Sediment Sampling Locations Map	53
Figure 6-10 Observed Sediment Types Map	54
Figure 6-11 Area of Lyngbya Growth on Fresh Pond	62
Figure 7-1 Fresh Pond Phosphorus Budget Categories	63
Figure 8-1 Potential Locations for Hypolimnetic Withdrawal Upgradient Discharge.....	71
Figure 8-1 Publicly Owned Sites Around / Near Fresh Pond.....	73
Figure 9-1 SSS Oxygenation – Process Flow Diagram	74

Figure 9-2 Building Layout of Oxygenation Injection System	74
Figure 9-3 Layout of Oxygenation by Sidestream Saturation System	75
Figure 9-4 Photos of SSS	76
Figure 9-5 Hypolimnetic Withdrawal System – Process Flow Diagram	79
Figure 9-6 Layout of Hypolimnetic Withdrawal, Treatment & Pond Return System.....	80
Figure 10-1 Pilot Scale HW-P Removal System – Process Flow Diagram & Layout.....	85
Figure 10-2 Pilot & Full Scale HW-P Removal Systems Plan.....	86
Figure 10-4 Full Scale HW-P Removal System – Process Flow Diagram & Layout.....	89
Figure A-1 Active USGS Shelter Island Groundwater Wells.....	96
Figure A-2 Active USGS S 38461.1 Well Groundwater Elevations	97
Figure A-3 Active USGS S 51177.1 Well Groundwater Elevations	97
Figure A-4 Active USGS S 90279.1 Well Groundwater Elevations	98
Figure A-5 Active USGS S 51176.1 Well Groundwater Elevations	98
Figure A-6 Inactive USGS Shelter Island Groundwater Wells	99

List of Tables

Table ES-1 HW Treatment Program Budget Detail	10
Table ES-2 HW Treatment Program Schedule.....	12
Table S-1 Fresh Pond Detention Time & Volumetric Flow Rate.....	16
Table S-2 Nutrient – July 29, 2021 Water Quality Data at Station 16.....	18
Table S-3 Sediment Phosphorus Forms.....	18
Table S-4 Fresh Pond Elevations	19
Table S-5 HOD Estimates.....	20
Table S-6 Estimated Phosphorus Load Based on Exposure of Sediment to Anoxia.....	20
Table 5-1 Fresh Pond Water Volumes at Various Depths	25
Table 5-2 Fresh Pond Flushing Volumes and Time.....	27
Table 5-3 Fresh Pond Elevations - 2021	33
Table 5-4 Groundwater Quality 2016 - 2018.....	35
Table 6-1 Temperature & DO Sampling Locations & Pond Depth.....	38
Table 6-2 Secchi Disc Measurements	41
Table 6-3 HOD Estimates	47
Table 6-4 Nutrient – Water Quality Data at Station 16.....	48
Table 6-5 Phosphorus Concentrations and Mass in Fresh Pond in 2021	50
Table 6-6 Nitrogen Concentrations and Mass in Fresh Pond in 2021	51
Table 6-7 Nitrogen to Phosphorus Ratios (mass to mass) in Fresh Pond in 2021	51
Table 6-8 Sediment Phosphorus Fractions.....	55
Table 6-9 Sediment Features Relating to Internal Phosphorus Loading in Fresh Pond.....	55
Table 6-10 Estimated Phosphorus Load Based on Progressive Sediment Exposure to Anoxia	56
Table 6-11 2018 CSLAP Fresh Pond Data.....	58
Table 6-12 2019 CSLAP Fresh Pond Data.....	59
Table 6-13 2020 CSLAP Fresh Pond Data.....	60
Table 6-14 Archived Fresh Pond HAB NYSDEC Reports	61
Table 7-1 Phosphorus Loads to Fresh Pond	65
Table 7-2 Fresh Pond Phosphorus Concentration Modeling	66
Table 8-1 Sediment P Release Rates & Days for Pond Water Removal Per Depths.....	72
Table 8-2 Town/County Parcels Around / Near Fresh Pond.....	72
Table 9-1 SSS Capital and Annual O&M Cost Estimates.....	77
Table 9-2 Hypolimnetic Withdrawal Oxygen Demand & Air Flow Rate	78

Table 9-2 Hypo Withdraw Capital and Annual O&M Cost Estimates.....	81
Table 10-1 HW Treatment Program Influent & Effluent Constituents for Lab Analysis.....	84
Table 10-2 Cost Summary for Project Phases.....	90
Table 10-3 Capital and Annual O&M Cost Estimates - Full Scale HW Treatment System.....	90
Table 10-4 Capital Cost Estimates - Pilot Scale HW Treatment System.....	91
Table 10-5 Capital Cost Estimates – Proof of Concept HW Treatment System.....	91
Table 10-4 HW Treatment Program Schedule.....	93
Table A-1 GW Well Locations.....	95
Table A-1 Groundwater Quality Data - USGS S 106177.1 Well.....	100
Table A-2 Groundwater Quality Data - USGS S 52050.1 Well.....	100
Table A-3 Groundwater Quality Data - USGS S 51175.1 Well.....	101
Table A-4 Groundwater Quality Data - USGS S 90279.1 Well.....	101

1. INTRODUCTION

The Town of Shelter Island received a New York State Department of Environmental Conservation (NYSDEC) grant to produce a feasibility study for in-waterbody control of nutrients on Fresh Pond. The study is to provide a cost-effective plan for reducing the internal loading of nutrients which are understood to be the cause of harmful algae blooms (HABs) which have been increasingly observed and documented on Fresh Pond.

As required by the NYSDEC grant, Feasibility Studies / Engineering Reports for projects that reduce internal loading of nutrients within waterbodies must include the required elements listed below. Practices to address these issues include: hypolimnetic aeration, hypolimnetic withdrawal, phosphorus inactivation and dredging. The feasibility study / engineering report must provide basis / justification for the recommendation(s) to reduce internal loading of nutrients.

Required Elements

- I. **Cover Page** (project title, owner, prepared by, professional's stamp, and date)
- II. **Executive Summary**: Overview of the project's purpose
- III. **Projective Objectives**: Describe goals of the in-waterbody practice element(s). Indicate whether the elements are a portion of a larger project.
- IV. **Existing Conditions**: Description of existing water quality conditions including:
 - a. Morphometry, including surface area, mean depth, and maximum depth.
 - b. Bathymetry, if available, with a description of data and collection method.
 - c. Time, duration, area and volume (acre-foot) extent of oxygen deficit.
 - d. Water quality conditions demonstrating oxygen deficit
 - e. Evidence of water quality impacts driven by oxygen deficit. For example, water quality data that demonstrates increased hypolimnetic phosphorus (monthly average), increased hypolimnetic metals or ammonia.
- V. **Project Description**: Provide a narrative that explains the proposed actions considered for addressing the problem and a justification for the recommended practice. Include a summary of the expected results, potential side effects, and measures to evaluate success of the proposed practice.
- VI. **Engineering Design Specifications**: Specifications must include equipment sizing and configuration, location of air compressors, diffusers/oxygen distribution system, pumps, electricity and other power demands, maintenance needs, etc.
- VII. **Safety Measures**: Provide a narrative of measures that would be required to protect public safety after the practice has been installed.
- VIII. **Anticipated Regulatory Approval and Permits**: List all permits and/or approvals that will apply, e.g., NYSDEC, New York State Department of Transportation (NYSDOT), etc., and include environmental impact study requirements, monitoring requirements and any local approvals required.
- IX. **Installation and Operating Cost Estimate**
- X. **Project Timeline**

Acknowledgements

This project has occurred due to the strong efforts of the Fresh Pond Neighborhood Association (FPNA) members Peter Grand (in particular) – pictured below in a kayak, James Eklund, Jerri



Mayer and others. They have provided strong support and efforts for making the project happen with funding from the Town, NYSDEC and private sources. Town Engineer Joe Finora, P.E. has provided invaluable assistance throughout the project and facilitated integration of Town resources to optimize project results.

Many thanks to Town Bay Constable Beau Payne, (pictured below next to Town Police boat), who provided boat and captain services, along with great conversations, for the data collection efforts. We had many memorable conversations.

I am grateful and honored that the highly regarded, with decades of Lake/Pond experience and professionally widely accomplished and respected limnologists, Dr. Ken Wagner and Wendy Gendron are part of the project Team. The Report is our collective effort. Their expertise has been invaluable and critical to the Pond's characterization. However, Lombardo Associates, Inc. is solely responsible for any project inadequacies.



It was most rewarding to observe the joy that a local resident had, per the below photo, from capturing a Fresh Pond big mouth bass as we went ashore at the end of one of the sampling events. Additionally, we have observed the connection to nature that many uses of the Pond and the nearby nature path enjoy as well as the others being desirous of the removal of fear of adverse water quality impacts.

This Report provides a path forward for Fresh Pond water quality and ecological restoration.



2. COVER PAGE

Project Title: Fresh Pond, Shelter Island In-Waterbody Nutrient Control Feasibility Study / Engineering Report

Owner: Town of Shelter Island, NY 38 North Ferry Road, Shelter Island, NY 11964-0970

Prepared by: Pio Lombardo, P.E – New York State PE #056900

This Feasibility / Engineering Report has been prepared in accordance with the NYSDEC New York State In-Waterbody Control for Nutrients Feasibility Study/Engineering Report Requirements, as listed at https://www.dec.ny.gov/docs/water_pdf/npginwtroutline.pdf

All data collected on the project complies with the March 22, 2021 Quality Assurance Project Plan (QAPP) for the Internal Phosphorus Loading Assessment for Fresh Pond, Shelter Island, NY, which is attached as Exhibit 2.



Signature: _____
Pio Lombardo, P.E.

Date: __July 21, 2022_____

EXECUTIVE SUMMARY

Shelter Island’s Fresh Pond in-waterbody nutrient control feasibility study and engineering report determined that the Pond’s impaired water quality is due to sediment phosphorus release (primarily iron-phosphate being solubilized) during anaerobic conditions caused by Hypolimnetic Oxygen Demand (HOD) - primarily from Sediment Oxygen Demand (SOD). Based upon field measurements,

- ✓ HOD was estimated at 65 kg of oxygen / day
- ✓ Sediment Phosphorus Release was estimated at 31.7 kg/year with 125 kg of available P in the surficial sediment

The recommended solution to restore the Pond’s water quality is to remove phosphorus from Pond sediments by, as illustrated on Figure ES-1, the following methods:

- ✓ Hypolimnetic withdrawal of 100,000 gallons per day (gpd)
- ✓ Filtration and aeration to mineralize / precipitate iron-phosphate and thereby remove phosphorus from the water. Iron will be added, if needed/desired, to maximize phosphorus removal
- ✓ Return the water to Fresh Pond hypolimnetic layer far from the intake / withdrawal facilities
- ✓ Operate the phosphorus removal system for the period needed to remove phosphorus from the actively releasing phosphorus sediment layer – approximately March through November.
- ✓ Operate the phosphorus removal system for 7 – 10 +/- years to remove the 125 kg of available P in the Pond sediments. Assume 8 years needed

Proof of concept and a pilot project are proposed for obtaining data to finalize design criteria to optimize the full-scale design. Sediment thickness definition throughout the Pond is included in the full scale system phase to establish baseline conditions.

Project budgets for the project phases are presented below:

Table ES-1 HW Treatment Program Budget Detail

Task #	Task Description	Budget	Labor	Expenses (lab, etc.)	Equipment	Engineering & Admin	Total
1	Proof of Concept	\$49,761	\$ 21,780	\$ 12,381	\$ 12,600	\$ 3,000	\$ 49,761
2	Pilot Scale System	\$226,166	\$ 33,210	\$ 35,456	\$ 127,500	\$ 30,000	\$226,166
3	Full Scale System	\$367,950					
4	8 Years O&M	\$514,110					
	Total	\$1,157,987					

Project Schedule, based upon project funding by December 31, 2022, is presented on Table ES-2. Depending on the results of the Proof of Concept and Pilot Project phases, the full scale project may not start until late summer – early fall 2024.



Table ES-2 HW Treatment Program Schedule

Schedule		Fresh Pond Shelter Island In-Waterbody Control for Nutrients - Corrective Action Implementation											
Months after Receipt of Authorization to Proceed		1	2	3	4	5	6	7	8	9	10		
Phase	Activity Description	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23		
1	Proof of Concept												
2	Pilot Project												
3	Full Scale Project	11	12	13	14	15	16	17	18	19	20	21	22
		Nov-23	Dec-23	Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24	Oct-24
3a	Design												
3b	Construction Bidding Process												
3c	Construction / System Install												
3d	System Start-Up Performance Testing												
3e	1st Full Year operation	27	28	29	30	31	32	33	34	35			
		Mar-25	Apr-25	May-25	Jun-25	Jul-25	Aug-25	Sep-25	Oct-25	Nov-25			
3f	Annually Years 2 - 8 +/- operation	March	April	May	June	July	August	Sept	Oct	Nov			

3. SUMMARY

This Shelter Island Fresh Pond in-waterbody nutrient control feasibility study and engineering report describes the work that was performed to quantify the causes of algae blooms, evaluates remediation solutions and provides engineering design / specifications for the remediation solution selected by the Town of Shelter Island. Sediment phosphorus release due to anaerobic (i.e., devoid of oxygen) conditions caused by the Hypolimnetic Oxygen Demand (HOD) is the primary cause of algae blooms. HOD is a combination of oxygen demand from the sediment and demand from the water column, but most HOD for Fresh Pond is from the sediment. Figure S-1 (<https://www.cleanlakesalliance.org/lake-turnover/>) illustrates how Ponds/Lakes stratify and turnover due to temperature changes. Water is unique in the way it changes density at different temperatures. Unlike almost all other liquids, water is densest at 39 degrees Fahrenheit (4 degrees Celsius), and is lighter at both warmer and colder temperatures. In other words, when water reaches the critical temperature of 39 degrees Fahrenheit, further cooling causes the water molecules to become less dense and rise to the surface. This unusual characteristic allows water to form distinct layers within an otherwise uniform liquid.

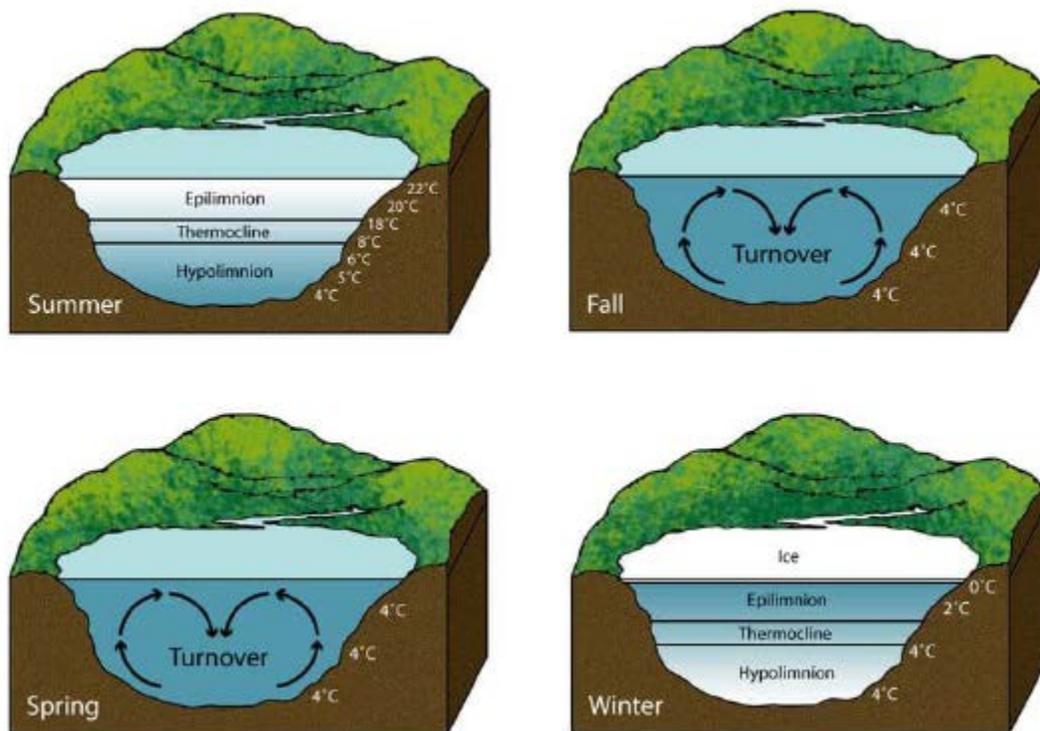


Figure S-1 Pond Seasonal Stratification – Turnover Illustration

Fresh Pond is a 14-acre glacial kettle-hole lake with a maximum depth of 47-feet, mean depth of 19 feet and a volume of approximately 88,070,000 gallons. The Pond's water quality has been sampled 2018 through 2021 by the Fresh Pond Neighborhood Association (FPNA) as a participant in the NYSDEC Citizens Statewide Lake Assessment Program (CSLAP) in which NYSDEC performs the laboratory analysis. The CSLAP sampling results document the significant adverse influence of Pond sediments on Pond water quality. This Report's Total Maximum Daily Load (TMDL) analysis of Fresh Pond estimates that 80+% of the phosphorus load to Fresh Pond is from internal sources, i.e., sediments. Clearly control of the internal phosphorus (P) is an essential requirement for Pond protection and improvement.

Fresh Pond’s contributing watershed area and hydrology was recently further defined/quantified by the United States Geological Survey (USGS) via their publication “Delineation of areas contributing groundwater and travel times to receiving waters in Kings, Queens, Nassau, and Suffolk Counties, New York: U.S. Geological Survey Scientific Investigations Report 2021–5047, 61 p., <https://doi.org/10.3133/sir20215047>” by Misut et al (2021). Fresh Pond is exposed groundwater with contributing waters from subwatersheds that discharge to Dickerson (USGS watershed #191) and Menantic (USGS watershed #193) Creeks, as shown on Figures S-2 through S-4. Figure S-5 illustrates this Report’s deduced watershed contributing area to Fresh Pond.

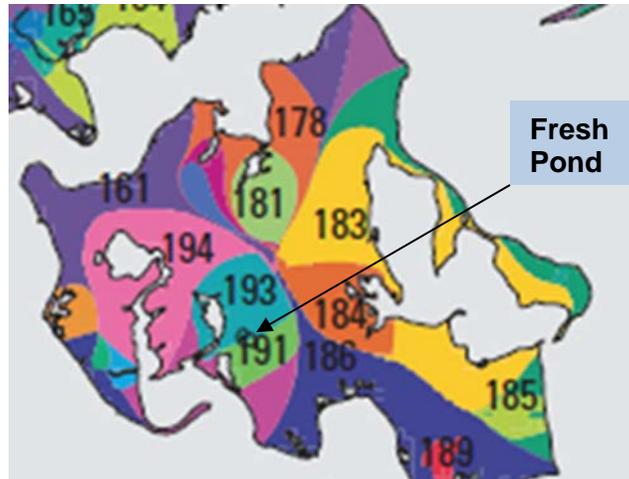


Figure S-2 USGS Watersheds 191 & 193 – Flow Through Fresh Pond

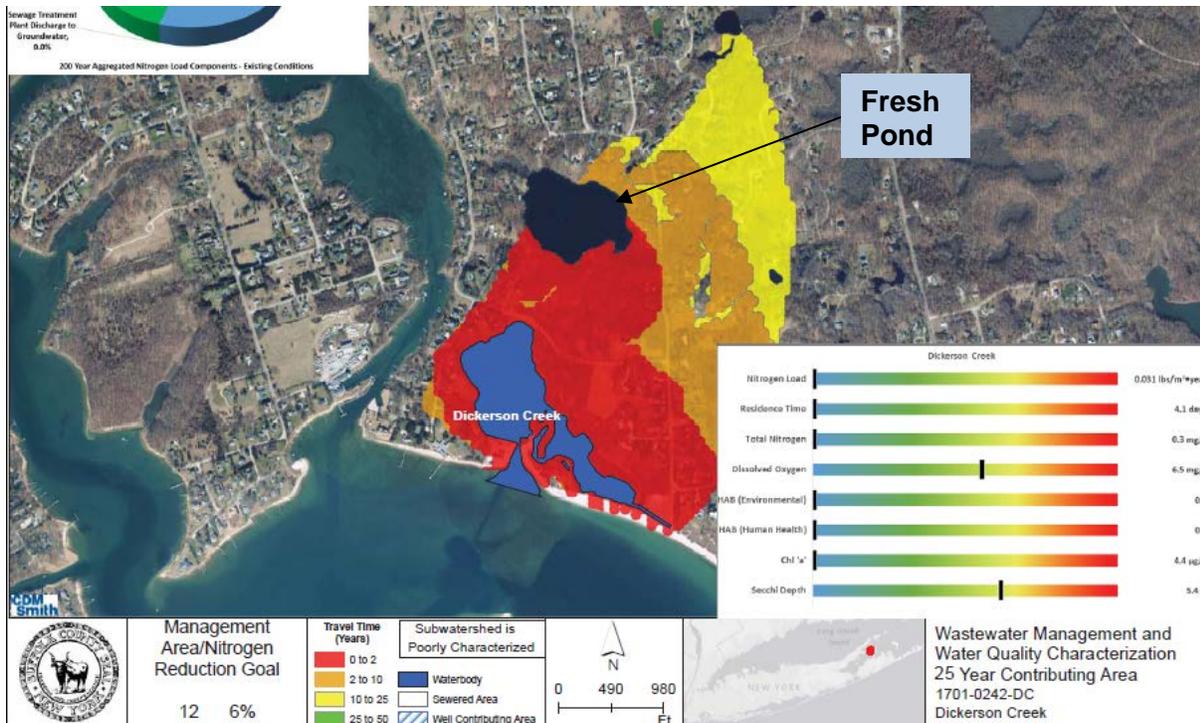


Figure S-3 Dickerson Creek Contributing Watershed Area

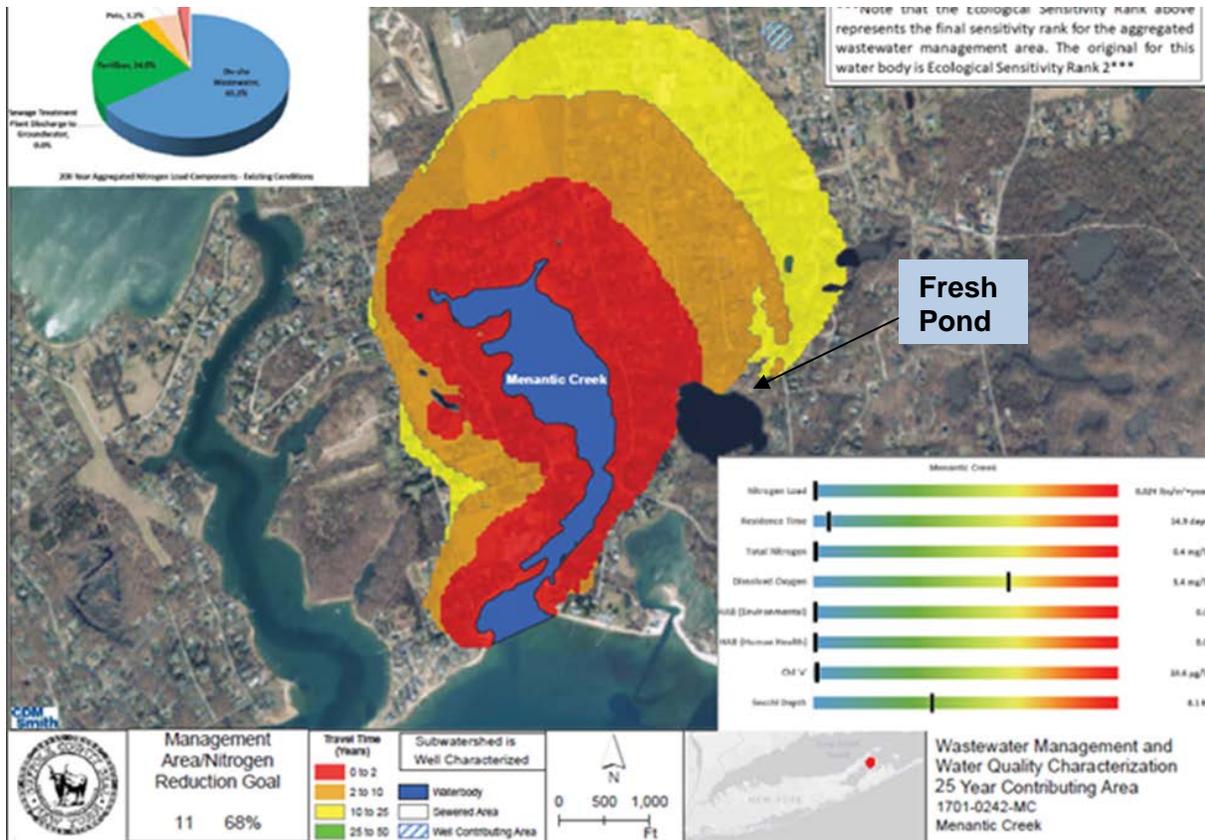


Figure S-4 Menantic Creek Contributing Watershed Area

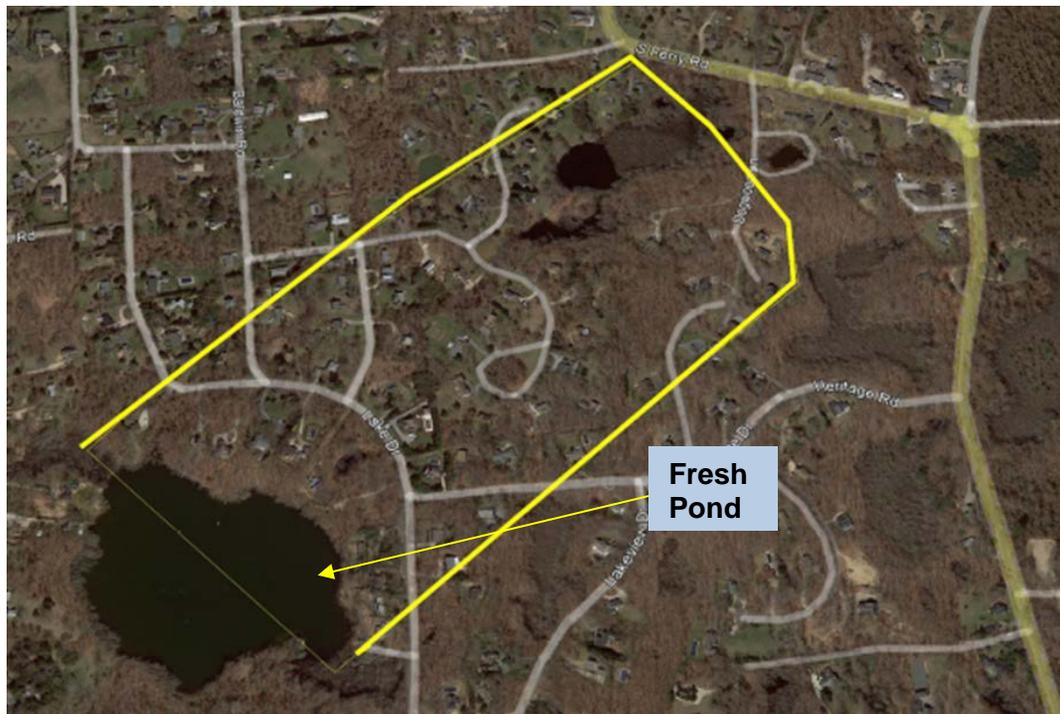


Figure S-5 Fresh Pond Contributing Watershed Area

Fresh Pond detention times and volumetric flow rate are presented on Table S-1.

Table S-1 Fresh Pond Detention Time & Volumetric Flow Rate

Watershed (WS) 191 Discharge to Dickerson Creek (cfs)	0.4
gpd	258,500
Fresh pond flux length in watershed 191 (ft)	375
Total Length of 191 (ft)	2,125
Fresh Pond % of 191 discharge (cfs)	17.65%
Fresh Pond WS 191 discharge (cfs)	0.07

Watershed 193 Discharge to Menantic Creek (cfs)	1.1
gpd	710,900
Fresh Pond flux length in watershed 193 (ft)	767.1
Total Flux Length of watershed 193 (ft)	4,290
Fresh Pond % of 193 discharge (cfs)	17.88%
Fresh Pond WS 193 discharge (cfs)	0.20

Ave. total flow through Fresh Pond (cfs)	0.27
Ave. total flow through Fresh Pond (gpd)	172,736
Ave. total flow through Fresh Pond (MGY)	63.0
Ave. total flow through Fresh Pond (gpm)	120

Percent of Fresh Pond Flow discharging to	
Menantic Creek	74%
Dickerson Creek	26%

Average Fresh Pond Detention Time (years)	1.40
Average Fresh Pond Detention Time (days)	510

The field data collection of the Pond's water quality performed by this project occurred from April 2021 through December 2021 and consisted of:

1. **Temperature and dissolved oxygen profiles** at multiple locations (see Figure S-6) and elevations and dates to determine the areal extent of hypolimnetic (primarily sediment) oxygen demand (HOD) which would define the area of sediment influence on water quality. Multiple sampling events at various elevations at deepest Pond station # 16. Data collection performed from April 6 through December 1, 2021.

Sediment influence, defined as causing anaerobic conditions, was documented at depths >20 feet, which represent ~44% of the Pond area.

A strong thermocline existed in Fresh Pond from depths 15 – 25 feet. The strong thermocline kept the hypolimnetic nutrients from being transported to surface layers where sufficient light existed and thereby prevented an algae bloom in the summer 2021.

2. **Continuous water temperature monitoring system** was installed at Station 16 at 9 elevations in September 2021 to enable a remote method to determine when Pond turnover and stratification occurred.
3. **Water quality (phosphorus and nitrogen primarily) data** at multiple elevations on multiple dates. Table S-2 presents results from comprehensive sampling on July 29, 2021.
4. **Sediment qualitative characterization** and sampling on May 1, 2021 through underwater camera and sediment grab samples.

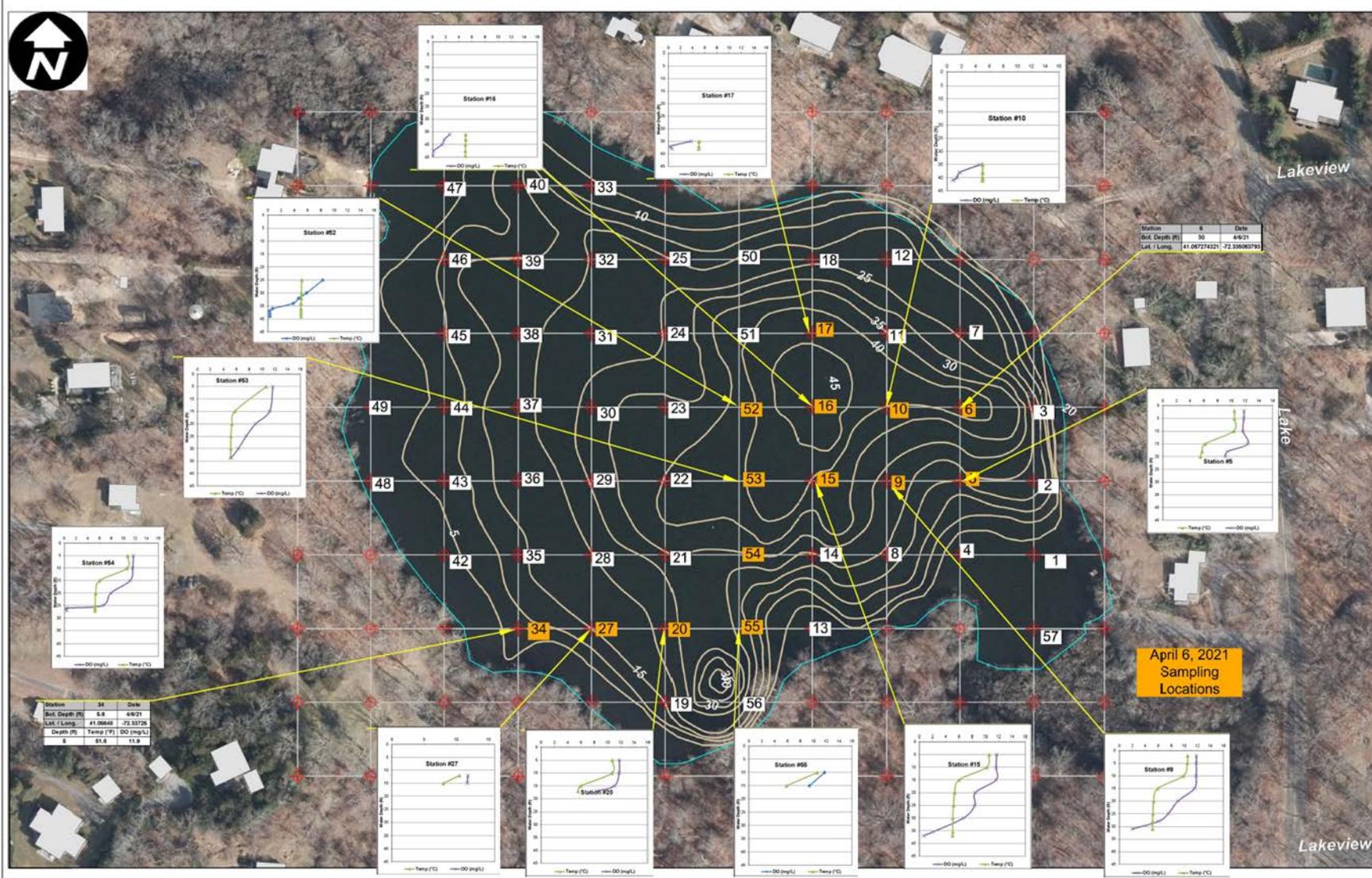


Figure S-6 Grid Map + Temperature & DO Profiles – April 6, 2021

Table S-2 Nutrient – July 29, 2021 Water Quality Data at Station 16

Fresh Pond Data Station 16 - July 29, 2021 11:30 am													
Depth	Temp	DO	DO	Conduct.	pH	Chl-a	Turbidity	Alkalinity	Secchi	Total P	TKN	NO ₂ + NO ₃	Iron
feet	°C	mg/l	% Sat	µS/cm	Units	µg/l	NTU	mg/l	meters	mg/l	mg/l	mg/l	mg/l
0.7	27.6	8.1	104.1	173	7.6	2.3	1.2	13.2	3.2				
5.0	27.4	8.2	104.9	172	7.6	3.0	1.1			0.015	0.643	<0.05	
10.0	26.2	7.9	99.0	172	7.6	4.6	1.2			0.036			
15.0	19.1	10.2	112.1	173	7.5	6.7	1.3			0.026			
20.0	12.7	0.3	2.5	173	7.1	31.7	3.0			0.111	1.700	<0.05	
25.0	7.8	0.1	1.0	185	7.0	12.8	3.1	20.7		0.101			0.25
30.0	6.4	0.0	0.0	192	6.5	10.5	3.0			0.194			1.54
35.0	6.1	0.0	0.0	199	6.2	10.2	2.8			0.311			2.06
40.0	5.9	0.0	0.0	209	6.1	10.1	2.8			0.482			3.00
45.0	5.9	0.0	0.0	211	5.9	10.1	2.9	32.8		0.574	5.090	<0.05	3.21

Sediment phosphorus fractions lab characterization. Five (5) sediment samples were analyzed for their phosphorus fractions as presented on Table S-3. Total P is the sum of all fractions minus Biogenic P, which is part of the Organic P fraction. The Fe-P is readily released during anaerobic conditions. Some organic P can be released, identified as the biogenic component, but tends to be slower than Fe-P release. Not all organic P is released.

Table S-3 Sediment Phosphorus Forms

	% solids	% Water	Total	Loosely Bound	Iron Bound	Al Bound	Biogenic	Calcium Bound	Organic	as % of Total		
										Iron Bound	Biogenic	Iron + Organic
FP-1A	7.12%	92.9%	2,582	<2.00	623	1,027	676	63.8	868	24%	34%	58%
FP-1B	7.17%	92.8%	2,683	<2.00	649	1,014	767	57.3	962	24%	36%	60%
FP-2	7.87%	92.10%	2,235	<2.00	526	874	622	55.2	780	24%	35%	58%
FP-3	8.47%	91.50%	2,003	<2.00	443	832	526	47.5	681	22%	34%	56%
FP-4	42.30%	57.70%	307	<2.00	44	118	102	9.59	136	14%	44%	58%
FP-5	14.40%	85.60%	1,082	<2.00	269	407	261	35.2	371	25%	34%	59%

Sediment (dry weight basis) Phosphorus Bound (mg/kg)

- Pond elevation monitoring gauge, as shown on Figure ES-7 with data on Table S-4.



Table S-4 Fresh Pond Elevations

Fresh Pond Water Elevation	
Date	Gauge - feet
21-May-21	2.29
17-Jun-21	2.1
23-Jun-21	2.07
11-Jul-21	2.15
05-Sep-21	1.74
13-Sep-21	1.67
08-Oct-21	1.5
15-Oct-21	1.44

Figure S-7 Pond Elevation Gauge

Hypolimnetic Oxygen Demand (HOD)

Due to the March 29, 2021 project authorization and extremely early Pond dissolved oxygen (DO) deficits, the data collection program did not catch profiles with higher oxygen top to bottom of the Pond. It is proposed that additional temperature – DO profile(s) should be measured if aeration is the preferred solution. These data will provide confidence on estimates of HOD and engineering design criteria of an aeration system. However, there is enough data to make estimates of HOD, albeit with the recognition that they are underestimates.

Table S-5 provides the range of HOD values for Fresh Pond from the data that could be confidently applied. The hypolimnion loses oxygen from at least April, with anoxia observed at >30 feet at the start of May and very low oxygen at >20 feet by the end of July. Dissolved oxygen remained substantial at depths of 15 feet through the stratification period in 2021, with a steep decline between 15 and 20 feet. This distribution is consistent with the observed oxygen profiles, but stratification and oxygen loss are occurring earlier than in most lakes. The small surface area with relatively large depth in a sheltered setting is apparently facilitating this process.

Typical HOD values are 0.5 (good) to 4 (very bad) grams per square meter per day (g/m²/d). Most Ponds/Lakes do not exceed 2 g/m²/day. The values for Fresh Pond are underestimates; more oxygen would have been removed if it had been there to be removed in the depth increments

near the bottom. The 4/30/21 oxygen measurements were <2 milligrams/liter (mg/L) as far as 15 feet above the bottom, so the underestimation may be substantial.

From experience on other Ponds, it is proposed that the actual HOD, with adequate oxygen and with warming temperature, would be twice what was measured, resulting in 2.5 +/- g/m²/day. Assuming area with HOD is at the 20-foot depth which has a surface area of 26,000 m², oxygen demand would then be **65 kilograms of oxygen/day**.

Table S-5 HOD Estimates

HOD Estimates		4/6-19/21	4/19-30/21
Station	Depth (ft)	HOD (g/m ² /d)	HOD (g/m ² /d)
9	31	0.62	1.56
10	41	1.15	
15	40	0.8	1.57
16	45	1.02	1.27
22	26		1.22
53	36	1.44	0.95
54	28	0.43	0.8
Average	35	0.91	1.23

Phosphorus Sediment Loading

Release of sediment P is not usually constant, as longer exposure to anoxia drives the redox potential lower and increases the rate of P release. As the area exposed to anoxia increases over the course of stratification, the deepest area will be exposed the longest and have the highest average release rate. Using the areas associated with defined depth layers, duration of low oxygen exposure from actual data, and assigning P release rates based on the actual data for Fresh Pond, a likely internal P load of 31.7 kg/yr (Table S-6) is calculated, similar to anticipated sediment release as a percent of the total reserves and very close to the P mass change over 2021 in the Pond.

Table S-6 presents the estimated sediment phosphorus load at 31.7 kg.

Table S-6 Estimated Phosphorus Load Based on Exposure of Sediment to Anoxia

Depth (ft)	Area (ac)	Avg P release (mg/m ² /d)	Duration of anoxic exposure (days)	P load (kg)
40+	1.00	7.5	210	6.4
30-40	2.13	6.5	180	10.0
20-30	3.31	5.5	150	11.0
15-20	1.96	4.5	120	4.3
Total	8.40			31.7

Internal P Load Control Options

The proven and typical methods for reducing internal phosphorus loading in Ponds are:

1. Dredging
2. Oxygenation of hypolimnetic waters
3. Phosphorus inactivation

Other methods exist and have enjoyed some success, but do not have the track record or widespread applicability that these three methods do. That does not mean that alternative approaches, such as hypolimnetic withdrawal, are not worth implementing, only that they need to be viewed as experimental and implemented with proper controls, monitoring and adjustment as the data dictate. Our analysis of hypolimnetic withdrawal is that it has the potential to be an effective, permanent and low-cost P control option.

Dredging is excessively expensive and is not considered viable. Phosphorus inactivation occurs by binding with a variety of materials. P binders include aluminum, calcium and lanthanum, each of which substitutes for iron as the main binder of P in the treated sediment. Aluminum has been the binder of choice in many applications due to its ease of application and low cost, however not easily permitted in New York State. Also, phosphorus inactivation is not NYSDEC grant eligible and would therefore represent a much more difficult approach to implement.

As a result of impediments to other options, the P control approaches remaining to be evaluated consist of:

- ✓ Oxygenation
- ✓ Hypolimnetic withdrawal

Oxygenation can be achieved by:

- a. Artificial circulation – Intentionally mixing the lake to prevent stratification and loss of oxygen near the bottom. This is not a natural solution and will make whatever nutrients are in the pond more available to algae. If adequate oxygen is maintained near the bottom there could be less P release, but the risk of moving some P into upper waters makes this approach risky.
- b. Hypolimnetic oxygenation
 - i. Submerged chambers into which air or pure oxygen is released.
 - ii. Onshore - Side stream saturation (SSS) which injects oxygen into water withdrawn from the hypolimnetic layer on a shore-based pressurized container to produce a supersaturated solution that is then discharged into the target bottom layer zone.
 - iii. Diffused release of pure oxygen – fine bubbles would be released into the deepest part of the pond with no chamber, with absorption of the oxygen before bubbles can cause destratification. This carries a risk of destratification with the range of depths needing oxygen in Fresh Pond.

The onshore SSS option is the recommended oxygenation technique. SSS provides extra oxygen, possibly 5 to 10 times what the water would have held naturally at the ambient temperature, which allows less water to be moved to get the necessary oxygen mass into the targeted zone of the pond.

Preliminary engineering of a Fresh Pond On-Shore SSS oxygenation system that provides a minimum of 65 kg/day of oxygen to Fresh Pond hypolimnetic water consists of the following components:

- 1,200+/- foot long intake pipe on the bottom of Fresh Pond
- Pressure swing absorption (PSA) units for onsite generation of oxygen and pumping equipment located in a 10' x 10' building on Fresh Pond Road
- 1,200 +/- foot long return piping discharging supersaturated waters to the Fresh Pond hypolimnion
- Electrical Supply and use

Hypolimnetic Withdrawal is achieved by suction pumping water out of the deep area of the Pond where high P levels exist, treating the water for phosphorus removal by aeration which will cause Fe-P precipitation and returning the treated water to the Pond's bottom waters, away from intake area. While this is a slower process than oxygenation that will take multiple years to remove the required P to mitigate sediment P release, it has appeal as a cost-effective, permanent solution as compared to oxygenation which needs to be performed forever.

Preliminary engineering of a Fresh Pond Hypolimnetic Withdrawal System that removes 32 kg P/year from Fresh Pond consists of:

- 700+/- foot long intake pipe on the bottom of Fresh Pond
- Pump assuming average flow of 100,000 gpd
- Water treatment system
- Return waters to Fresh Pond

Town Selected Approach

Due to its ability to provide a permanent solution, the Town selected the Hypolimnetic Withdrawal System on a platform to be built on Fresh Pond.

4. PROJECT OBJECTIVES & SCOPE OF WORK OUTLINE

The project objectives are:

- ✓ Determine the extent to which sediments are adversely affecting Pond water quality by sediment oxygen demand and release of sediment nutrients – with a focus on phosphorus
- ✓ Perform a preliminary Total Maximum Daily Load (TMDL) analysis for Fresh Pond to understand the relative sediment nutrient contributions as compared to other sources
- ✓ Identify and evaluate options for internal Phosphorus control. With Town, select preferred option
- ✓ Prepare Engineering Plan of Preferred Alternative

These objectives will be achieved by the performance of the following tasks, whose results are presented in this Report.

Task 1 Review existing data and provide systematic analysis of pond chemistry

Task 2 Field sampling and data collection & Determine Internal Load

- Task 2.1 Assessment of Internal Loading Potential**
- Task 2.2 Determine extent of soft sediment coverage**
- Task 2.3 Determine sediment quality in the potential P contributory zone**
- Task 2.4 Determine sediment oxygen demand**
- Task 2.5 Evaluate internal load**

Task 3 Preliminary TMDL analysis

Task 4. Identify & Evaluate options for internal P load control. With Town, Select Preferred Option

Task 5 Engineering Plan of Proposed Preferred Remediation Alternative

- a. Equipment Sizing and Layout**
- b. Capital and annual O&M cost estimates**
- c. Permitting Requirements**
- d. Implementation Plan / Schedule**

Task 6 Project Report

Complies with NYSDEC requirements for an In-Waterbody Control for Nutrients Feasibility Study/Engineering Report.

5. EXISTING CONDITIONS

Relevant existing conditions in Fresh Pond and its contributing watershed are presented in this Section to provide background information. Watershed information is essential for the preliminary TMDL analysis presented in Section 7.

Fresh Pond presently has a NYSDEC recreational lake Class "C". It is understood that Fresh Pond is classified as "Class C" based on the New York State surface water classification system. Per §701.8, the best usage of Class C waters is fishing. "These waters shall be suitable for fish, shellfish, and wildlife propagation and survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes." In 2018 Suffolk County Department of Health Services declared it unsuitable for swimming <https://shelterislandreporter.timesreview.com/2018/07/12/signs-posted-dont-swim-fresh-pond/>.

5.1 FRESH POND LOCATION, BATHYMETRY, WATERSHED DEFINITION & HYDROGEOLOGY

Fresh Pond Regional Location Map and Local Location Map are presented on Figures 5-1 and 5-2, respectively. The NYSDEC Bathymetric Map is presented on Figure 5-3 https://www.dec.ny.gov/docs/fish_marine_pdf/fshpd2map.pdf.

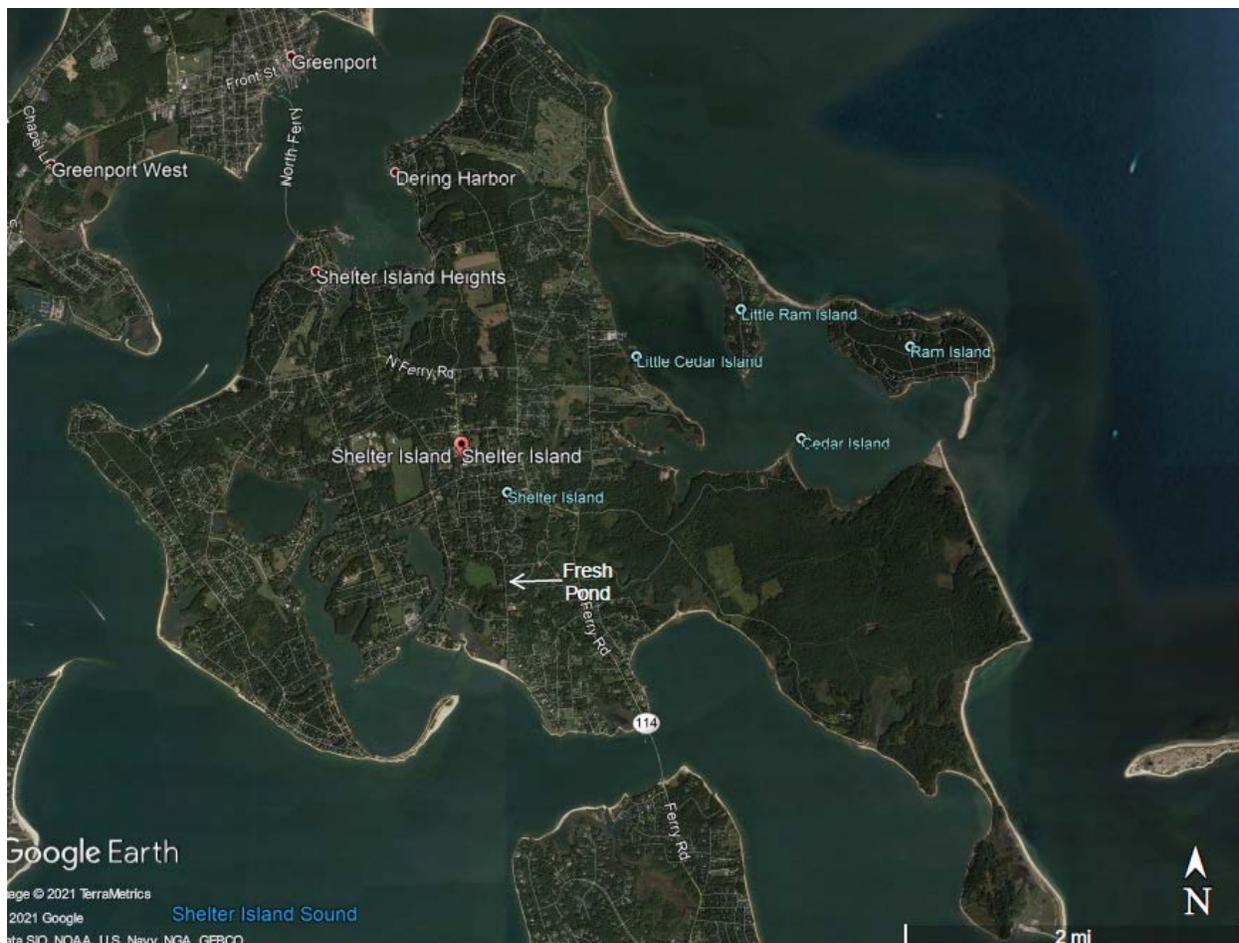


Figure 5-1 Regional Location Map - Fresh Pond

Fresh Pond is a 14-acre glacial kettle-hole lake with a maximum depth of 47-feet, mean depth of 19 feet and a volume of approximately 88,070,000 gallons. Table 5-1 presents the Pond's water volumes at various depths, total volume and mean depth calculation based upon the Figure 5-3 NYSDEC Bathymetric Map.

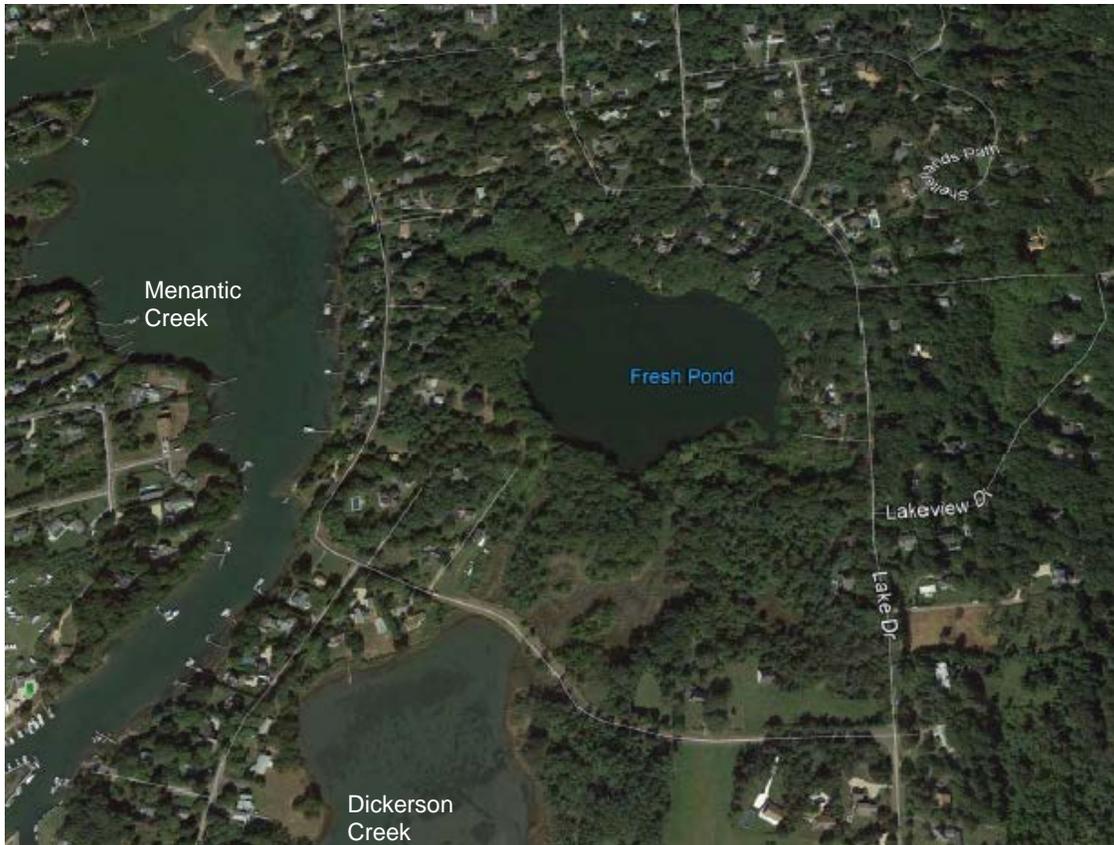


Figure 5-2 Local Location Map - Fresh Pond

Table 5-1 Fresh Pond Water Volumes at Various Depths

Fresh Pond Areas & Water Volumes at Various Depths							Mean Depth (ft)	18.6		
Depth (ft)	Area (acres)	% of Total	Area (sf)	Area (m ²)	Depth Interval Cubic Feet	% of Total	Total Gallons at Depth Interval	Total Liters at Depth Interval	Volume (gallons) below depth	
0	14.55	100%	633,798	58,880					88,070,000	
5	11.36	78%	494,842	45,971	2,821,599	24%	21,105,600	79,893,349	66,964,400	
10	9.76	67%	425,146	39,496	2,299,968	20%	17,203,800	65,123,437	49,760,600	
15	8.39	58%	365,468	33,952	1,976,535	17%	14,784,500	55,965,394	34,976,100	
20	6.44	44%	280,526	26,061	1,614,987	14%	12,080,100	45,728,131	22,896,000	
25	4.49	31%	195,584	18,170	1,190,277	10%	8,903,300	33,702,641	13,992,700	
30	3.13	22%	136,343	12,666	829,818	7%	6,207,000	23,496,040	7,785,700	
35	2.02	14%	87,991	8,174	560,835	4.8%	4,195,000	15,879,795	3,590,700	
40	1.01	6.9%	43,996	4,087	329,967	2.8%	2,468,200	9,343,149	1,122,500	
45	0.26	1.8%	11,326	1,052	138,303	1.2%	1,034,500	3,916,007	88,000	
47	0.01	0.07%	436	40	11,761	0.1%	88,000	333,116		
					11,774,050	100%	88,070,000	333,381,059		

Spot depth measurements throughout the Pond during data collection efforts were consistent with the Figure 5-3 NYSDEC Bathymetric Map depths.

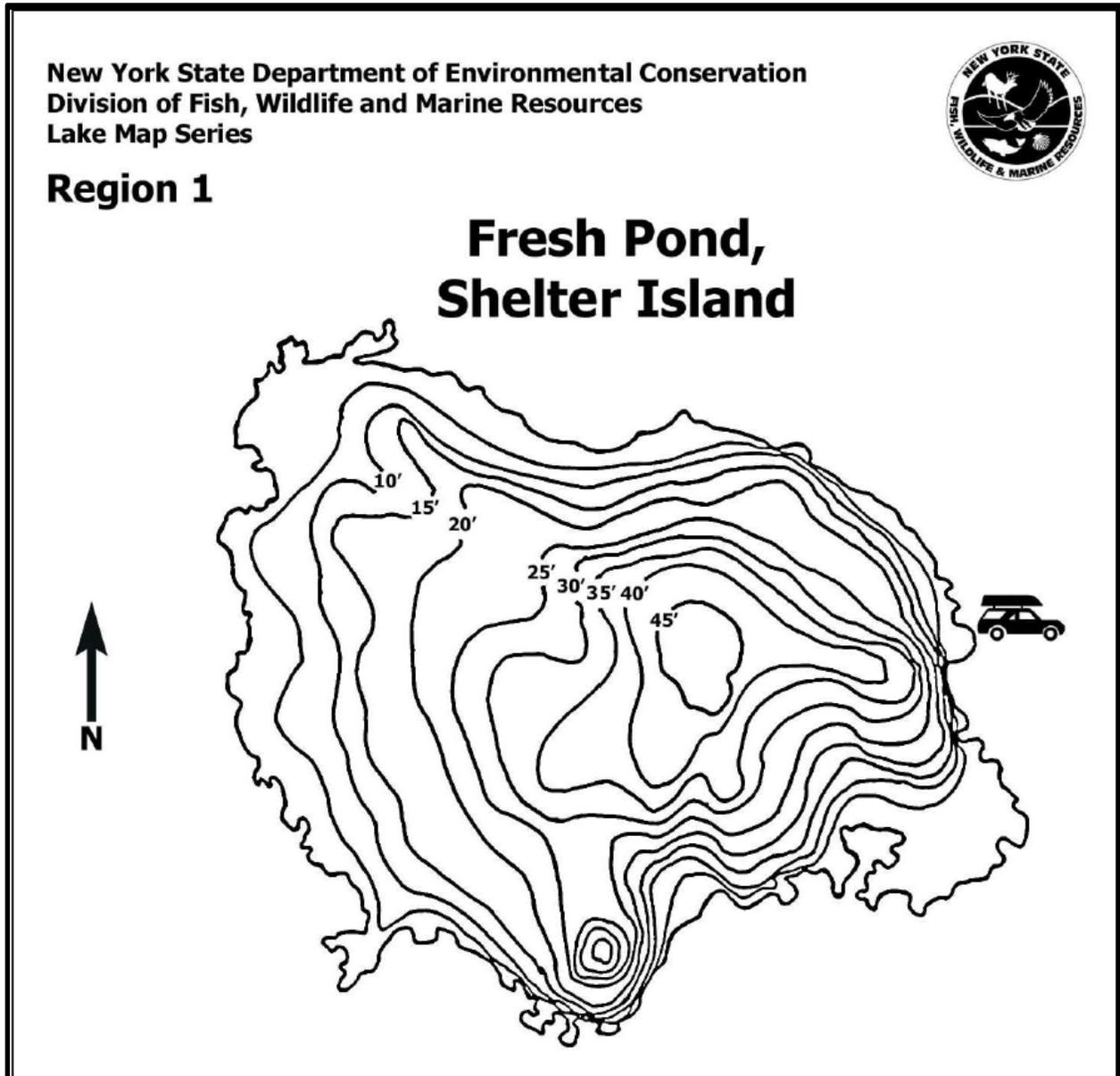


Figure 5-3 Bathymetric Map - Fresh Pond

Based upon the following

- | | |
|------------|---|
| Figure 5-4 | Groundwater elevations |
| Figure 5-5 | USGS watersheds 191 & 193 flow through Fresh Pond |
| Figure 5-6 | Groundwater Time of Travel to Dickerson Creek |
| Figure 5-7 | Groundwater Time of Travel to Menantic Creek |

and volumetric flow discharging from USGS watersheds as presented in Misut et al. (2021), volumetric flows through Fresh Pond and discharging to Dickerson and Menantic Creeks were estimated and are presented on Table 5-2.

Table 5-2 Fresh Pond Flushing Volumes and Time

Watershed (WS) 191 Discharge to Dickerson Creek (cfs)	0.4	Watershed 193 Discharge to Menantic Creek (cfs)	1.1
gpd	258,500	gpd	710,900
Fresh pond flux length in watershed 191 (ft)	375	Fresh Pond flux length in watershed 193 (ft)	767.1
Total Length of 191 (ft)	2,125	Total Flux Length of watershed 193 (ft)	4,290
Fresh Pond % of 191 discharge (cfs)	17.65%	Fresh Pond % of 193 discharge (cfs)	17.88%
Fresh Pond WS 191 discharge (cfs)	0.07	Fresh Pond WS 193 discharge (cfs)	0.20
Ave. total flow through Fresh Pond (cfs)	0.27	Percent of Fresh Pond Flow discharging to	
Ave. total flow through Fresh Pond (gpd)	172,736	Menantic Creek	74%
Ave. total flow through Fresh Pond (MGY)	63.0	Dickerson Creek	26%
Ave. total flow through Fresh Pond (gpm)	120		
Average Fresh Pond Detention Time (years)	1.40		
Average Fresh Pond Detention Time (days)	510		

The Pond's contributory watershed area, including the Pond, is estimated at approximately 90 acres, and is presented on Figures 5-8. There are 68 developed residential properties within the Fresh Pond watershed

Figure 5-9 is a map of the wetlands adjacent to / near Fresh Pond.



Figure 5-4 Shelter Island Groundwater Elevations

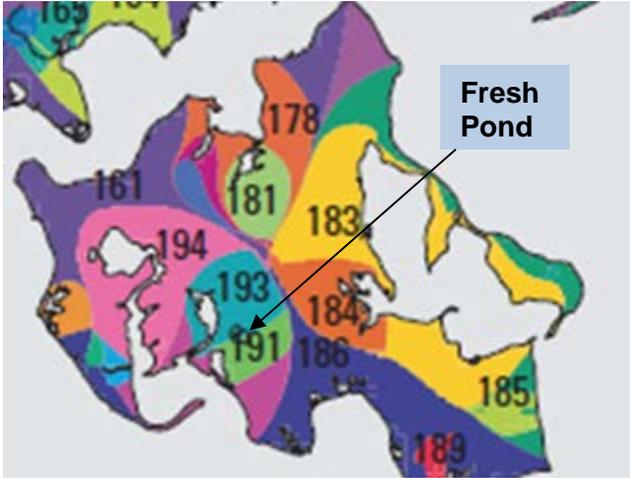


Figure 5-5 USGS Watersheds 191 & 193

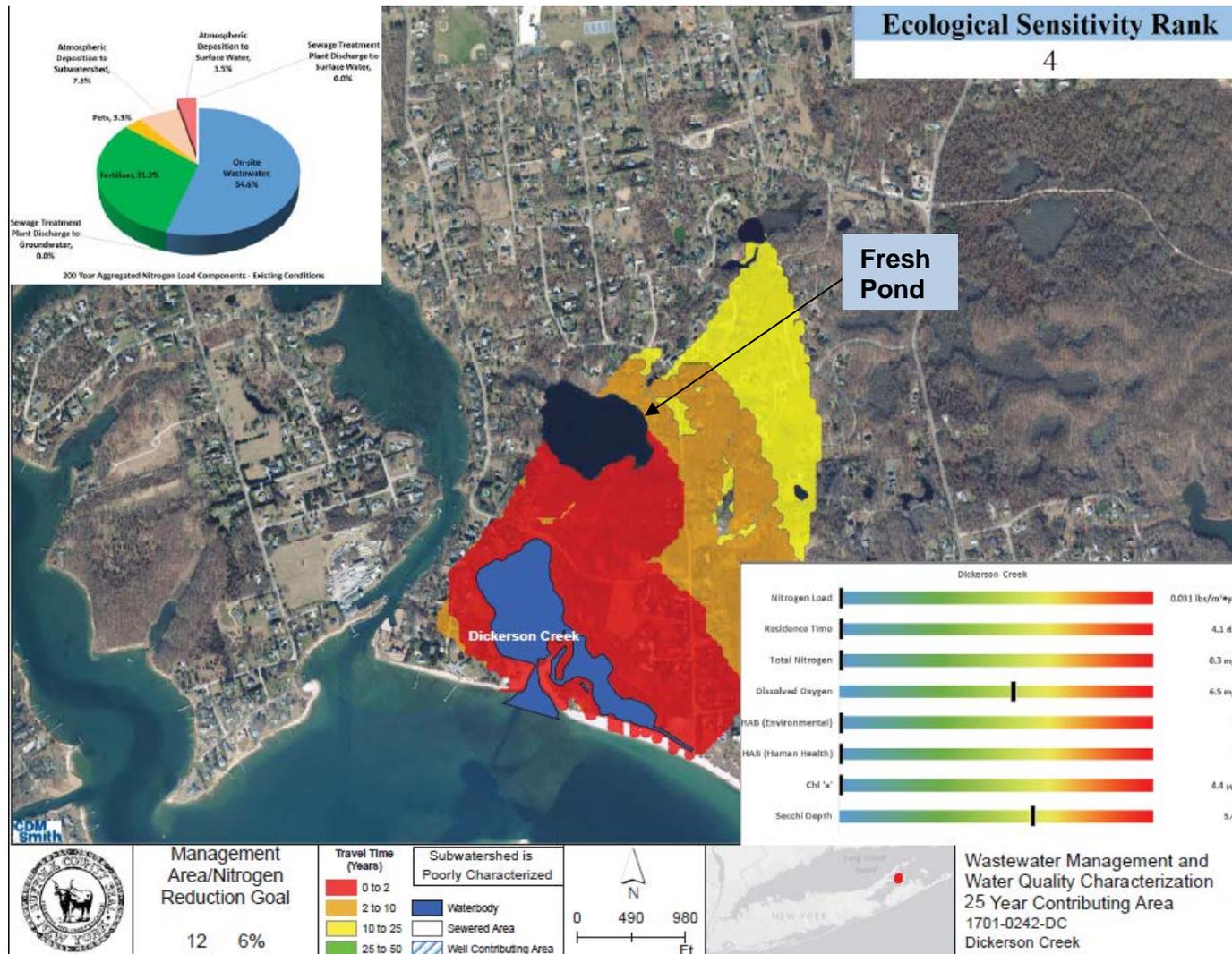


Figure 5-6 Dickerson Creek Contributing Area

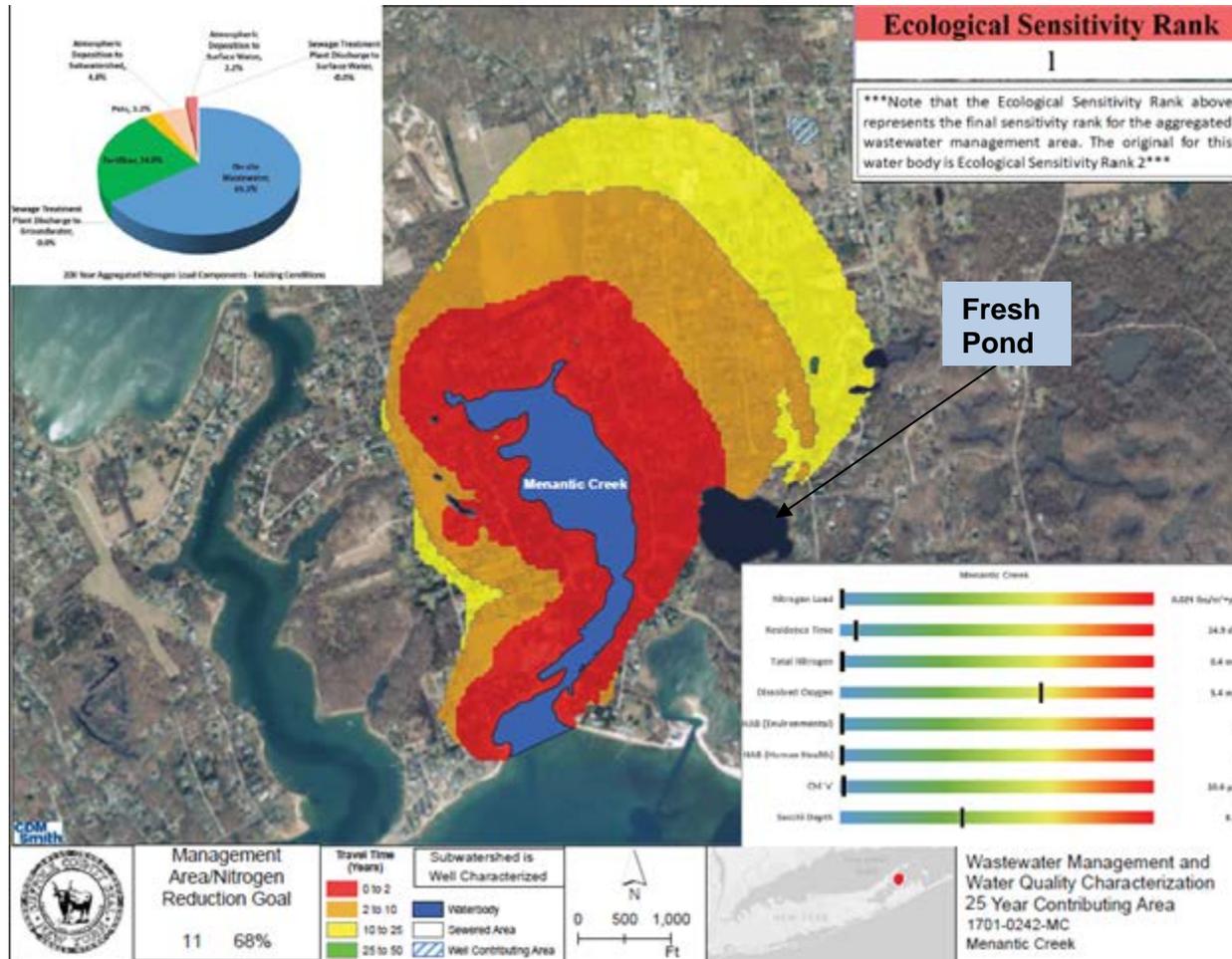


Figure 5-7 Menantic Creek Contributing Area

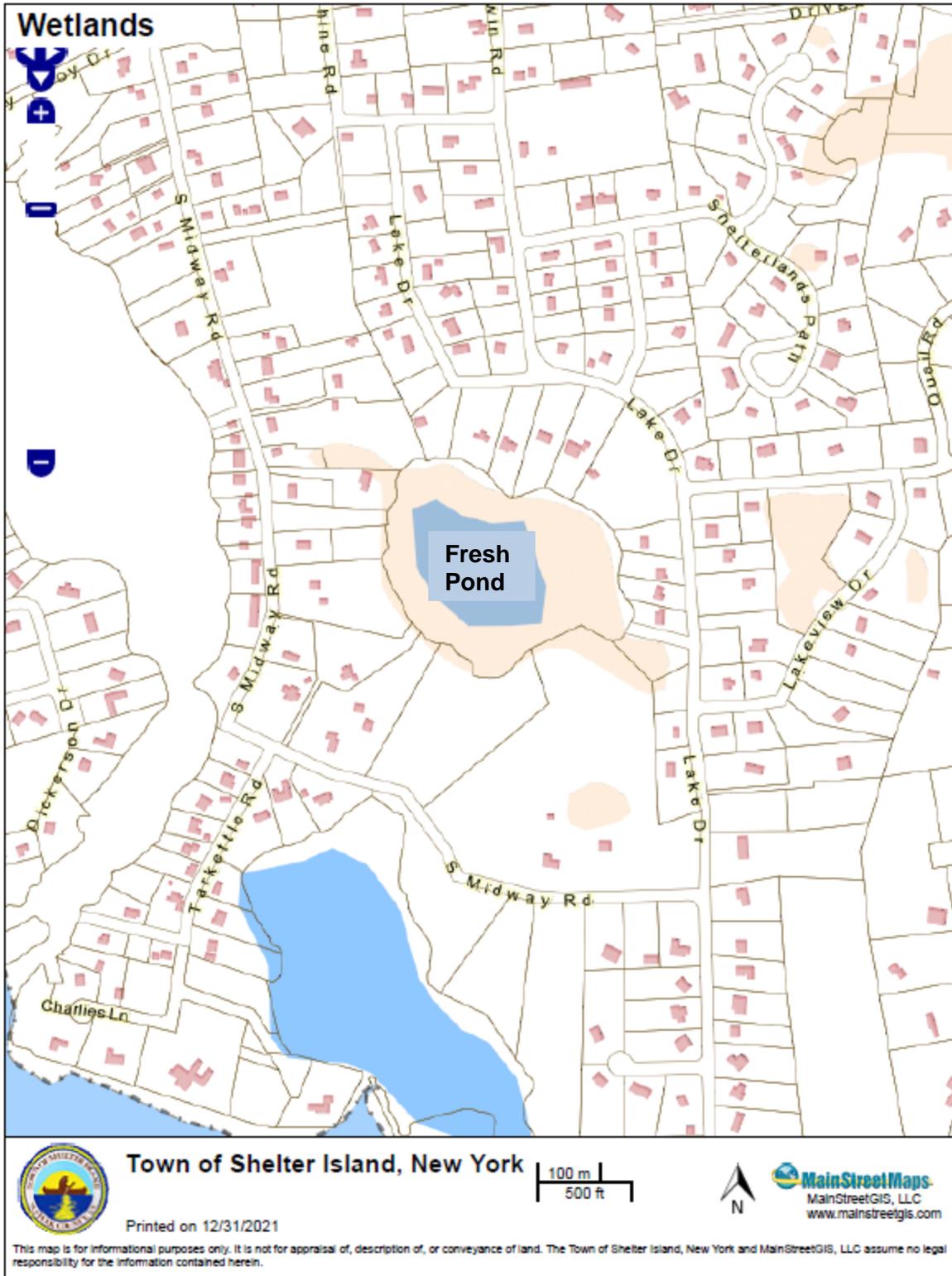


Figure 5-9 Wetlands Near Fresh Pond

Fresh Pond has no surface discharge. The bottom of Fresh Pond is above the fresh-salt water interface, based on conversations with Paul Misut of USGS who indicated that the freshwater/saltwater interface is approximately 150 feet below sea level in this area.

Figure 5-10 illustrates the location of the USGS well S106177.1 (USGS-410340072201201), which is **NOT** within the Fresh Pond watershed and the location of a Pond water level gauge. Table 5-4 presents the 2021 collected Pond elevation data. A photo of the gauge is presented on Figure 5-11.

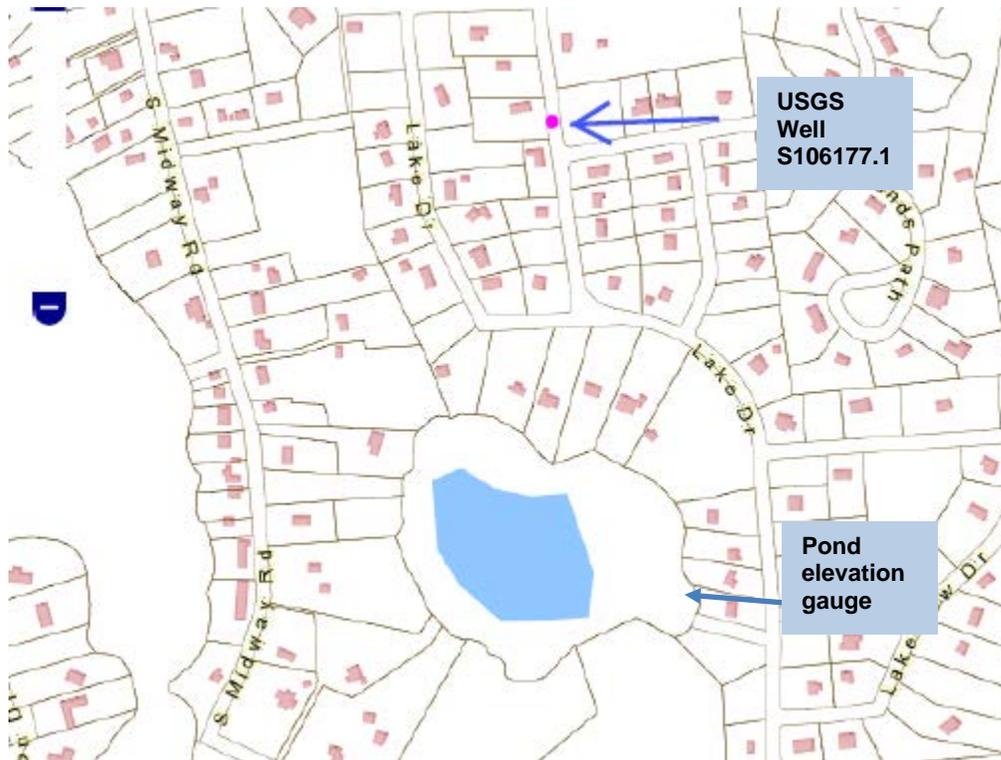


Figure 5-10 USGS well and Pond Elevation Gauge Locations

Table 5-3 Fresh Pond Elevations - 2021

Fresh Pond Water Elevation	
Date	Gauge - feet
21-May-21	2.29
17-Jun-21	2.1
23-Jun-21	2.07
11-Jul-21	2.15
05-Sep-21	1.74
13-Sep-21	1.67
08-Oct-21	1.5
15-Oct-21	1.44
14-Dec-21	1.6



Figure 5-11 Pond Elevation Gauge

Groundwater linear velocity was estimated based upon a hydraulic conductivity of 85+/- ft/day for the upper glacial aquifer for Fresh Pond area (Walter et al., 2020). Walter et al., 2020 state that the anisotropy (ratio of horizontal over vertical hydraulic conductivity) of the upper glacial aquifer is estimated to be 10:1; but local values could be as low as 3:1.

Groundwater aquifer gradient (slope) towards Fresh Pond	~ 0.001 (i.e., 0.1%)
Groundwater linear velocity	~ 0.25 feet / day

5.2 GROUNDWATER QUALITY

Table 5-4 presents the USGS collected groundwater quality data at well S106177.1. Additional USGS groundwater data is presented in Appendix A.

Table 5-4 Groundwater Quality 2016 - 2018

Ground Water Quality Data - USGS Well # S106177.1			
Latitude 41°03'40", Longitude 72°20'12" NAD27			
Land-surface elevation 30.3 feet above NGVD29			
Well depth is 70 feet below land surface. Hole depth 73 bls			
Location: near Strawberry Lane + Baldwin Road			
Constituent \ Date	12/2/2016	11/8/2017	9/27/2018
Temp (°C)	12.8	13.0	13.9
Specific Cond (us/cm)	206	202	189
D.O. (mg/L)	9.0	7.8	6.8
pH	6.6	5.8	5.9
Organic N (mg/L)	0.33	0.09	
Ammonia-N (mg/L)	0.01	0.02	0.02
Nitrite-N + Nitrate-N (mg/L)	5.95	5.36	4.9
Ortho-phosphate-P (mg/L)	0.026	0.031	0.037
Iron (mg/L)	0.0118	<.010	0.0265

5.3 WATERSHED SOILS

Soil information is important as soil types influence the degree to which wastewater and other sources of land applied phosphorus is removed prior to discharging to Fresh Pond. Figure 5-12 presents the Soils Map for Fresh Pond watershed. Watershed soils are of the Montauk-Haven-Riverhead association which has well drained to moderately well drained, moderately coarse textured and medium-textured soils on moraines.



Figure 5-12 Fresh Pond Watershed Soils

Soil Symbol	Soil Type
CpE	Carver and Plymouth soils, 15 to 35 percent slopes
HaB	Haven loam, 2 to 6 percent slopes
HaC	Haven loam, 6 to 12 percent slopes
MkB	Montauk loam, 3 to 8 percent slopes
MnC	Montauk loamy sand, 8 to 15 percent slopes
PIC	Plymouth loamy coarse sand, 8 to 15 percent slopes
Ra	Raynham loam
SwA	Swansea muck, 0 to 1 percent slopes, coastal lowland

5.4 STORMWATER

The only location of direct stormwater runoff is at Fresh Pond Road. Due to its small contributing watershed, and gravel road, it is not expected to be significant stormwater contributor to Fresh Pond. Figure 5-13 presents the location of Stormwater Catch Basins within the Watershed.

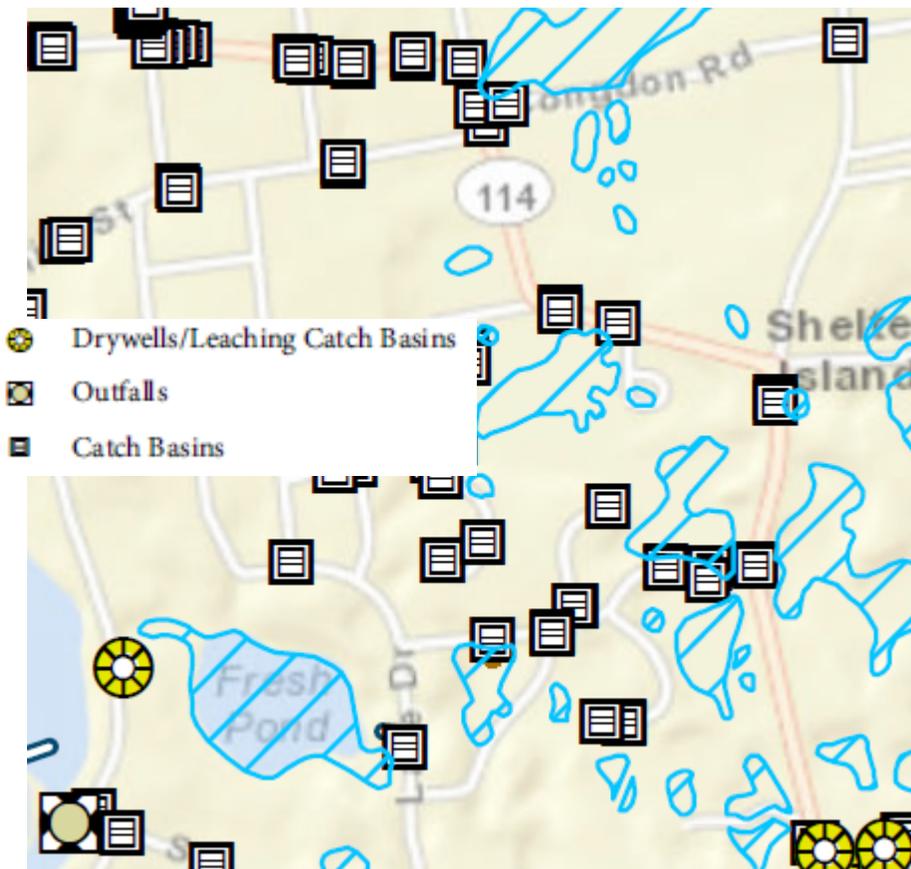


Figure 5-13 Stormwater Catch Basins within Watershed

6. WATER QUALITY CONDITIONS DEMONSTRATING OXYGEN DEFICIT

As shown in this Section based upon 2021 data, Fresh Pond stratifies during the spring through fall of the year, with the boundary (thermocline) at about 15 feet. The volume of water in the upper layer (epilimnion) is approximately 53 million gallons (60% of the total) while the volume of the lower layer (hypolimnion) contains about 35 million gallons (40% of the total). The Pond's bottom area below a water depth of 15 feet is about 8.4 acres see Table 5-1.

6.1 TEMPERATURE & DISSOLVED OXYGEN

To determine Pond oxygen deficit and sediment oxygen demand, temperature and oxygen profiles were collected on Fresh Pond at the stations shown on Figure 6-1 and listed on Table 6-1 on April 6, 19 and 30 and May 21, 2021. Additional temperature and dissolved oxygen profiles were collected at Station 16 on June 23, Sept. 13, Oct. 8 and December 1, 2021.

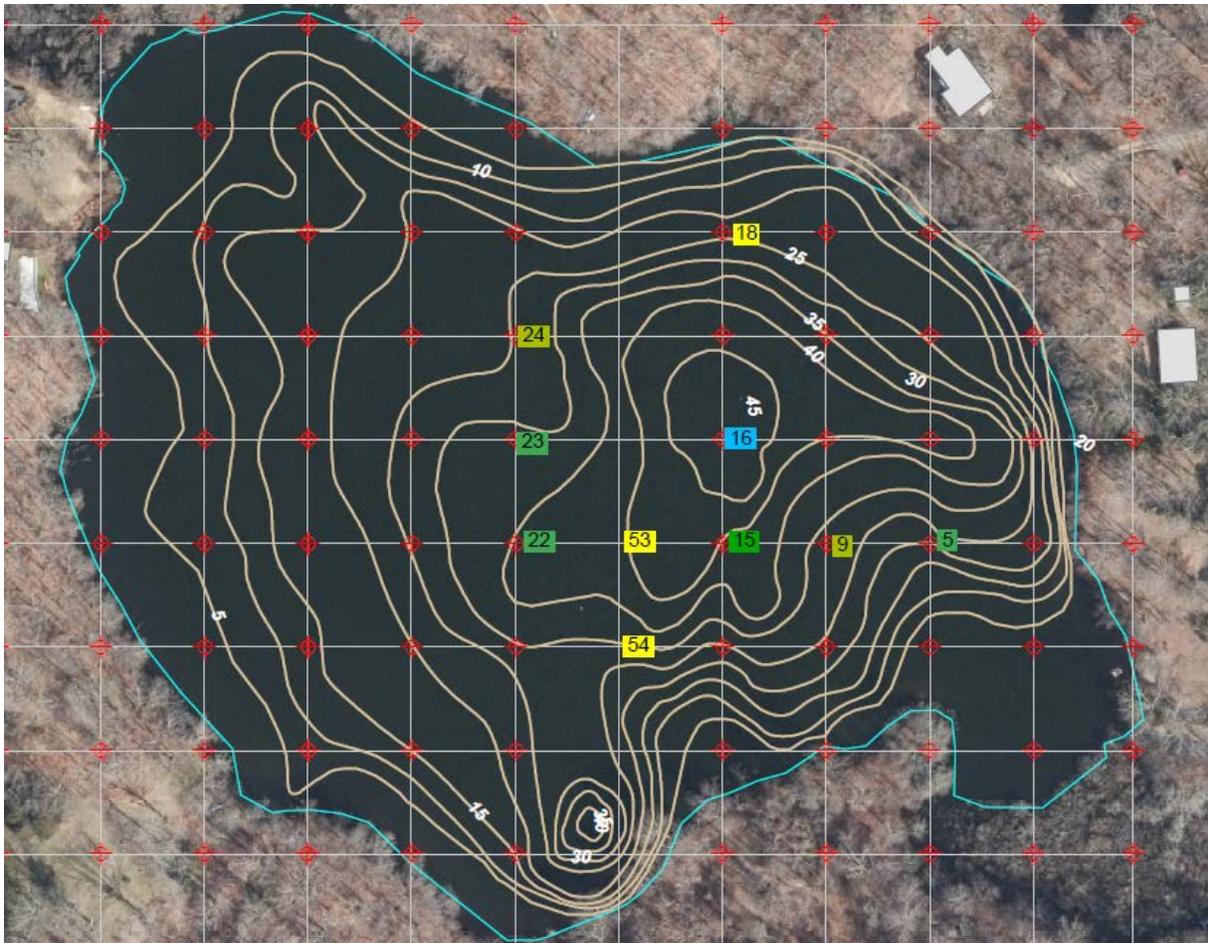


Figure 6-1 Fresh Pond Sampling Location Grid Map

Temperature and dissolved oxygen profiles for the stations and sampling dates are presented in Appendix B.

Temp + DO Profile Sampling Locations				
#	Station ID	Pond Depth (feet)	Lat	Long
1	5	20	41.057000	-72.335061
2	9	30	41.057005	-72.335423
3	15	40	41.057010	-72.335786
4	16	45	41.057285	-72.335779
5	17-18	35	41.057733	-72.335850
6	18	24	41.057834	-72.335765
7	53	40	41.057013	-72.336146
8	54	30	41.056740	-72.336148
9	22	35	41.057021	-72.336511
10	23	30	41.057295	-72.336504
11	24	25	41.057570	-72.336497

Table 6-1 Temperature & DO Sampling Locations & Pond Depth

Representative profiles for Stations 16 (deepest location at 45+ feet) and Station 23 (30 foot depth) for April 30, 2021 are presented on Figure 6-2. Figures 6-3A and 6-3B present Station 16 Temp – DO profiles for June 23 & Sept. 13 and Oct. 8 & Dec. 1,

2021, respectively. Figures 6-4 through 6-7 present results of all stations on a Pond aerial. *(Note: Due to scale, best to view Figures 6-4 through 6-7 in expanded electronic view or print onto 11 x 17 or larger paper.)* Conductivity was typically 200 uS/cm, which indicates moderate dissolved solids concentration as expected for fresh water in noncalcerous soil watersheds.

A Secchi disk is an 8-inch (20 cm) disk with alternating black and white quadrants. It is lowered into the water of a Pond until it can no longer be seen by the observer. The depth of disappearance, called the Secchi depth, is a measure of the transparency of the water. (<https://www.nalms.org/secchidipin/monitoring-methods/the-secchi-disk/what-is-a-secchi-disk/>). Secchi disc measurements were 10 +/- feet on May 21, 2021.

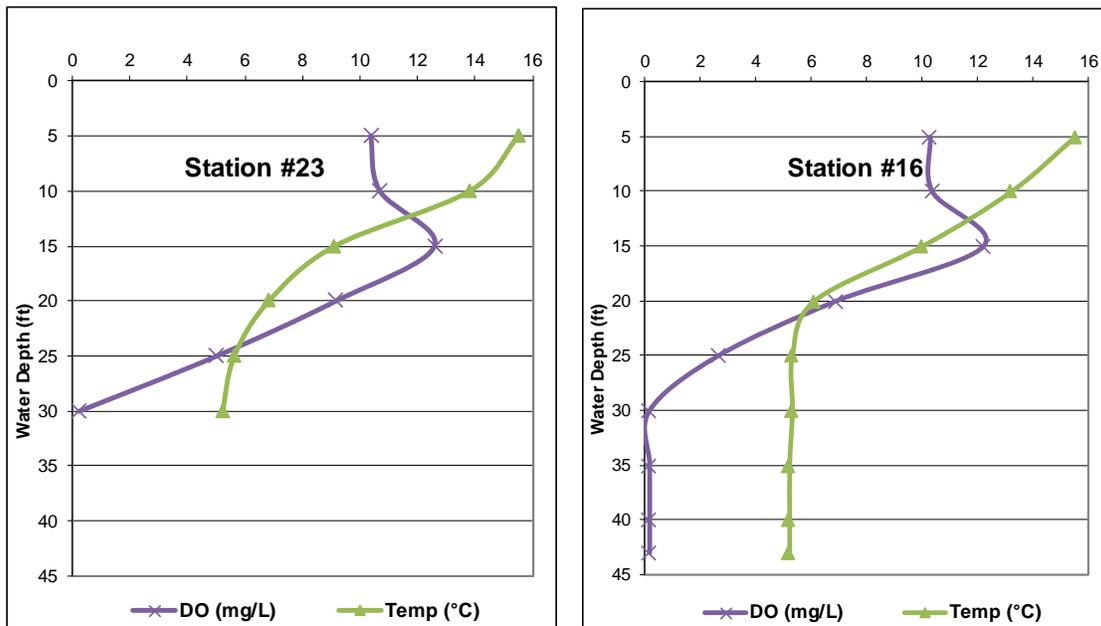
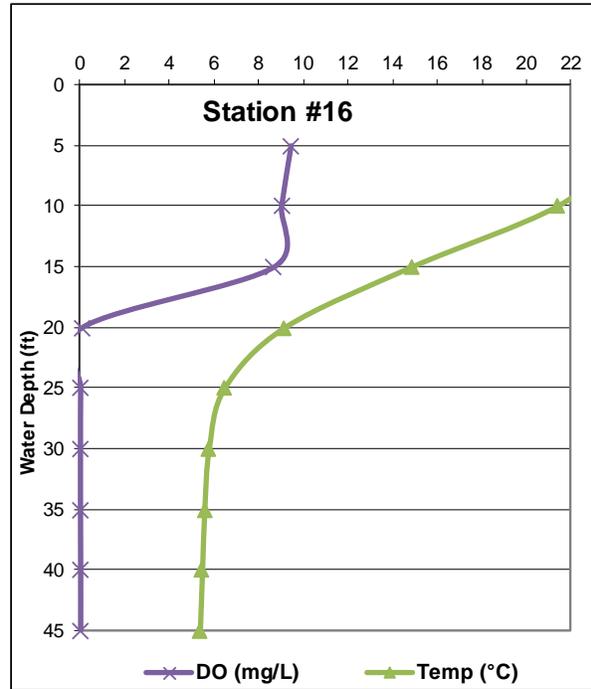


Figure 6-2 Temperature & DO Profiles Stations 16 & 23 – April 30, 2021

Station	16		Date
Bot. Depth (ft)	45		6/23/21
Lat. / Long.	41.057285	-72.335779	
Depth (ft)	Temp (°C)	Cond	DO (mg/L)
5	24.8	206.0	9.48
10	21.4	209.0	9.05
15	14.9	208.0	8.72
20	9.2	215.0	0.09
25	6.5	218.0	0.02
30	5.8	230.0	0.01
35	5.6		0.01
40	5.5	240.0	0.02
45	5.4	250.0	0.02



Station	16		Date
Bot. Depth (ft)	45		9/13/21
Lat. / Long.	41.057285	-72.335779	
Depth (ft)	Temp (°C)	Cond	DO (mg/L)
5	23.8	201.1	7.27
10	23.8	201.1	7.16
15	22.8	203.0	3.56
20	15.6	211.2	3.68
25	8.9	234.4	0.07
30	7.2	244.0	0.03
35	6.3	256.8	0.03
40	6.1	268.1	0.03
45	6.1	275.9	0.03

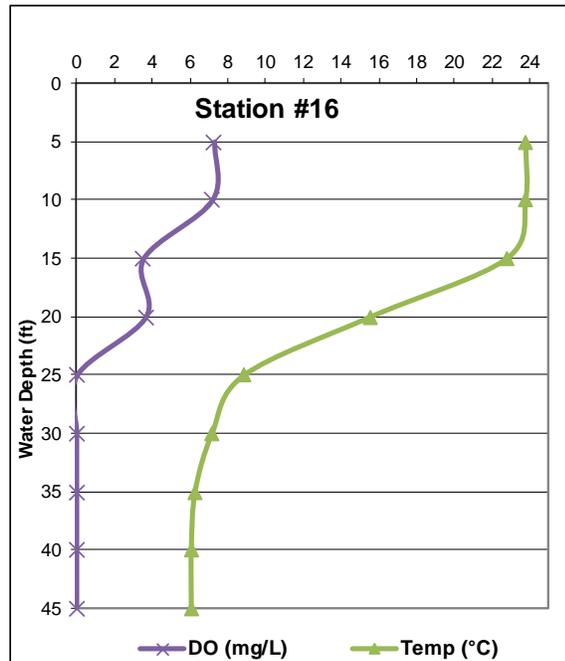
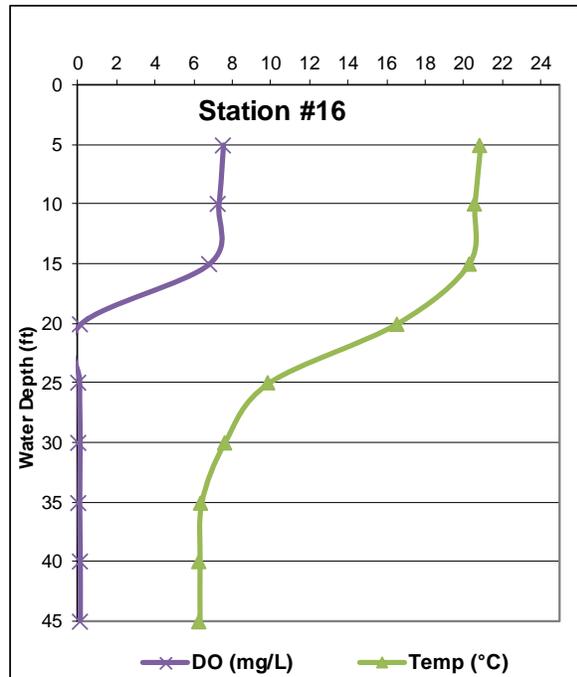


Figure 6-3A Temperature & DO Profiles Stations 16 – June 23 & Sept. 13, 2021

Station	16		Date
Bot. Depth (ft)	45		10/8/21
Lat. / Long.	41.057285	-72.335779	
Depth (ft)	Temp (°C)	Cond	DO (mg/L)
5	20.9	202.0	7.56
10	20.6	202.0	7.32
15	20.3	202.0	6.83
20	16.6	212.0	0.17
25	9.9	236.0	0.07
30	7.6	247.0	0.09
35	6.4	262.0	0.07
40	6.3	276.0	0.10
45	6.3	282.0	0.10



Station	16		Date
Bot. Depth (ft)	45		12/1/21
Lat. / Long.	41.057285	-72.335779	
Depth (ft)	Temp (°C)	Cond	DO (mg/L)
5	7.4	204	7.24
10	7.4	204	7.23
15	7.3	204	7.13
20	7.2	204	6.98
25	7.2	204	6.91
30	7.2	204	6.77
35	7.1	204	6.73
40	7.1	204	6.61
45	7.2	204	0.15

Secchi Disc 5 feet
 1.525 meters

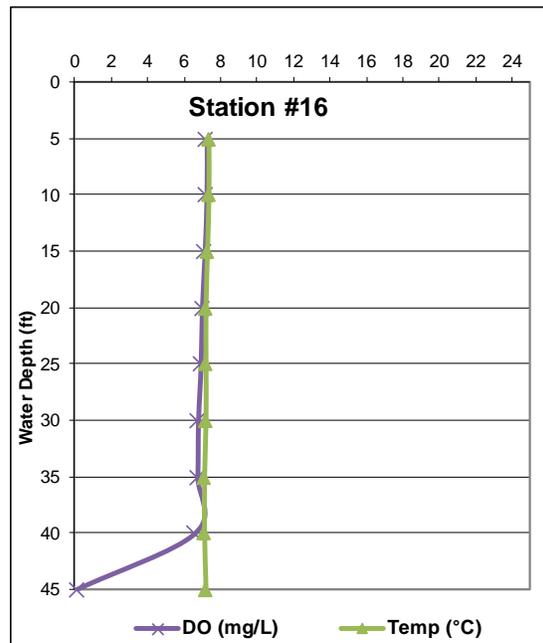


Figure 6-3B Temperature & DO Profiles Stations 16 – Oct. 8 & December 1, 2021

Table 6-2 Secchi Disc Measurements

Secchi Disc Readings		
Date	Meters	Feet
21-May-21	3.54	11.60
17-Jun-21	2.10	6.90
23-Jun-21	1.80	5.90
11-Jul-21	1.83	6.00
13-Sep-21	2.13	7.00
15-Oct-21	3.20	10.50
01-Dec-21	1.52	5.00

Figure 6-8 illustrates continuous monitored temperature profiles at 5-foot intervals at Station 16.

As the Figures illustrate, DO depletion was observed / documented for Pond areas at 20 feet and deeper. According to Table 5-1, Pond area with a depth \geq 20 feet is 280,500 sf (26,100 square meters), 44% of Pond area.

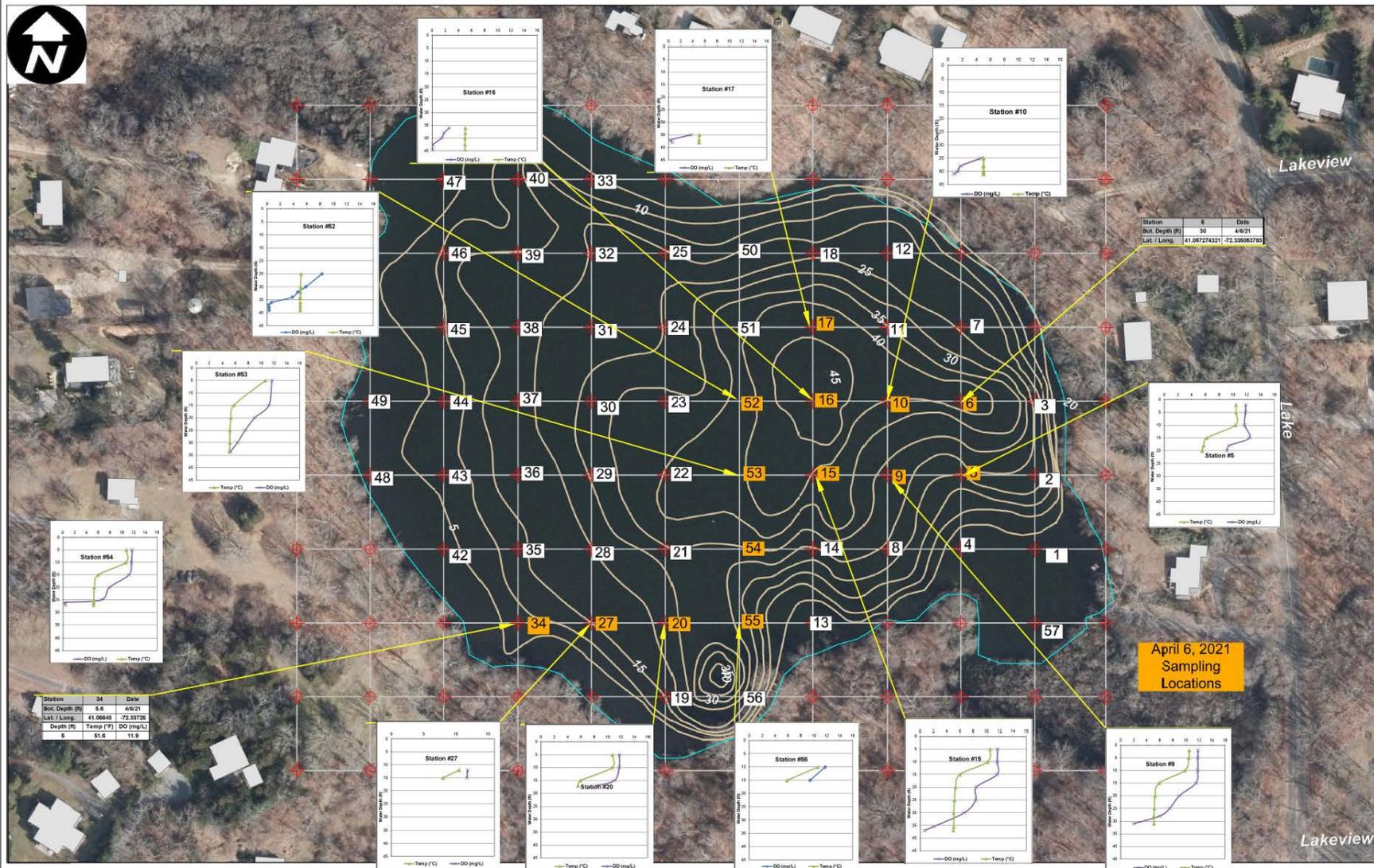


Figure 6-4 Temperature & DO Profiles All Stations – April 6, 2021

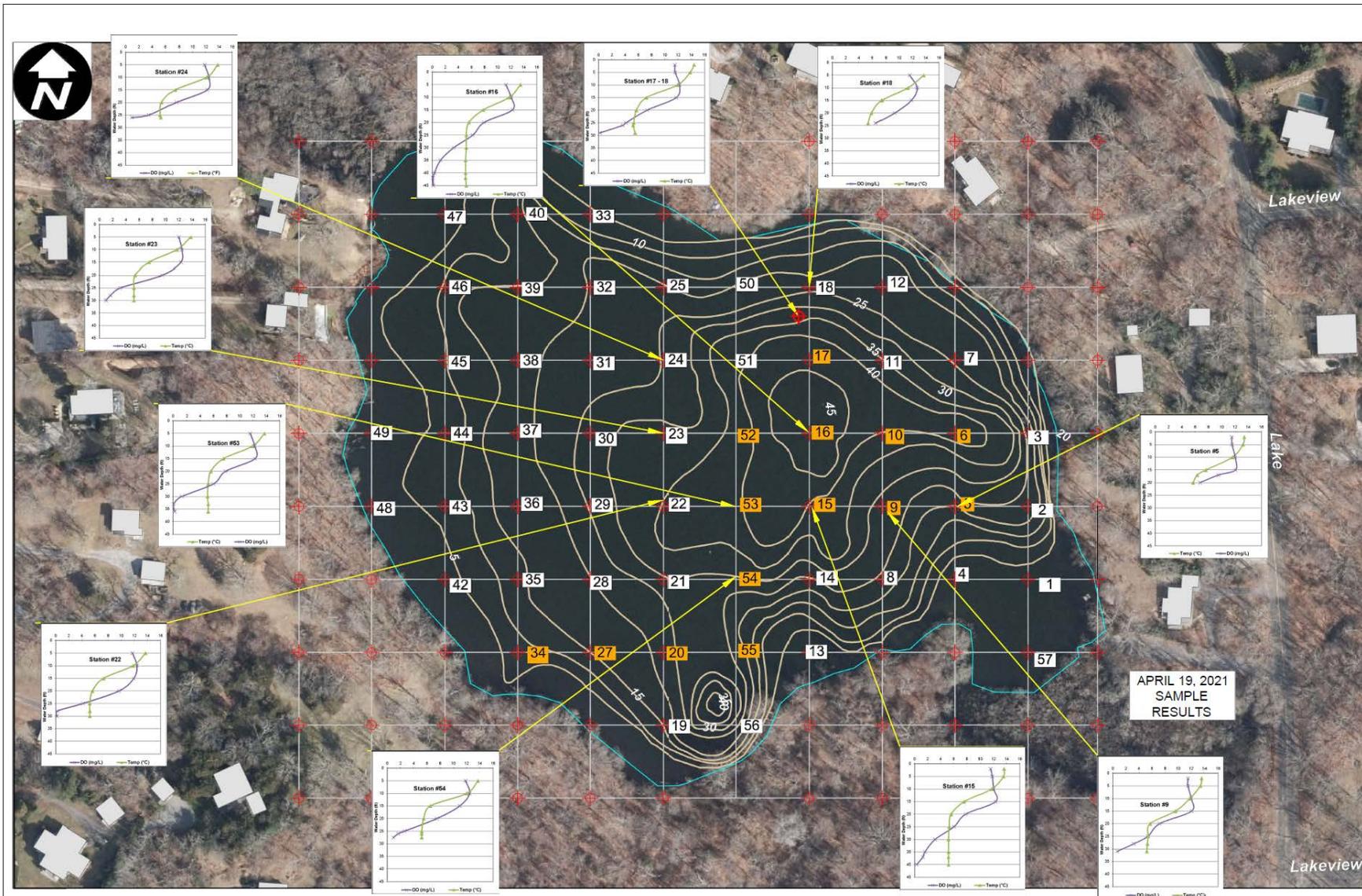


Figure 6-5 Temperature & DO Profiles All Stations – April 19, 2021

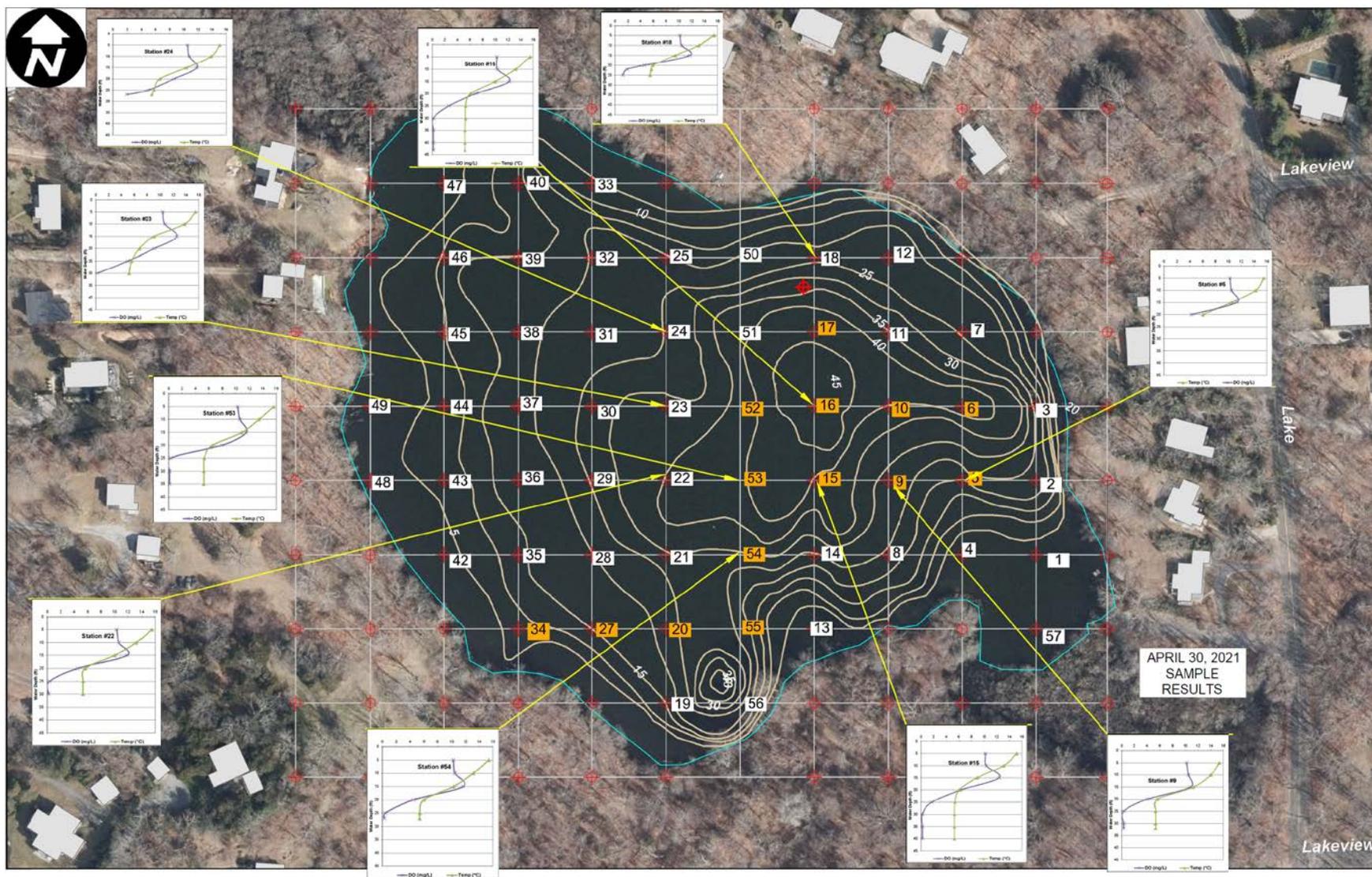


Figure 6-6 Temperature & DO Profiles All Stations – April 30, 2021

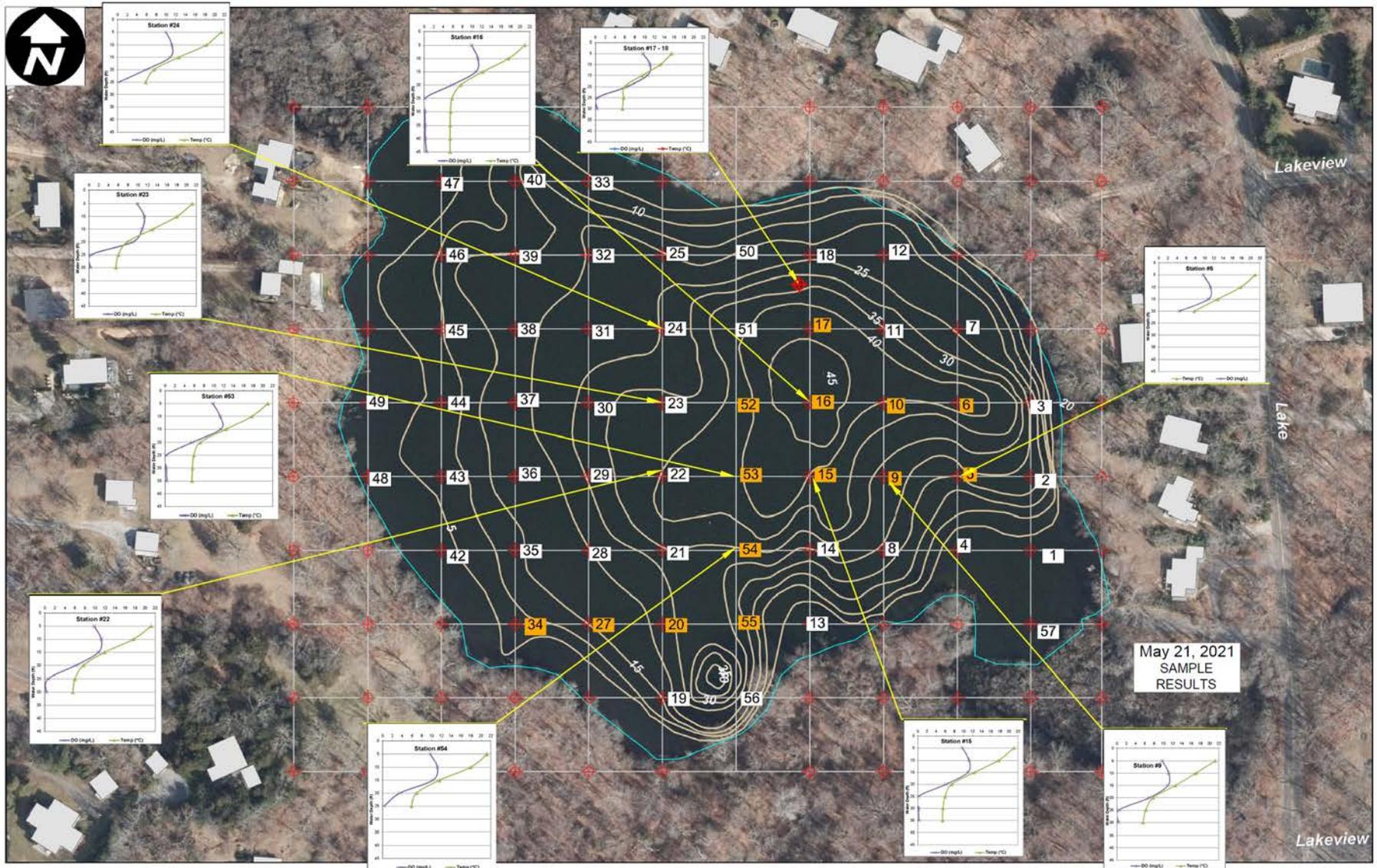


Figure 6-7 Temperature & DO Profiles All Stations – May 21, 2021

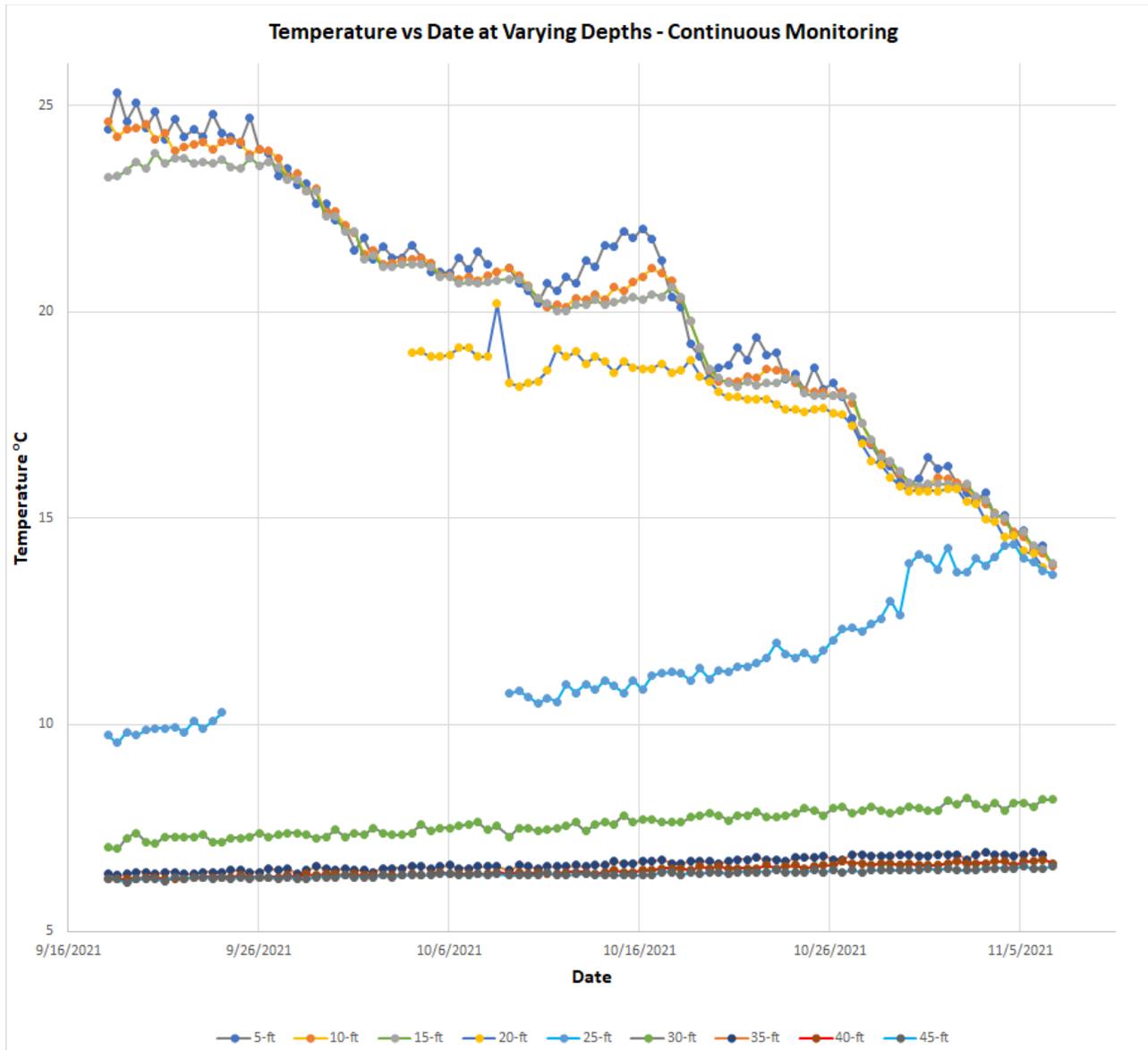


Figure 6-8 Station 16
Temperature – 9 Depths

6.2 HYPOLIMNETIC OXYGEN DEMAND (HOD)

HOD is a combination of oxygen demand from the sediment and demand from the water column, but most oxygen demand for Fresh Pond is from the sediment. The hypolimnion loses oxygen from at least April, with anoxia observed at >30 feet at the start of May and very low oxygen at >20 feet by the end of July. Dissolved oxygen remained substantial at depths of 15 feet through the stratification period in 2021, with a steep decline between 15 and 20 feet. This distribution is consistent with the observed oxygen profiles, but stratification and oxygen loss are occurring earlier than in most lakes. The small surface area with relatively large depth in a sheltered setting is apparently facilitating this process.

Due to the March 29, 2021 project authorization and extremely early Pond DO deficits, the data collection program did not catch profiles with higher oxygen top to bottom of the Pond. Dec. 1, 2021 data showed that the Pond does mix with high DO levels throughout the Pond, except for below 40 feet. Continuous water temperature monitoring devices at various elevations were installed at Station 16 (see Figure 6-8). It is recommended that additional temperature – DO profile(s) should be measured if oxygenation is the preferred solution. These data will provide confidence on estimates of HOD and engineering design criteria of an oxygenation system. However, there is enough data to make estimates of HOD, albeit with the recognition that they are underestimates.

Table 6-3 provides the range of Hypolimnetic Oxygen Demand (HOD) values for Fresh Pond from the data that could be confidently applied. Virtually all had low oxygen in the bottom increment (usually set at 5 ft), and removal of oxygen once it reaches 2 mg/L slows and is non-linear, preventing accurate calculation of the demand. Water shallower than 20 ft is mixing and receiving atmospheric oxygen, so only values between 20 ft and the bottom are useful for HOD calculation. Some oxygen input to deeper water is possible when stratification is not strong, so HOD could be even higher as a function of oxygen being added between measurements. Other factors that affect estimations are change in temperature, as warmer water holds less oxygen and accelerates HOD. Hypolimnion water temperatures during the sampling period were relatively constant at 5.0 to 5.4 °C.

Table 6-3 HOD Estimates

HOD Estimates		4/6-19/21	4/19-30/21
Station	Depth (ft)	HOD (g/m ² /d)	HOD (g/m ² /d)
9	31	0.62	1.56
10	41	1.15	
15	40	0.8	1.57
16	45	1.02	1.27
22	26		1.22
53	36	1.44	0.95
54	28	0.43	0.8
Average	35	0.91	1.23

Typical HOD values are 0.5 (good) to 4 (very bad) g/m²/day. Most Ponds/Lakes do not exceed 2 g/m²/day. The values for Fresh Pond are underestimates; more oxygen would have been removed if it had been there to be removed in the depth increments near the bottom. The 4/30/21 oxygen measurements were <2 mg/L as far as 15 ft above the bottom, so the underestimation may be substantial.

From experience on other Ponds, it is proposed that the actual HOD, with adequate oxygen and with warming temperature, would be twice what was measured, resulting in 2.5 +/- g/m²/day.

Assuming area with HOD is at the 20-foot depth, equating to an area of 26,000 m², see Table 5-1, oxygen demand in the hypolimnion of Fresh Pond would then be would then be 65 kilograms of oxygen/day.

6.3 FRESH POND NUTRIENT DATA

Table 6-4 presents the Nutrient – Water Quality Data at Station 16, with the lab reports presented in Exhibit 1. Surface values for total phosphorus and Total Kjeldahl Nitrogen (TKN) were low to moderate near the surface and increased with depth. Release of P from sediments exposed to anoxic conditions is indicated. Likewise, release of ammonium into low oxygen waters with minimal conversion to nitrate is suggested. While the phosphorus concentrations in deeper water are excessive, they appear to remain there with very little upward transport into the epilimnion through October. The pattern over time suggests that much of the phosphorus released from sediment precipitates out as oxygen returns to deeper water during an extended destratification period, limiting transport of phosphorus into the upper waters. This was fortuitous in 2021 but may not have been the case in all previous years when cyanobacteria blooms were detected. Elevated phosphorus with low nitrate nitrogen concentrations favors cyanobacteria, which unlike other algae, can utilize dissolved nitrogen gas.

Table 6-4 Nutrient – Water Quality Data at Station 16

Fresh Pond Water Quality - May 1, 2021				Fresh Pond Water Quality - Oct. 8, 2021			
Station 16 @ buoy				Station 16 @ buoy			
Depth (ft below surface)	Total Phosphorus (mg/L)	TKN (mg/L)	NO ₂ + NO ₃ as N (mg/L)	Depth (ft below surface)	Total Phosphorus (mg/L)	TKN (mg/L)	NO ₂ + NO ₃ as N (mg/L)
1	0.0298	0.755	0.127	5	0.011	0.745	<0.1
18	0.0691	0.775	0.114	15	0.013	0.584	<0.1
44	0.194	2.19	<0.05	17	0.02	0.546	<0.1
				20	0.054	0.87	<0.1
				45	0.838	5.7	<0.1

Fresh Pond Data Station 16 - July 29, 2021 11:30 am													
Depth	Temp	DO	DO	Conduct.	pH	Chl-a	Turbidity	Alkalinity	Secchi	Total P	TKN	NO ₂ + NO ₃	Iron
feet	°C	mg/l	% Sat	µS/cm	Units	µg/l	NTU	mg/l	meters	mg/l	mg/l	mg/l	mg/l
0.7	27.6	8.1	104.1	173	7.6	2.3	1.2	13.2	3.2				
5.0	27.4	8.2	104.9	172	7.6	3.0	1.1			0.015	0.643	<0.05	
10.0	26.2	7.9	99.0	172	7.6	4.6	1.2			0.036			
15.0	19.1	10.2	112.1	173	7.5	6.7	1.3			0.026			
20.0	12.7	0.3	2.5	173	7.1	31.7	3.0			0.111	1.700	<0.05	
25.0	7.8	0.1	1.0	185	7.0	12.8	3.1	20.7		0.101			0.25
30.0	6.4	0.0	0.0	192	6.5	10.5	3.0			0.194			1.54
35.0	6.1	0.0	0.0	199	6.2	10.2	2.8			0.311			2.06
40.0	5.9	0.0	0.0	209	6.1	10.1	2.8			0.482			3.00
45.0	5.9	0.0	0.0	211	5.9	10.1	2.9	32.8		0.574	5.090	<0.05	3.21

Fresh Pond Data Station 16 - Dec. 1, 2021				
Depth	Total P	TKN	NO ₂ + NO ₃	Iron
feet	mg/l	mg/l	mg/l	mg/l
5.0	0.055			
10.0	0.058			
15.0	0.051			
20.0	0.046			
25.0	0.047			
30.0	0.052	0.853	0.026	
35.0	0.040			0.4
40.0	0.049	0.825	0.027	
45.0				0.296

The July 29, 2021 chlorophyll a data at the 20 foot depth and below on Table 6-4 illustrates the algae development near the thermocline and below where high concentrations of phosphorus exist. The Secchi depth on July 29, 2021 was 3.2 m. The point at which light starts to seriously limit algal growth is two (2) times Secchi, which is 6.4 m or 21 ft. Consequently, the 20 foot depth is right where algae want to be to get P from below and enough light from above. While this layer of algae could include several species, from the algae data it could very well be *Planktothrix*, an often toxic cyanobacterium that tends to grow at the thermocline and was found in the sample from the upper waters of Fresh Pond on July 29, 2021, just not at high levels. Some of the Chrysophytes, like *Dinobryon* from that date, also like that depth zone and are motile so they can hold at that position. However, it is strongly suspected that the chl-a data at the 20 foot depth is a thin layer of *Planktothrix*. There are multiple potential explanations for higher chl-a at deeper than 20 feet. Many of the cyanobacteria known from Fresh Pond have gas pockets in cells that they can decrease or increase, changing buoyancy to rise or descend in the water column. Some are known to go deeper for more P then rise for more light, so there could be live algae in the deeper zone temporarily. The data may reflect *Planktothrix* going up and down, but there were no algae samples from deeper water to identify algae type. Non-living organic matter settling through that zone sometimes fluoresces like chl-a, but that happens mostly right at the bottom. The strong stratification in 2021 seems to have saved Fresh Pond from a surface bloom.

6.4 ASSESSMENT OF INTERNAL LOADING POTENTIAL

Water was tested for Total Phosphorus (P), nitrate-nitrite and Total Kjeldahl Nitrogen (TKN) at several depths in May, July and October 2021. Assigning the value to the corresponding water layers (5-foot increments) and interpolating for layers in between, the concentrations and masses are generated and presented on Table 6-5. The surface concentration was considerably lower than the bottom concentration for each date and declined over time while the bottom concentration increased. The overall mass of P in Fresh Pond increased between May and October, consistent with internal P loading as a dominant P source, but an overwhelming majority of the increase remained in the hypolimnion. Very little of the accumulated P made it into shallow water between May and early October, an indication of very strong thermal stratification and separation of the water layers physically and chemically.

Table 6-5 Phosphorus Concentrations and Mass in Fresh Pond in 2021

		Date	5/1/21	Date	7/29/21	Date	10/8/21	Date	12/1/21
Depth interval (ft)	Layer vol (L)	P conc (mg/L)	P mass (kg)						
0-5	79,893,349	0.030	2.38	0.015	1.19	0.011	0.88	0.055	4.39
5-10	65,123,437	0.030	1.94	0.036	2.35	0.013	0.85	0.058	3.78
10-15	55,965,394	0.030	1.67	0.026	1.43	0.020	1.12	0.051	2.85
15-20	45,728,131	0.049	2.26	0.111	5.08	0.054	2.47	0.046	2.10
20-25	33,702,641	0.069	2.33	0.101	3.40	0.211	7.10	0.047	1.58
25-30	23,496,040	0.100	2.36	0.194	4.56	0.368	8.64	0.052	1.22
30-35	15,879,795	0.132	2.09	0.311	4.94	0.524	8.33	0.040	0.64
35-40	9,343,149	0.163	1.52	0.482	4.50	0.681	6.36	0.049	0.46
40-47	4,249,123	0.194	0.82	0.574	2.44	0.838	3.56	0.049	0.21
All		0.089	17.37	0.206	29.89	0.302	39.31	0.050	17.24
<20		0.035	8.25	0.047	10.04	0.025	5.31	0.053	13.13
>20		0.132	9.12	0.332	19.84	0.524	33.99	0.047	4.11

The increase in P in the hypolimnion was about 25 kg between May 1 and October 8, 2021. There was some internal loading earlier than the start of May, suggested by both low oxygen and the increased P concentration in deep water at the time of May sampling. When the system is well mixed the surface and bottom P concentrations will be very similar, suggesting that about 100 ug/L of P had accumulated in the bottom water prior to the start of assessment, equating to a mass of approximately 7 kg. There could be additional internal loading after the last sampling on October 8th, but an internal load on the order of 32 kg/year is estimated for Fresh Pond from 2021 data.

A similar exercise using total nitrogen (nitrate plus Total Kjeldahl N) allows estimation of the N mass in Fresh Pond (Table 6-6). Nitrate concentrations were low at all times and undetectable by mid-summer, so the table really reflects TKN, which is the organic N form plus ammonia. There is a substantial increase in N between the start of May and end of July, but a slight decline in August through September as indicated by early October data. Deep accumulation of N is mainly as ammonium, but there is processing of nitrate and organic N as it enters the pond, and the situation is not as straightforward as for P.

The ratio of N to P is a useful indicator of which of these nutrients will limit productivity in the pond. Calculated ratios of N to P for Fresh Pond (Table 6-7) indicate that P is limiting in the surface water (ratio >10:1) at all times and in the epilimnion and in the hypolimnion in the spring, but deep-water ratios transition to N limitation (<10:1) over the course of the summer. N limitation favors cyanobacteria, many of which can utilize dissolved N gas not available to other algae. For Fresh Pond in 2021, the conditions favoring cyanobacteria only existed at depths too deep to provide enough light for cyanobacteria to grow, at least into October. In recent years with cyanobacteria blooms (2019, 2020) there may have been mixing events that brought more P into upper waters, lowering the N to P ratio. Alternatively, enough light may have penetrated to a depth with a low N to P ratio, allowing cyanobacteria to grow at the sediment-water interface or near the boundary of the upper and lower water layers then rise to cause blooms.

Table 6-6 Nitrogen Concentrations and Mass in Fresh Pond in 2021

		Date	5/1/21	Date	7/29/21	Date	10/8/21
Depth interval	Layer vol (L)	N conc (mg/L)	N mass (kg)	N conc (mg/L)	N mass (kg)	N conc (mg/L)	N mass (kg)
0-5	79,893,349	0.882	70.47	0.668	53.37	0.745	59.52
5-10	65,123,437	0.884	57.57	1.020	66.43	0.584	38.03
10-15	55,965,394	0.876	49.03	1.372	76.78	0.546	30.56
15-20	45,728,131	0.878	40.15	1.725	78.88	0.870	39.78
20-25	33,702,641	0.889	29.96	2.403	80.99	1.836	61.88
25-30	23,496,040	1.221	28.69	3.081	72.39	2.802	65.84
30-35	15,879,795	1.553	24.66	3.759	59.69	3.768	59.84
35-40	9,343,149	1.885	17.61	4.437	41.46	4.734	44.23
40-47	4,249,123	2.215	9.41	5.115	21.73	5.700	24.22
All		1.254	327.55	2.620	551.72	2.398	423.89
<20		0.880	217.21	1.196	275.46	0.686	167.89
>20		1.553	110.34	3.759	276.26	3.768	256.00

Based on the mass of P accumulating in the hypolimnion, the rate of P release from sediment was estimated at 4.6 mg/m²/day for the May through July period and 7.8 mg/m²/day for the August through September period. These are rates well within the typical range observed in ponds with low oxygen in deep water. The average for the entire period covered by sampling was just under 6 mg/m²/day, very close to the average reported for such waterbodies. The difference for Fresh Pond is that this release starts earlier and lasts longer than for many other lakes/ponds that have lower depth to area ratios.

Table 6-7 Nitrogen to Phosphorus Ratios (mass to mass) in Fresh Pond in 2021

Depth (ft)	5/1/21	7/29/21	10/8/21
0-5	29.60	44.83	67.73
5-10	29.66	28.25	44.92
10-15	29.40	53.80	27.30
15-20	17.76	15.54	16.11
20-25	12.87	23.79	8.71
25-30	12.17	15.88	7.62
30-35	11.80	12.09	7.19
35-40	11.58	9.21	6.95
40-47	11.42	8.91	6.80
All	18.472	23.590	21.481
<20	26.603	35.608	39.015
>20	11.967	13.975	7.454

6.5 SEDIMENT AREAL EXTENT, QUALITY AND P RELEASE

Figures 6-9 and 6-10 present maps of sediment sampling locations and sediment types, respectively. Total P is the sum of all fractions minus Biogenic P, which is part of the Organic P fraction.

Five sediment samples were collected from Fresh Pond on May 1, 2021, at varying depths and tested for solids content and various P fractions (Table 6-8). A duplicate was collected at the deepest station (FP-1) and the results were very similar, so those data were averaged for further calculations. Table 6-9 presents Sediment Features Relating to Internal Phosphorus Loading in Fresh Pond.

The field notes indicate that the deepest 3 stations (FP-1, 2 and 3, all from sediment under water at least 30 feet deep) had brown muck with black streaking throughout the core sample representing the upper 4 inches (10 cm) of the sediment. The sample from FP-4, from 24.5 feet of water depth, had a 1-inch layer of muck over sandy sediment. It is not known if this is the typical depth of organic sediment at that water depth, but it is apparent that the muck layer is not deep everywhere. The sample from FP-5 contained what was termed peaty muck, having a lesser level of decomposition and more large particles of vegetation. That sample was collected from a water depth of 17.2 feet, in the transition zone from muck to sand dominance in the substrate.

The iron-bound P (Fe-P) content was highest in deeper water, a typical situation, but the lowest Fe-P was at FP-4, at 24.5 feet of water depth and the Fe-P at FP-5 at 17.2 feet of water depth was slightly higher. As the solids content also varies, the P concentration is not the best feature for comparison. Calculation of the mass of Fe-P in the upper 4 inches of sediment (Table 6-8) demonstrates the same pattern, but except for FP-4 (2.8 g/m²), the stations all had fairly similar P mass (4.1 to 5.0 g/m²). Values of <0.5 g/m² are considered low while values >2 are considered to represent a distinct threat of internal loading and values >5 g/m² are considered extreme. The potential for P loading from sediments exposed to anoxia in Fresh Pond is very high.

The actual amount of P loaded from sediments exposed to anoxia is mostly a function of the duration of exposure. For most lakes with a summer of anoxia (up to 100 days) over some portion of the bottom, about 10% of the Fe-P in the upper 4 inches of sediment is released on average. For Fresh Pond, with low oxygen from sometime in April into October, the duration of anoxia is at least twice that of many other waterbodies and the release might be 20% or more.

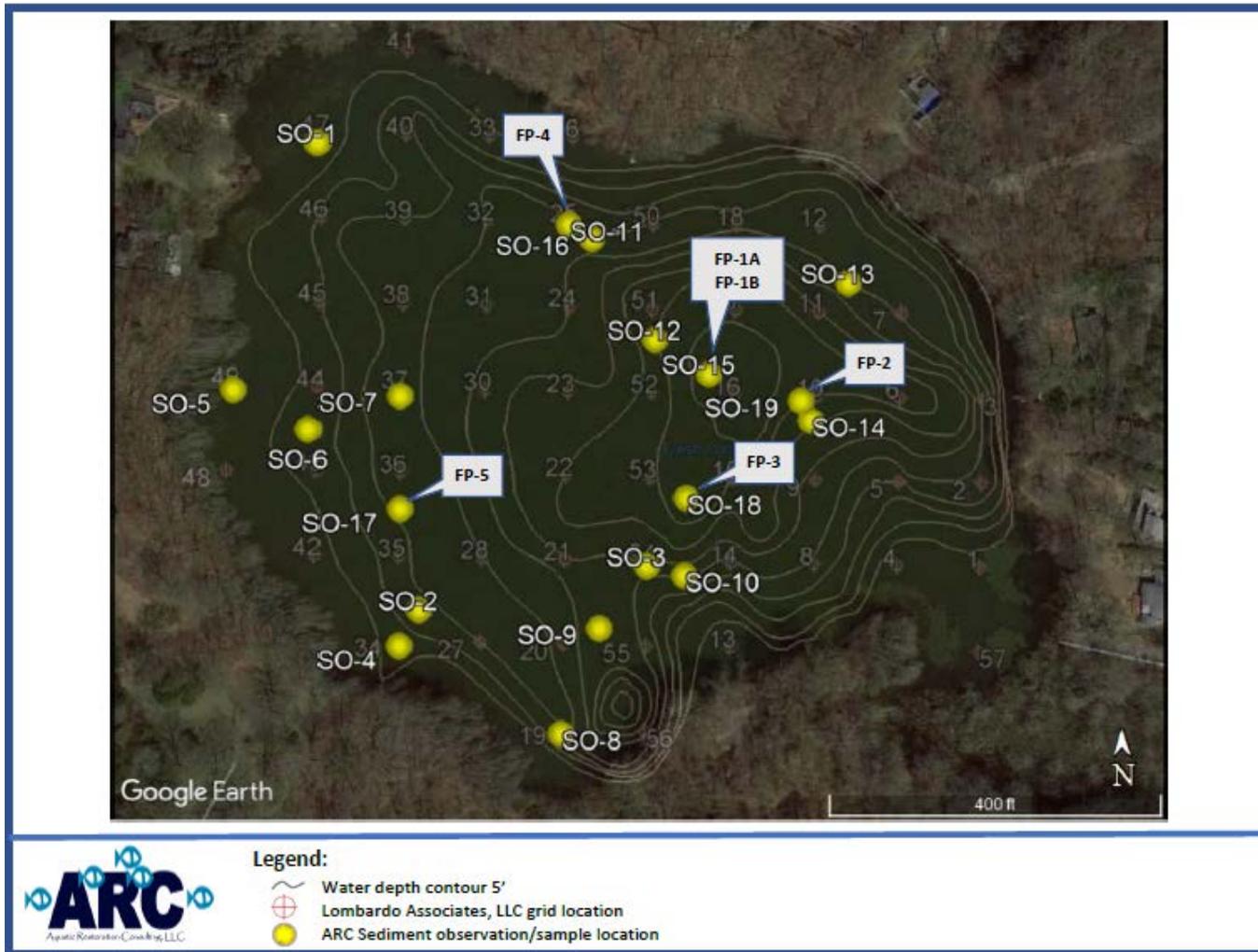


Figure 6-9 Sediment Sampling Locations Map

Table 6-8 Sediment Phosphorus Fractions

	% solids	% Water	Total	Loosely Bound	Iron Bound	Al Bound	Biogenic	Calcium Bound	Organic	as % of Total		
										Iron Bound	Organic	Iron + Organic
FP-1A	7.12%	92.9%	2,582	<2.00	623	1,027	676	63.8	868	24%	34%	58%
FP-1B	7.17%	92.8%	2,683	<2.00	649	1,014	767	57.3	962	24%	36%	60%
FP-2	7.87%	92.10%	2,235	<2.00	526	874	622	55.2	780	24%	35%	58%
FP-3	8.47%	91.50%	2,003	<2.00	443	832	526	47.5	681	22%	34%	56%
FP-4	42.30%	57.70%	307	<2.00	44	118	102	9.59	136	14%	44%	58%
FP-5	14.40%	85.60%	1,082	<2.00	269	407	261	35.2	371	25%	34%	59%

Sediment (dry weight basis) Phosphorus Bound (mg/kg)

Table 6-9 Sediment Features Relating to Internal Phosphorus Loading in Fresh Pond

Lake or Area	LAKE or AREA					
	FP 1AB	FP 2	FP 3	FP 4	FP 5	Total
Depth (ft)	44.6	42.3	35.2	24.5	17.2	
Represented Depth Zone (ft)	43-47	40-43	30-40	20-30	15-20	
Mean Available Sediment P (mg/kg DW)	636	526	443	44	269	
Target Depth of Sediment to be Addressed (cm)	10	10	10	10	10	
Volume of Sediment to be Addressed per m2 (m3)	0.100	0.100	0.100	0.100	0.100	
Specific Gravity of Sediment	1.10	1.10	1.10	1.50	1.10	
Percent Solids (as a fraction)	0.07	0.08	0.08	0.42	0.14	
Mass of Sediment to be Addressed (kg/m2)	7.9	8.7	9.3	63.5	15.8	
Mass of P to be Addressed (g/m2)	5.00	4.55	4.13	2.76	4.26	
Target Area (ac)	0.50	0.50	2.12	3.31	1.95	8.4
Target Area (m2)	2024	2024	8583	13401	7895	33927
Total Fe-P (g)	10126	9218	35426	36987	33639	125396
Lake Volume (m3)	333381	333381	333381	333381	333381	
Potential increase in P with 10% release (ug/L)	3.0	2.8	10.6	11.1	10.1	38
Potential increase in P with 20% release (ug/L)	6.1	5.5	21.3	22.2	20.2	75

Total P is the sum of all fractions minus Biogenic P, which is part of the Organic P fraction. The iron bound and organic biogenic phosphorus mass is the P that is could be released during anaerobic conditions. The amount released will relate to the mass of available P present and the duration of exposure to low oxygen, with the Fresh Pond case suggesting an annual release of >20% of the available P.

Based on the sediment data, Appendix C, there are about 125.4 kg of P in the sediment exposed to anoxia, suggesting a release of about 25 kg per year at 20%. That would increase the overall P concentration of the pond by 75 ug/L, but the change in the volume weighted P concentration is actually higher, suggesting that even more than 20% of the P in the upper 4 inches of sediment is being released. At 25% release the internal P load would be 31.4 kg/yr, a close match for the observed P accumulation in the hypolimnion.

Release of sediment P is not usually constant, as longer exposure to anoxia drives the redox potential lower and increases the rate of P release. As the area exposed to anoxia increases over the course of stratification, the deepest area will be exposed the longest and have the highest average release rate. Using the areas associated with defined depth layers, duration of low oxygen exposure from actual data, and assigning P release rates based on the actual data for Fresh Pond, a likely internal P load of 31.7 kg/yr (Table 6-10) is calculated, similar to anticipated sediment release as a percent of the total reserves and very close to the P mass change over 2021 in the Pond.

Table 6-10 Estimated Phosphorus Load Based on Progressive Sediment Exposure to Anoxia

Depth (ft)	Area (ac)	Avg P release (mg/m ² /d)	Duration of anoxic exposure (days)	P load (kg)
40+	1.00	7.5	210	6.4
30-40	2.13	6.5	180	10.0
20-30	3.31	5.5	150	11.0
15-20	1.96	4.5	120	4.3
Total	8.40			31.7

6.6 DATA COLLECTED BY FRESH POND ASSOCIATION & OTHERS

The Fresh Pond Neighborhood Association (FPNA) has participated in the NYSDEC Citizens Statewide Lake Assessment Program (CSLAP) in which NYSDEC performs the laboratory analysis for volunteer collected Pond samples at near surface and deep water locations. 2018 through 2020 Pond water quality data and Reports are presented in Appendix D with Tables 6-11 through 6-14 presenting the 2018, 2019 and 2020 CSLAP Pond water quality and HAB data, respectively. Sampling location is at Pond buoy which is at the deepest Pond depth adjacent to site 16 on Figure 6-3. Surface and deep sampling depths are 1.5 feet and 45 feet (1.5 feet off bottom) below the Pond surface, respectively. Shoreline algae analysis was also performed. NYS DEC confirmed HAB at Fresh Pond based upon July 8, 2019 sampling. "The results from the shoreline bloom sample on 7/8 confirm the presence of a cyanobacteria HAB in Fresh Pond (Suffolk Co.) based on blue-green chlorophyll a level of 115.75 µg/L (above the DEC Confirmed Bloom threshold of 25 µg/L) and a microscopic analysis of Microcystis, Lyngbya, filamentous green algae, unicellular non-colonial green algae. Appendix D also contains the DEC assessment of Fresh Pond which states that it is impaired for secondary contact recreation <https://gisservices.dec.ny.gov/gis/diil/>.

Appendix E contains the results of 2021 Fresh Pond phytoplankton species, their density and biomass as determined by Dr. Ken Wagner based upon samples collected by Peter Grand.

Together, the accumulated algal data suggests distinct potential for cyanobacteria blooms and related toxicity, but not with any degree of predictability among years. The strength of stratification appears to be a dominant factor, with more strongly stratified conditions keeping P released from sediment in water deep enough to limit cyanobacteria production. However, any mixing event or deeper penetration of light can promote cyanobacteria production and dominance, leading to unhealthy conditions in Fresh Pond. Given relatively low P concentrations in surface waters, it is likely that most cyanobacteria blooms are forming at the sediment-water interface in water of intermediate depth (20-30 ft) or at the thermocline (15-20 ft) and then moving upward by formation of gas pockets in cells.

This ecological strategy allows cyanobacteria to take advantage of available P at depths with just enough light to allow survival, then to float upward with excess P in cells and enjoy expanded growth closer to the surface with more light. Such blooms tend not to last more than a couple of weeks, but can be sequential such that different species succeed each other in bloom formation. The alternative mode is for cyanobacteria to be present at lower levels in surface water or near the thermocline, then take advantage of increased P when mixing events occur. Both are possible mechanisms in Fresh Pond.

Table 6-11 2018 CSLAP Fresh Pond Data

Fresh Pond Water Quality - 2018 CSLAP								
Date	10-Jun	24-Jun	8-Jul	22-Jul	29-Jul	12-Aug	26-Aug	9-Sep
Clarity (m)	2.2	2.3	3.0	3.0	2.7	2.4	1.3	2.2
Surface TP (mg/L)	0.030	0.025	0.028	0.010	0.018	0.016	0.022	0.021
Surface TDP (mg/L)	0.008	0.019	0.023	0.011	0.007	0.007	0.016	0.006
Deep TP (mg/L)	0.377	0.664	0.462	0.566	0.682	0.638	0.769	0.460
TN (mg/L)	0.750	0.637	1.010		0.606	0.648	0.818	1.03
TDN (mg/L)	0.640	0.681	0.686		0.558	0.505	0.651	0.936
Deep / Surface NH4	58		99	37	30	608	119	58
TN/TP	25	25	36		34	41	37	49
pH	7.2	8.0	7.0	7.2	7.2	7.0	8.5	6.8
Chl a (ug/L)		8.7		5.0000	2.4	4.8	26.9	7.1
Upper Temp (°C)	23	22	27	27	29	29	27	24
Lower Temp (°C)	8	8	9	9	9	9	10	9

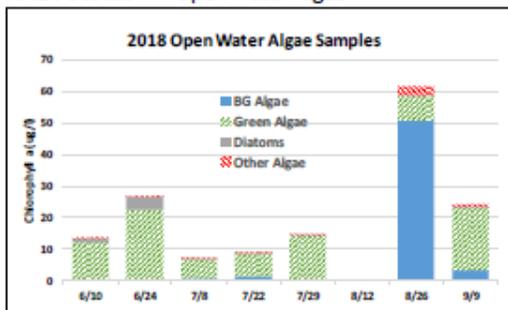
Shoreline bloom and HABs notifications

Date of first listing	Date of last listing	# weeks on the DEC notification list	# Weeks with updates
7/13/2018	9/7/2018	5	3

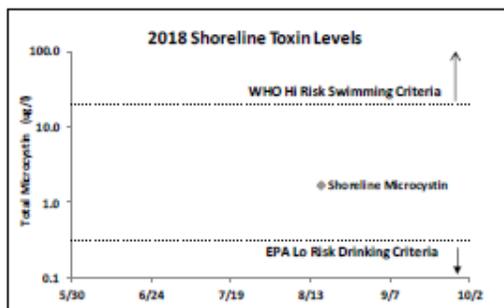
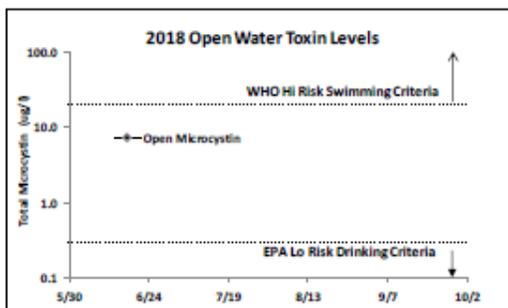
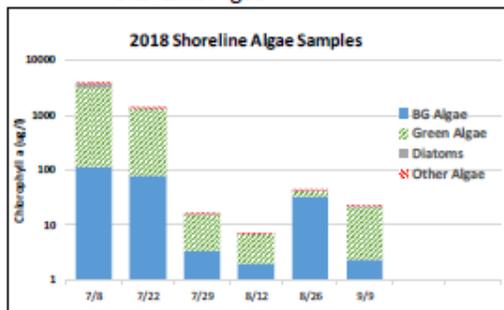
Shoreline HAB Sample Dates 2018

HAB Indicators	HAB criteria	7/8/2018	7/22/2018	7/29/2018	8/12/2018	8/26/2018	9/9/2018
BGA	25 - 30 ug/L	115.8	80.5	3.3	2.0	33.5	2.3
microcystin	20 ug/L	ND	ND	ND	ND	ND	ND
anatoxin - a	4 ug/L						

HABs Status Open water Algae



Shoreline Algae



BGA = Blue Green Algae

Table 6-12 2019 CSLAP Fresh Pond Data

Fresh Pond Water Quality - 2019 CSLAP								
Date	16-Jun	30-Jun	14-Jul	28-Jul	11-Aug	25-Aug	8-Sep	23-Sep
Clarity (m)	2.6	2.8	2.6	2.8	2.2	1.7	1.6	1.9
Surface TP (mg/L)								.01-.02
Surface TDP (mg/L)								<0.01
Deep TP (mg/L)							>0.02	>0.02
Deep TDP (mg/L)							<0.01	>0.02
TN (mg/L)	0.626	0.53		0.442	0.506	0.779	0.627	0.558
TDN (mg/L)	0.492	0.445	0.443	0.441	0.461	0.515	0.504	0.391
Deep / Surface NH4	26	28	61	201	173	50	56	167
Chl a (ug/L)	9.8	0.4	4.7	2.8	5.9	10.6		3.5
Upper Temp (°C)	22	24	29	28	27	25	22	23
Lower Temp (°C)	8	11	10	11	19	9	14	9

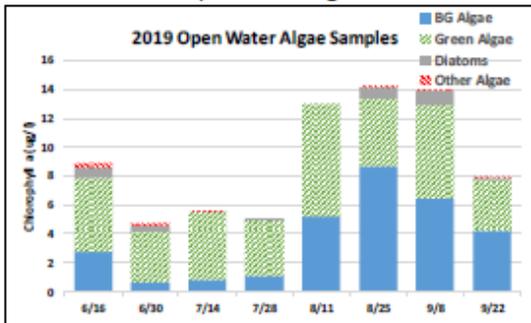
Shoreline bloom and HABs notifications

Date of first listing	Date of last listing
6/16/2019	9/22/2019

Shoreline HAB Sample Dates 2019

HAB Indicators	HAB criteria	6/16	6/30	7/14	7/28	8/11	8/18	9/8	9/22
BGA	25 - 30 ug/L	3268.3	0.0	18.1	60.5	1580.0	1056.5	7.6	611.2
Microcystin	20 ug/L	5.6	0.3	0.3	0.8	12.3	39.3	23.6	75.0
Microscopy	Dominant	filamentous green algae	filamentous green algae	Oedogonium		filamentous green algae, Microcystis	Planktothrix, Woronchinia	Microcystis, Ceratium	filamentous green algae

HABs Status Open water Algae



Shoreline Algae

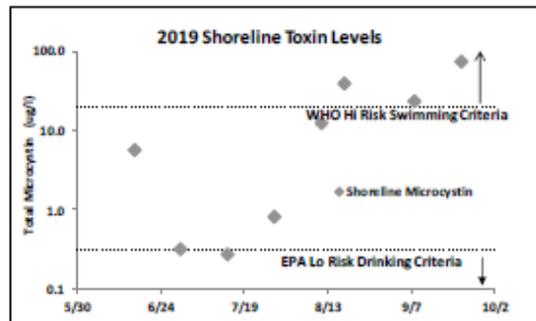
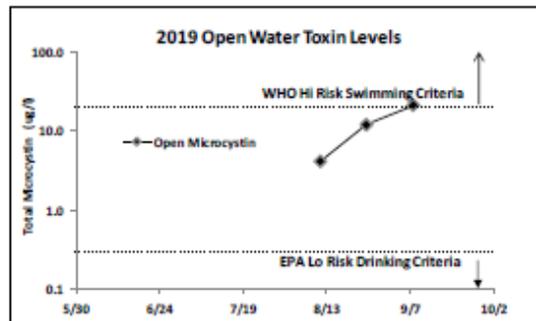
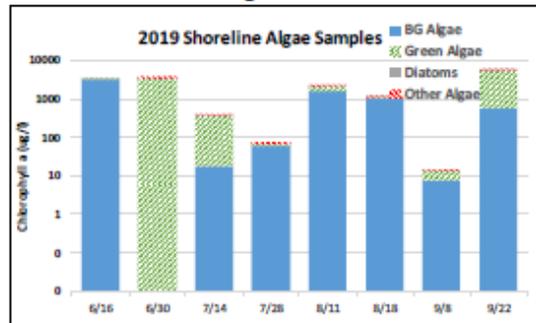


Table 6-13 2020 CSLAP Fresh Pond Data

Fresh Pond Water Quality - 2020 CSLAP								
Date	7-Jun	21-Jun	5-Jul	19-Jul	2-Aug	16-Aug	30-Aug	3-Sep
Clarity (m)	3.5	2.6	1.4	1.0	2.0	1.0	2.0	2.0
Surface TP (mg/L)	0.025	0.0254	0.025	0.035	0.026	0.018	0.018	0.022
Surface TDP (mg/L)	0.017	0.009	0.006	0.018	0.007	0.009	0.004	0.012
Deep TP (mg/L)	0.406	0.396	0.401	0.091	0.531	0.064	0.411	0.651
Deep TDP (mg/L)	0.046	0.02	0.035	0.02	0.016	0.022	0.007	0.035
TN (mg/L)	0.645	0.622	0.65	0.9	0.697	0.851	0.755	0.635
TDN (mg/L)	0.527	0.486	0.629	0.844		0.615	0.623	0.527
TN/TP	26	24	26	26	27	47	42	29
Surface NH ₃	0.022		0.025	0.021	0.019	0.021	0.032	0.022
Deep NH ₃	1.88		0.443	2.99	3.33		3.96	
Chl a (ug/L)	2	0.4	5	5.7	10.1		8.7	
pH	7.4	7.8	7.3	9.2	7.5	7.9	7.6	7.6
Upper Temp (°C)	23	25	27	28	28	26	26	24
Lower Temp (°C)	8	8	14	22	10	8	9	9

NYHABs notifications

Were there any reported HABs this season? **Yes.**

Date of First Listing	Date of Last Listing	Number of Reports
07/05/2020	08/30/2020	55

Shoreline HAB Sample Dates 2020

There were no shoreline HAB samples taken this season.

Open Water Algae

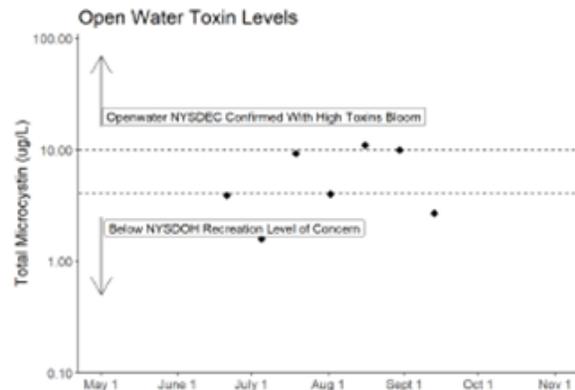
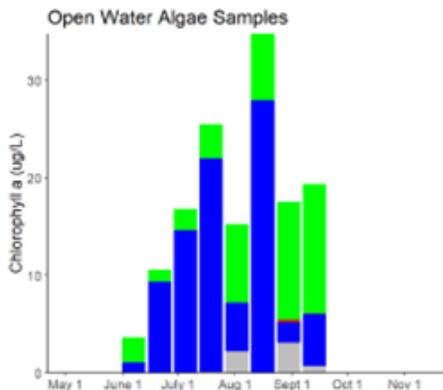


Table 6-14 Archived Fresh Pond HAB NYSDEC Reports

#	Date of Report	Lake Name	HAB Status	Extent of the HAB	County	Count
1	7/27/2019, 8:00 PM	Fresh Pond	Confirmed	Small Localized	Suffolk County	1
2	8/10/2019, 8:00 PM	Fresh Pond	Confirmed	Small Localized	Suffolk County	1
3	8/17/2019, 8:00 PM	Fresh Pond	Confirmed with High Toxins	Widespread or Lakewide	Suffolk County	1
4	9/8/2019, 8:00 AM	Fresh Pond	Confirmed with High Toxins	Open Water	Suffolk County	1
5	9/22/2019, 8:00 AM	Fresh Pond	Confirmed with High Toxins	Small Localized	Suffolk County	1

6.7 LYNGBYA GROWTH ISSUE

As there have been Lyngbya mats mixed with filamentous green algae in the area adjacent to where the public can access the Pond via Fresh Pond Road (see Figure 6-11), there is a possible risk of cyanotoxins in that area and concern has been expressed over managing those peripheral cyanobacterial mats. Changes in cyanobacteria taxonomy have made characterization of assemblages more difficult and less consistent among monitoring groups using different references, and what is called Lyngbya in Fresh Pond is currently known as *Microseira* in the most updated taxonomic literature. It is a potential toxin producer, so its presence suggests risk, but like most cyanobacteria it does not always or even routinely produce toxins, so toxin data are needed to know if a hazardous condition truly exists.

The available data for algae and toxins do not indicate a hazardous level of toxins in association with the mats, but monitoring has not been consistent and algal identifications have not closely matched the presence of toxins. That is, toxins have been found at potentially hazardous levels in both open water and shoreline samples, but nearly always when planktonic cyanobacteria such as *Microcystis* and *Planktothrix* have been identified as dominant. Such cyanobacteria are buoyant and can be concentrated by wind along shorelines in the downwind direction, leading to very high BGA chlorophyll-a concentrations and microcystin concentrations above the threshold for safe recreational use of the Pond. Testing has been for only one toxin, microcystin, while multiple toxins can be produced. While microcystin is the most common toxin, other toxins could be present when it is not. Consequently, the presence of potential toxin-producing cyanobacteria is often treated as a threat and actions to minimize abundance are often taken as a precaution. The only place where Lyngbya/*Microseira* mats have been documented in Fresh Pond is in about a 0.1-acre area adjacent to the public access point at the end of Fresh Pond Road, to the south or left as one faces the Pond.

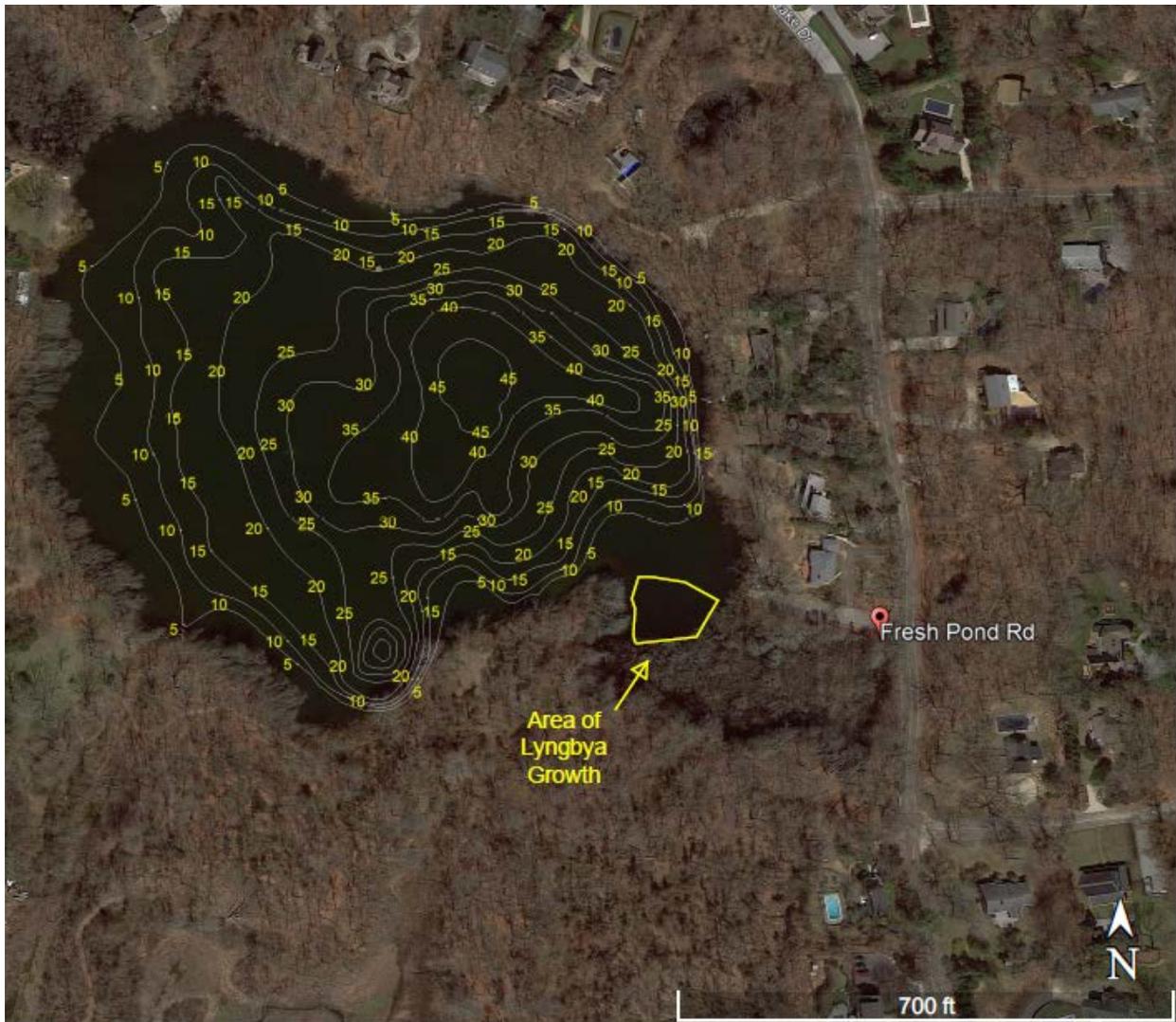


Figure 6-11 Area of Lyngbya Growth on Fresh Pond

7. TMDL PHOSPHORUS BUDGET

7.1 INTRODUCTION

A Total Maximum Daily Load (TMDL) is prepared for a waterbody that does not meet the water quality standard for a pollutant. For Fresh Pond the pollutant is phosphorus.

Per <https://www.epa.gov/tmdl/developing-total-maximum-daily-loads-tmdls>, “The TMDL establishes a target for total load of [a] pollutant the water body can assimilate and allocates the load to point sources (called the wasteload allocation [or WLA]) and nonpoint sources (called the load allocation [or LA]). The margin of safety takes into account the uncertainty between the model and the actual environment. Data and information such as land use, water quality monitoring results, modeling techniques, calculation methods and other relevant evidence are included in the TMDL.”

The components of a phosphorus budget for Fresh Pond are illustrated on Figure 7-1 and are:

1. Wastewater – via groundwater
2. Fertilizer – via groundwater
3. Stormwater runoff
4. Atmospheric Deposition
5. Waterfowl
6. Benthic Flux

Agriculture is not currently practiced in the watershed. Phosphorus loadings within the Fresh Pond watershed were calculated using literature-based values for each of the above listed sources. The following sections provide details on the calculated nutrient loadings, with the associated assumptions, to Fresh Pond for each of the budget components.

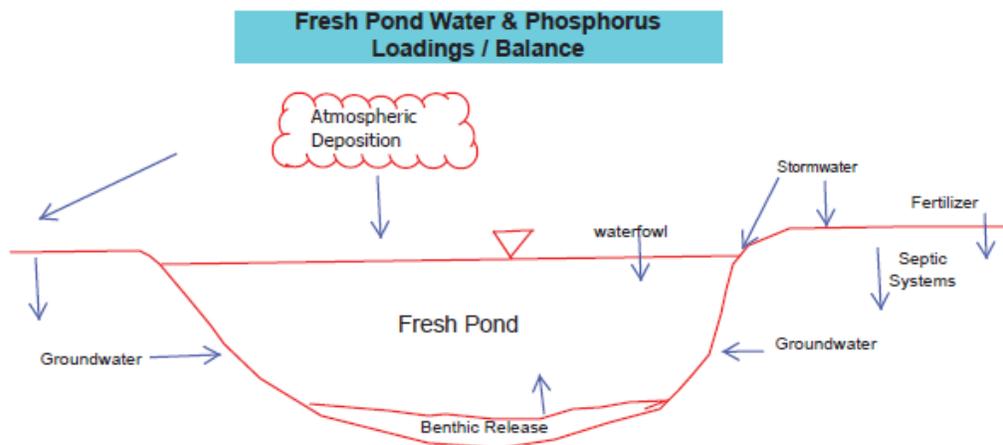


Figure 7-1 Fresh Pond Phosphorus Budget Categories

Wastewater management practices in the Fresh Pond groundwater watershed consist exclusively of onsite systems. There are 68 developed residential properties (some seasonally used) in the Fresh Pond watershed. Historical practice is conventional septic systems with septic tanks and leaching pools.

When favorable conditions exist, soils can remove nearly all of the phosphorus from septic tank effluent wastewater. In areas with noncalcareous (characterized by the lack of calcium carbonate in the parent material soils), as exist in the Fresh Pond watershed, phosphorus removal can occur by mineralization with iron (via reductive iron dissolution) and / or possibly aluminum, via wastewater acidification which solubilizes aluminum which then mineralizes the dissolved phosphorus as variscite (Lombardo et al., 2005).

Sorption of phosphorus by sands also removes phosphorus, but sands have limited capacity and sorption is reversible. Phosphorus retardation factor (groundwater velocity/solute velocity) of 25 - 37 has been observed with septic systems (Robertson, W.D.,2008).

It is noted that the NY 2010 Nutrient Runoff Law prohibits the application of fertilizers containing phosphorus except when a soil test indicates that additional phosphorus is needed for growth of that lawn or non-agricultural turf; or the phosphorus fertilizer is used for newly established lawn or non-agricultural turf during the first growing season.

7.2 TOTAL P LOAD TO FRESH POND

Other sources of P to Fresh Pond besides the internal load include direct atmospheric deposition (precipitation and dryfall), groundwater seepage (with any wastewater and fertilizer), overland runoff, and wildlife inputs, see Figure 7-1. There are limited data for each other source, but most can be estimated and compared with the internal load.

Atmospheric input in this area tends to average 0.1 kg/ha/yr. With a 14.5-acre (5.87 ha) Pond, atmospheric inputs are estimated at 0.6 kg/yr. Wildlife inputs are usually based on the number of observed birds or other wildlife on the pond over time. There are no reliable data, but the total is probably not more than 20 units (i.e., animal such as a bird or beaver) for the year, and in reality, a lot of birds will only be there for half a year. At an average of 0.2 kg/unit/year, the wildlife P load is estimated at 0.4 kg/yr. Both of these estimates could be off as much as 50%, which would still minimize their importance compared to the internal load.

Surface runoff is often a major source of P to ponds, but with very sandy soil and minimal engineered drainage systems in the watershed, surface runoff inputs to Fresh Pond are very low. Some direct runoff from land immediately surrounding the pond is possible, but most runoff will be infiltrated into the sandy soil and enter as groundwater, accounted for separately. With an estimated input of 1.6 million gallons of runoff per year at an average concentration of 0.26 mg/L (from New York State Stormwater Management Design Manual January 2015), equates to 1.6 kg/yr. Again, a substantial error in this estimate would not matter greatly in comparison to the internal load.

That leaves groundwater, which is the major source of water to Fresh Pond. Alternately stated, Fresh Pond is exposed groundwater. The USGS estimated the water input at 63 million gallons per year (see Table 5-2). Data from a well slightly north of Fresh Pond (Table 5-4) indicate soluble P concentrations averaging 31 ug/L, equating to an input of 7.4 kg/yr if representative of all groundwater entering Fresh Pond. As the well nitrogen data suggests the groundwater is influenced by a septic plume and that that load is likely to be attenuated by the time the groundwater reaches the pond, suggesting a P load of <<<3.7 kg/yr. Estimated inputs to soil in the watershed that include fertilizer and wastewater are 110 kg/yr to groundwater within the watershed. Assuming that in the watershed overall there will be a 95% attenuation of P through mineralization and soil sorption, the load to the pond via groundwater would be about 5.5 kg/yr.

This load may increase over time as P moves through soil over time, albeit slowly, but at this point there is no reason to believe that groundwater is a major contributor of P. N as nitrate is much less removed by soil and concentrations of that nutrient will be much higher in groundwater. Groundwater may be a major contributor of N to Fresh Pond, but not P.

Summing up the P inputs to Fresh Pond (Table 7-1) as currently understood, the total load is 38.9 kg/yr with the internal load representing >80% of the total. Whatever the variation or error associated with these estimates, it is unlikely that any source other than internal load will be a controlling factor for P in Fresh Pond and control of the internal P load will be essential to Pond protection and improvement.

Table 7-1 Phosphorus Loads to Fresh Pond

Load source	kg/yr	% of total
Internal Load	31.7	81.5%
Groundwater	4.6	11.8%
Surface runoff	1.6	4.1%
Atmospheric	0.6	1.5%
Wildlife	0.4	1.0%
Total	38.9	100.0%

7.3 POND MODELING ANALYSIS

There are multiple simple, empirical models of Pond water quality function that can be used to estimate the P concentration from a load or vice versa. Applying a suite of five references, listed in Appendix F, such models embodied in the Pond Loading and Response Model, the average spring P concentration predicted for a waterbody with the area, depth, and inflow features of Fresh Pond and a load of 38.9 kg/yr is 53 ug/L, see Table 7-2. The volume weighted mean P concentration from the May sampling is 52 ug/L. A concentration of <10 ug/L would provide superior conditions while a concentration no more than 20 ug/L should be tolerable in terms of limiting cyanobacteria blooms. A major decrease in the P load is therefore needed and the only source that can provide enough reduction is the internal load.

If actions were taken that reduced the internal load by 75%, the average spring P concentration would be 20 ug/L. With a reduction of 90%, the concentration would be 14 ug/L. As the Pond strongly stratifies and much of the internally loaded P does not reach the upper waters until stratification breaks down, and much of it may recombine with Fe and precipitate out at that time, the surface concentration may be much lower than the average concentration moving through summer. In 2021 the surface P concentration declined from 30 ug/L at the start of May to 15 ug/L in late July and 11 ug/L in early October and no blooms were detected. This may be a function of strong stratification, but the very wet July weather may have also brought Fe-laden groundwater into the Pond that caused a natural inactivation of P in surface waters.

Whatever the mechanism of reduced P availability at the surface, the average water column concentration will be higher than the surface concentration in Fresh Pond and conditions will likely be better than what the models indicate. Using current conditions, the models suggest that the Pond will experience blooms much of the summer and that clarity will be only slightly more than a meter, neither of which was the case in 2021. But blooms in the past few years demonstrate that with any upward movement of P there can be problems in Fresh Pond.

Table 7-2 Fresh Pond Phosphorus Concentration Modeling

SYMBOL	PARAMETER	UNITS	DERIVATION	VALUE	NAME	FORMULA	PREDICTION	
							CONC. (ppb)	LOAD (g/m2/yr)
TP	Lake Total Phosphorus Conc.	ppb	From data or model	20	Mass Balance	$TP=L/(Z(F))*1000$	53	
L	Phosphorus Load to Lake	g P/m2/yr	From data or model	0.38	(minimum load)	$L=TP(Z)(F)/1000$		0.14
TPin	Influent (Inflow) Total Phosphorus	ppb	From data	53	Kirchner-Dillon 1975	$TP=L(1-Rp)/(Z(F))*1000$	24	
TPout	Effluent (Outlet) Total Phosphorus	ppb	From data	20	(K-D)	$L=TP(Z)(F)/(1-Rp)/1000$		0.31
I	Inflow	m3/yr	From data	146000000	Vollenweider 1975	$TP=L/(Z(S+F))*1000$	35	
A	Lake Area	m2	From data	20500000	(V)	$L=TP(Z)(S+F)/1000$		0.22
V	Lake Volume	m3	From data	205000000	Reckhow 1977 (General)	$TP=L/(11.6+1.2(Z(F)))*1000$	19	
Z	Mean Depth	m	Volume/area	10	(Rg)	$L=TP(11.6+1.2(Z(F)))/1000$		0.40
F	Flushing Rate	flushings/yr	Inflow/volume	0.712	Larsen-Mercier 1976	$TP=L(1-Rlm)/(Z(F))*1000$	24	
S	Suspended Fraction	no units	Effluent TP/Influent TP	0.377	(L-M)	$L=TP(Z)(F)/(1-Rlm)/1000$		0.31
Qs	Areal Water Load	m/yr	Z(F)	7.122	Jones-Bachmann 1976	$TP=0.84(L)/(Z(0.65+F))*1000$	23	
Vs	Settling Velocity	m	Z(S)	3.774	(J-B)	$L=TP(Z)(0.65+F)/0.84/1000$		0.32
R	Retention Coefficient (from TP)	no units	(TPin-TPout)/TPin	0.623				
Rp	Retention Coefficient (settling rate)	no units	$((Vs+13.2)/2)/(((Vs+13.2)/2)+Qs)$	0.544	Average of Model Values		25	
Rlm	Retention Coefficient (flushing rate)	no units	$1/(1+F*0.5)$	0.542	(without mass balance)			0.31

8. OPTIONS FOR INTERNAL P LOAD CONTROL

Key design criteria for assessment of options:

Hypolimnetic oxygen demand (HOD)	65 kg/day (26,000 m ² at 20 ft depth)
Phosphorus Sediment Loading	31.7 kg/year

8.1 OPTIONS DESCRIPTION

The methodologies for reducing internal phosphorus loading in Ponds are:

1. Dredging
2. Oxygenation of hypolimnetic waters
3. Hypolimnetic withdrawal (HW)
4. Phosphorus inactivation

At this time, the NYSDEC fundable options are:

1. Dredging
2. Oxygenation of hypolimnetic waters
3. Hypolimnetic withdrawal

Oxygenation of hypolimnetic waters and HW need to be implemented with proper controls, monitoring and adjustment as the data dictates.

Dredging.

Dredging is simply the removal of accumulated sediment, targeting the organic, P-rich substrate that is associated with low oxygen and release of P. However, dredging is not a simple process. A determination of how much material must be removed is needed, predicated on reaching a substrate that has less oxygen demand and/or less available P. Hydraulic dredging, whereby a mixture of water and solids are removed in a slurry and deposited in a containment area where the sediment can be dewatered, is more commonly applied when the target sediment is well offshore in deeper water. Even then, there are technical restrictions on how deep dredging can go and the need for a substantial area for dewatering is a limiting factor. Unless recovery of depth is viewed as essential, dredging is rarely used to address internal P loading.

The cost of dredging depends on site-specific circumstances and disposal options, that latter factor depending heavily on the quality of the sediment and available disposal areas. The cost can vary greatly. Recent dredging in East Hampton Village of a 5 foot Pond will relatively clean sediments had costs of \$100/cy. The exact amount of sediment below a water depth of 15-20 feet in Fresh Pond is not precisely known but is believed to be at least 22,200 cy (which is 2 feet of sediment over ~300,000 sf), suggesting a **minimum cost of \$2.2 million.**

Oxygenation

- a. Artificial circulation – Intentionally mixing the lake to prevent stratification and loss of oxygen near the bottom. This is not a natural solution and will make whatever nutrients are in the pond more available to algae. If adequate oxygen is maintained near the bottom

there could be less P release, but the risk of moving some P into upper waters makes this approach risky.

b. Hypolimnetic oxygenation

- i. Submerged chambers into which air or pure oxygen is released.
- ii. Onshore - Side stream saturation (SSS) which injects oxygen into water withdrawn from the hypolimnetic layer on a shore-based pressurized container to produce a supersaturated solution that is then discharged into the target bottom layer zone.
- iii. Diffused release of pure oxygen – fine bubbles would be released into the deepest part of the pond with no chamber, with absorption of the oxygen before bubbles can cause destratification. This carries a risk of destratification with the range of depths needing oxygen in Fresh Pond.

Oxygenation of water near the sediment-water interface is directed at the hypolimnion where low oxygen exists as a natural result of accumulating organic matter over many years and attendant decomposition while stratification limits the downward movement of oxygen from upper waters. One can circulate the water by pumping or air driven means to homogenize and distribute oxygen throughout the waterbody without any engineered addition of oxygen; this is called **artificial circulation**. One can also add oxygen in a controlled fashion to increase oxygen in bottom waters without mixing the waterbody; this is called **hypolimnetic oxygenation**.

Artificial circulation (mixing the Pond) has a long track record with some notable successes, but it does have a tendency to maximize the availability of whatever nutrients are in the water and it is rare to eliminate all internal loading with a circulation system. Such a system may well reduce the average P concentration, but with such a strong vertical gradient in Fresh Pond when it is stratified and apparent limitation on availability of P in surface waters, the results could still be a net increase in surface P from the observed 2021 levels. If power is lost, poor quality water can develop quickly in the deeper waters of a waterbody like Fresh Pond and resumption of circulation can make conditions much worse in the upper waters; this has happened in multiple cases. Circulation of a naturally stratified pond should only be undertaken with sufficient safeguards to ensure that the pond remains mixed and may still require additional P reduction to achieve goals. This option is not recommended for Fresh Pond.

Hypolimnetic Oxygenation. Oxygenation without breaking stratification is a matter of providing enough oxygen to the needed volume of water when it is needed. Oxygen demand was determined for Fresh Pond from spring 2021 measurements and ranged from 0.43 to 1.57 g/m²/day (Table 6-4). Values increased over just the few weeks of data collection in response to warming waters, which increases decomposition rates and therefore hypolimnetic oxygen demand (HOD). However, once the oxygen has dropped to below about 2 mg/L the uptake is no longer linear or predictable, if even measurable, so field measurements later in spring and summer are not useful for calculating HOD. Rounding up from the highest believable HOD is usually sufficient. For Fresh Pond, HOD of about 2 g/m²/day is to be expected and is well within the range observed in other waterbodies and is consistent with observed oxygen loss in the Fresh Pond system.

With a targeted HOD, oxygenation can be accomplished either by releasing tiny bubbles of pure oxygen that are absorbed before the bubbles can rise enough to cause mixing or by oxygenating water from the deep zone in a chamber and replacing that water in the deep zone. Diffused oxygen systems are less expensive than chambered oxygenators but **require a vertical run of about 20 feet to be effective**. That distance is possible from the deepest part of Fresh Pond to

the thermocline, but only over an area of about 3 acres. That will make it difficult to oxygenate everywhere it is needed without causing destratification. Due to the likely destratification, this option is not recommended for Fresh Pond.

The **Chambered Approach** can involve oxygenation at the Pond's bottom or on shore. The former offers less of an onshore footprint, but there still has to be a source of oxygen and a pump, and maintaining submerged components is problematic. Further, the submerged system needs a stable, hard platform, which does not exist where the soft sediment is deep. For applications like Fresh Pond, a shore-based oxygenation system is generally preferable. The onshore chamber approach is often called a sidestream saturation system (SSS), as water pumped up from the bottom of the pond is oxygenated in a chamber to a supersaturated condition then placed back in the bottom of the pond. The extra oxygen, possibly 5 to 10 times what the water would have held naturally at the ambient temperature, allows less water to be moved to get the necessary oxygen mass into the targeted zone of the pond.

Commercial SSS have started to become available but there is still more to be learned about optimal application. A recent project on Cape Cod, in conditions with some similarity to Fresh Pond, required several adjustments to achieve reliable oxygen delivery after the initial installation. In a 2015 review of oxygenation approaches for the drinking water industry, Wagner (2015) noted that virtually all oxygenation systems require some site-specific adjustment to function optimally and all installations should have a planned 2- to 3-year adjustment period. Oxygenation has great potential to improve habitat as well as reduce internal loading but is not yet a mature area of implementation.

If oxygenation is to be the implemented strategy at Fresh Pond, SSS offers the greatest potential for success with operational flexibility that may prove essential to that success and long-term cost management. It is more expensive than diffused pure oxygen but can be adjusted to meet spatial and temporal needs without mixing the pond. SSS would be preferable to a circulation system but more expensive as well.

Phosphorus inactivation

P inactivation has gained popularity in recent years, owing to substantial successes in many waterbodies. The process is very flexible, allowing sediment, the water column, or inflows to be treated as often as necessary. For Fresh Pond, the preferred approach would be to inactivate P in the surficial sediment (upper 4 inches) on a one-time basis, locking that P in the sediment and reducing internal P loading for an extended period of time. The duration of benefits depends on external P sources and the upward migration of P that was not inactivated through the inactivated sediment layer. Stratified lakes that have been treated have experienced reduced internal P loading for about 2 decades. When added to Pond water, the P binder removes phosphates through precipitation, forming a heavier than water particulate known as a floc. This floc then settles to the lake bottom to create a barrier that retards sediment phosphorus release.

Possible P binders include aluminum, calcium and lanthanum, each of which substitutes for iron as the main binder of P in the treated sediment. Aluminum has been the binder of choice in the northeastern USA, given that it is second in natural abundance only to iron and is relatively easy to obtain, as it is being used in many water and wastewater treatment facilities. The Pond's pH is not high enough (needs to be $\gg 8$) to apply calcium for successful P inactivation. Lanthanum (the active ingredient in the product Phoslock) can be an effective P binder under a range of conditions and the bentonite clay on which it is delivered may coat the bottom to reduce HOD

somewhat. Phoslock reacts with phosphate to form an inert mineral known as rhabdophane. Phoslock is the commercial name for a bentonite clay in which the sodium and/or calcium ions have been exchanged for lanthanum. However, it is more expensive than aluminum and does not have as extensive a track record in this area.

P inactivation by aluminum involves a dose calculated to bind up most of the P currently attached to iron. Work in Maine determined that having about three times as much Al as Fe in sediment is sufficient to squelch internal P loading but most dosing is based on adding 10 to 20 times as much Al as there is currently Fe-P in the target sediment. Calculations for Fresh Pond suggest that this dose may vary slightly with depth, but that most of the pond deeper than 15 feet has 4-5 g P/m² to be inactivated.

The minimal follow-up work involved in P inactivation is very attractive, leading to lower cost over the expected lifespan of treatment benefits, but there is a regulatory barrier with such treatments in NY. The State of New York applies a definition of “pesticide” that encompasses any substance or practice that limits the ability of a targeted species to become abundant. Consequently, P inactivators have been declared pesticides under those regulations but are not registered as pesticides with the federal government, which is a requirement to be permitted in NY.

Some P inactivation projects have been conducted in NY either before the regulatory issue was raised or under experimental use permits since then. Critically, the NYSDEC funding program does not consider P inactivation a fundable option.

Hypolimnetic Withdrawal (HW)

The typical application of HW is to remove deep water during the summer, causing the removal of high P water and leaving less P in the waterbody and sediments.

For Fresh Pond, hypolimnetic withdrawal would mean either:

- Removing enough water fast enough to prevent anoxic conditions from developing or
- Removing enough water fast enough to remove the sediment released phosphorus and eventually removing the P content of the sediments.

Pulling water out fast enough to avoid anoxia would mean removing at least 16% of the pond’s volume of 88,000,000 and possibly up to 40% in the space of two weeks, which is not practical.

The alternative of removing water, and as needed treating it actively or passively, and discharging it downgradient of the Pond is the typical HW technique. For downgradient discharge, any treatment requirements would be dictated by the receiving water body, which is the saline Dickerson Creek. It is expected that nitrogen, rather than phosphorus, discharges will be of greater concern to Dickerson Creek which discharges to Peconic Bay. Based upon a hydrogeologic analysis, impacts on Fresh Pond and area watersheds of using the downgradient discharge approach are not considered significant. However, despite significant evaluation efforts, there are no available lands to locate the needed withdrawal equipment and a downgradient discharge.

Discharging the withdrawn waters upgradient of Fresh Pond was examined but determined not technically viable due to the insufficient amount of land availability.

Figure 8-1 shows the Potential Locations for Hypolimnetic Withdrawal Discharge upgradient of Fresh Pond along Lake Drive. The potential infiltration trenches are each 1,500 feet long, for a total of 3,000 feet. Assuming a maximum trench width of 3 feet results in 9,000 sf – which is too small for the proposed HW option.



Figure 8-1 Potential Locations for Hypolimnetic Withdrawal Upgradient Discharge

Consequently, treating withdrawn waters for phosphorus removal and returning the treated waters to Fresh Pond is the only available HW option.

Treatment for phosphorus removal is proposed to be achieved by iron-P mineralization, which naturally occurs in Ponds during turnover. As shown on Table 6-5 and discussed in Section 6.4, phosphorus removal from the Pond's water (not including sediments) occurred during turnover in which the oxygenated surface waters mixed with bottom waters, transforming the dissolved ferrous iron to ferric, which then mineralizes phosphorus to form the solid strengite, which settles into the sediment. Engineering this scientific process is the proposed HW method to remove phosphorus from the Pond's sediments, and therefore the Pond's waters.

Generally, ten (10) parts by weight of dissolved iron are needed to mineralize one (1) part by weight of dissolved P. While the Table 6-3 data suggests that sufficient iron exists in hypolimnetic waters to mineralize P, iron addition to supplement Pond iron levels may be desirable to maximize phosphorus removal. An aspirator on the withdrawn water pipe is proposed to provide the HW oxygen demand.

With about 125 kg of available P in the surficial sediment and assuming the current release rate of 32 kg/year stays constant, it would take at least 4 years to remove the available P in the surficial sediments. Minimization of internal P loading by this approach will likely take longer, perhaps a

decade, as the P release rate will decrease as P is removed. It is possible that the internal P reserves could be exhausted in under a decade based on the P load analysis conducted as part of this study, compared with two decades or more in cases where a smaller percentage of the P reserves have been released from sediment each year.

For reference and future operational purposes, Table 8-1 summarizes the P release rate estimates, volumes of water at the different depths and time to remove the various volumes with a withdraw rate of 200,000 gpd.

Table 8-1 Sediment P Release Rates & Days for Pond Water Removal Per Depths

Depth	Volume (gallons) below depth (ft)	Pond Area at depth (acres)	Estimated Duration of Anoxic Exposure (days)	Estimated Avg. P Release Rate (mg/m ² /d)	P Load (kg/year)	Days to Remove Volume Below Depth at 200,000 gpd withdraw rate
15	35,000,000	8.39	120	4.5	4.3	175
20	23,000,000	6.44	150	5.5	11	115
25	14,000,000	4.49	180	6.5	10	70
30	8,000,000	3.13	210	7.5	6.4	40
					Total	31.7

Summary

The above discussion addresses the need to reduce internal loading of P to Fresh Pond. However, the reduction of oxygen demand would also have a major positive impact on habitat value within the Pond, so measures that reduce oxygen demand provide additional benefits beyond just P control and algae bloom prevention. Dredging provides such benefits but is too expensive to consider further at this point. Oxygenation provides such benefit, although the level of P control is likely to be somewhat less than from dredging or P inactivation. P inactivation will reduce algal production and will therefore reduce oxygen demand slightly but will not address the accumulated organic matter and will not prevent anoxia over much of the hypolimnetic volume.

P inactivation provides the fastest achievement of the P reduction goal at the least cost but is not available due to regulatory constraints. Oxygenation would have rapid results at slightly higher capital cost than P inactivation but also carries an annual operation cost that is significant, and would be a required annual expense. Hypolimnetic withdrawal will achieve P reduction goal over a number of years and provides a permanent solution.

8.2 CANDIDATE REMEDIATION SITES

Figure 8-1 presents and Table 8-2 lists Town and Town/County owned parcels along/near Fresh Pond, along with the locations of Fresh Pond Road and a potential platform on Fresh Pond.

Table 8-2 Town/County Parcels Around / Near Fresh Pond

- Site # 1 SCTM # 700-1-19-111, 53 Lake Drive, Town of SI/County of Suffolk
- Site # 2 SCTM # 700-23-1-29, 65 S Midway Rd, Town of SI/County of Suffolk
- Site # 3, SCTM # 700-1-19-23.6, 45A S Midway Rd, Town of SI/County of Suffolk
- Fresh Pond Access Road – between Site # 1 and parcel 700-19-1-110
- On Fresh Pond – off of Fresh Pond Road

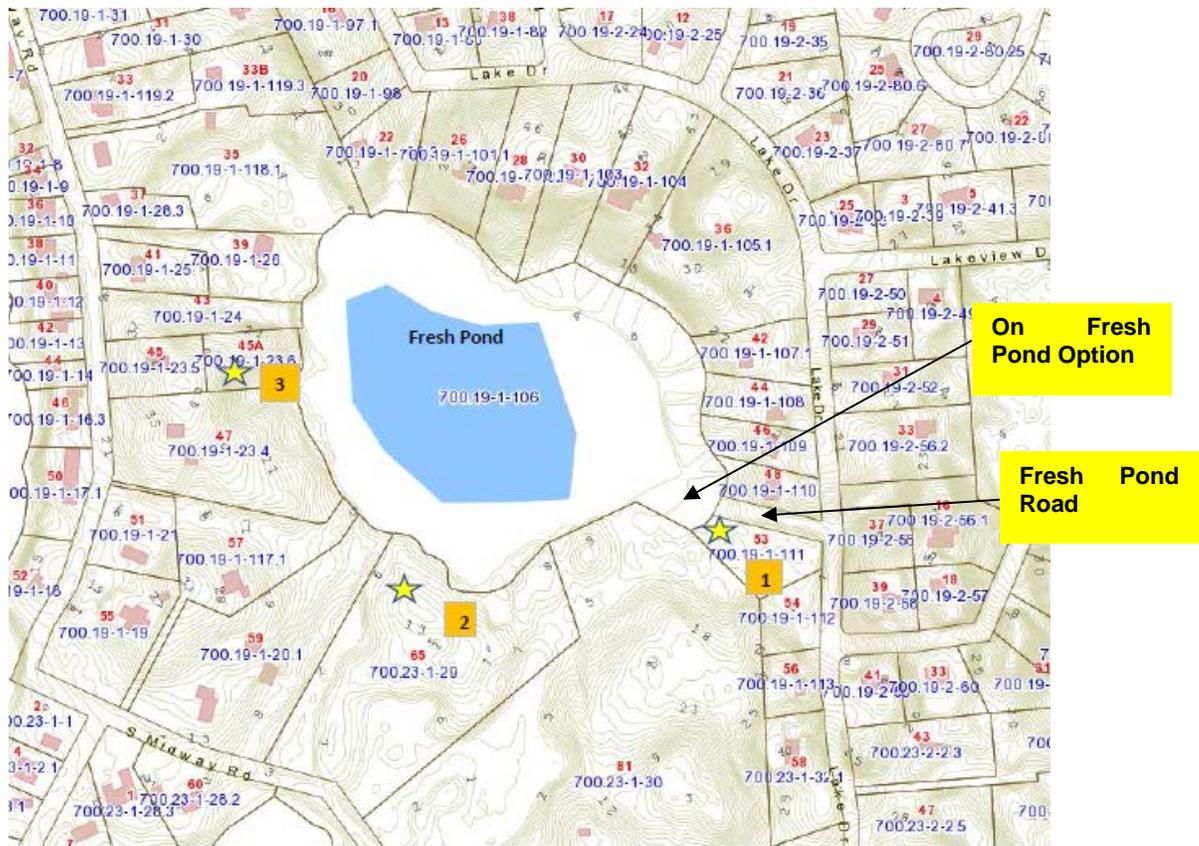


Figure 8-1 Publicly Owned Sites Around / Near Fresh Pond

Figure 8-2 sites 2 and 3 were obtained with Community Preservation Funds (CPF) which have use restrictions such that they are unavailable. Site 1 is predominately a wetland.

From an access and engineering perspective, the Fresh Pond Road site is very attractive for locating oxygenation or MW equipment. However, the Road is not available due to the need to maintain access for emergency boat / first responder and the general public as it is the only public access to Fresh Pond.

Consequently, a platform on Fresh Pond is required for the oxygenation or HW treatment equipment along with water withdrawal and discharge equipment.

9. SCREENED ALTERNATIVES PRELIMINARY ENGINEERING & COST ESTIMATES

Based upon the analysis in Chapter 8, the screened alternatives on which preliminary engineering and cost estimates will be performed are:

1. Oxygenation by sidestream saturation system (SSS), with facilities located on Fresh Pond Road, **injecting minimum 65 kg of oxygen / day** into hypolimnetic waters.
2. Hypolimnetic withdrawal of 100,000+/- gpd, treatment for **P removal of 31.7 kg/year** and discharge to Fresh Pond.

9.1 OXYGENATION ALTERNATIVE

Oxygen Demand

The hypolimnetic oxygen demand (HOD) is estimated at 65 kg/day. The Fresh Pond SSS process flow diagram to inject a minimum of 65 kg of oxygen / day into hypolimnetic waters is presented on Figure 9-1. A building layout of a Fresh Pond SSS is presented on Figure 9-2, with a layout of extraction and return piping on Figure 9-3. Photos of oxygenation extraction / return piping are presented on Figure 9-4 – from <https://www.ortanspondcoalition.org/oxygenation-demonstration/> and WRS, 2021.

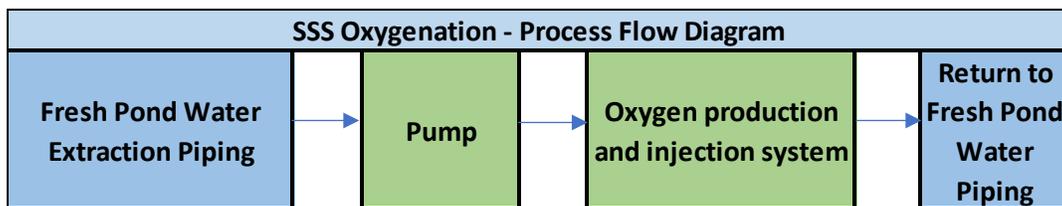


Figure 9-1 SSS Oxygenation – Process Flow Diagram

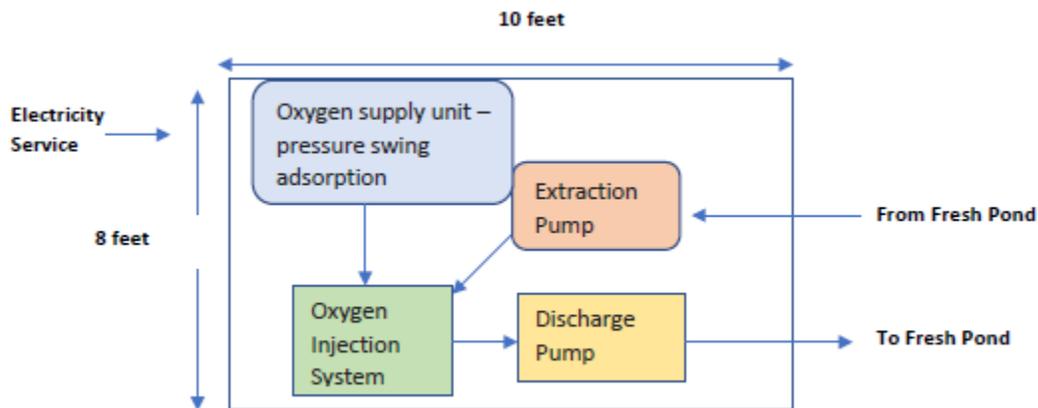


Figure 9-2 Building Layout of Oxygenation Injection System



Figure 9-3 Layout of Oxygenation by Sidestream Saturation System



Figure 9-4 Photos of SSS

The SSS cost estimating details are presented on Table 9-1.

Table 9-1 SSS Capital and Annual O&M Cost Estimates

Fresh Pond SSS Oxygenation - Opinion of Probable Capital Cost				
Activity	Quantities	Units	Unit Cost	Activity Costs
Mobilization / Demob	1	LS	\$15,000	\$15,000
Platform on Fresh Pond	30' x 30'	LS	\$25,000	\$25,000
Extraction & Disposal Piping	1,000	LF	\$25	\$25,000
Building with Power	1	LS	\$20,000	\$20,000
Pumps	2	#	\$3,000	\$6,000
Oxygen production and injection system	1	LS	\$125,000	\$125,000
Subtotal - SSS Construction Costs				\$216,000
Miscellaneous	10%	%	\$216,000	\$21,600
Contingency	20%	%	\$216,000	\$43,200
Engineering, Permitting & Admin	1	LS	\$75,000	\$75,000
Total - SSS Construction Costs (2022 \$)				\$355,800
Total - SSS Construction Costs (2024\$)				\$391,380
Fresh Pond SSS Oxygenation - Opinion of Probable Annual O&M Cost				
Activity	Quantities	Units	Unit Cost	Activity Costs
Electricity Extraction	4,000	kwh	\$0.22	\$880
Oxygen production / injection	40,000	kwh	\$0.22	\$8,800
Labor	12	per day	\$800	\$9,600
Misc. / Contingency	1	LS	\$3,000	\$3,000
Engineering Oversight	1	LS	\$15,000	\$15,000
Subtotal - SSS Annual O&M Costs				\$37,280

9.2 HYPOLIMNETIC WITHDRAWAL

The oxygen demand for hypolimnetic withdrawal (HW) is a function of the hypolimnetic water quality and the withdrawal flow rate. The design objective is to maximize P removal annually (target of 31.7 kg/year) and to remove the 125 kg of available P in the surficial sediment over multiple years of operation. To achieve this, a flow rate of 70-gpm was selected. Table 9-2 presents the HW oxygen demand and corresponding air flow rate required.

Table 9-2 Hypolimnetic Withdrawal Oxygen Demand & Air Flow Rate

Oxygen Demand Constituent	Conc. (mg/L)	mg O ₂ / mg Constituent	O ₂ Demand (mg/L)
Oxygen deficit (mg/L)	5	1	5
Ammonia-N conversion (mg/L)	4	4.6	18.4
Sulfide conversion (mg/L)	1	2	2
BOD (mg/L)	2	2	4
Misc OD (mg/L)	2	2	4
Total O ₂ Demand (mg/L)			33.4

HW Flow rate		O ₂ Demand (lbs/day)	Oxy. Transfer Efficiency	Air Flow Req'd	
gpm	gpd			ft ³ /day	CFM
70	100,800	28.10	5.00%	35,170	24.4

A key design/operational HW objective is to have the sediments release as much P as possible in order to remove as quickly as possible the ~ 125 kg of available P in the surficial sediments. At higher P concentrations of hypolimnetic waters (say in early June), less time of operation would be needed. However, with this approach the risk of an algae bloom due to the high HW P concentrations/mass (which will be heavily influenced by climatic conditions) would be greater than by starting the HW early (in April) and operating it longer. Data collection during operation would be used to guide HW operations.

Figure 9-5 presents the proposed HW and P Removal Process Flow Diagram. Figure 9-6 presents a preliminary layout of the proposed HW withdrawal, treatment and return to Pond system. As shown on Table 8-1, repeated below for convenience, HW early in the season focused on the bottom waters may enable the HW to minimize the bloom risks. It is proposed that the HW system would be designed to enable flexibility for either operational approach.

Depth	Volume (gallons) below depth (ft)	Pond Area at depth (acres)	Estimated Duration of Anoxic Exposure (days)	Estimated Avg. P Release Rate (mg/m ² /d)	P Load (kg/year)	Days to Remove Volume Below Depth at 200,000 gpd withdraw rate
15	35,000,000	8.39	120	4.5	4.3	175
20	23,000,000	6.44	150	5.5	11	115
25	14,000,000	4.49	180	6.5	10	70
30	8,000,000	3.13	210	7.5	6.4	40
Total					31.7	

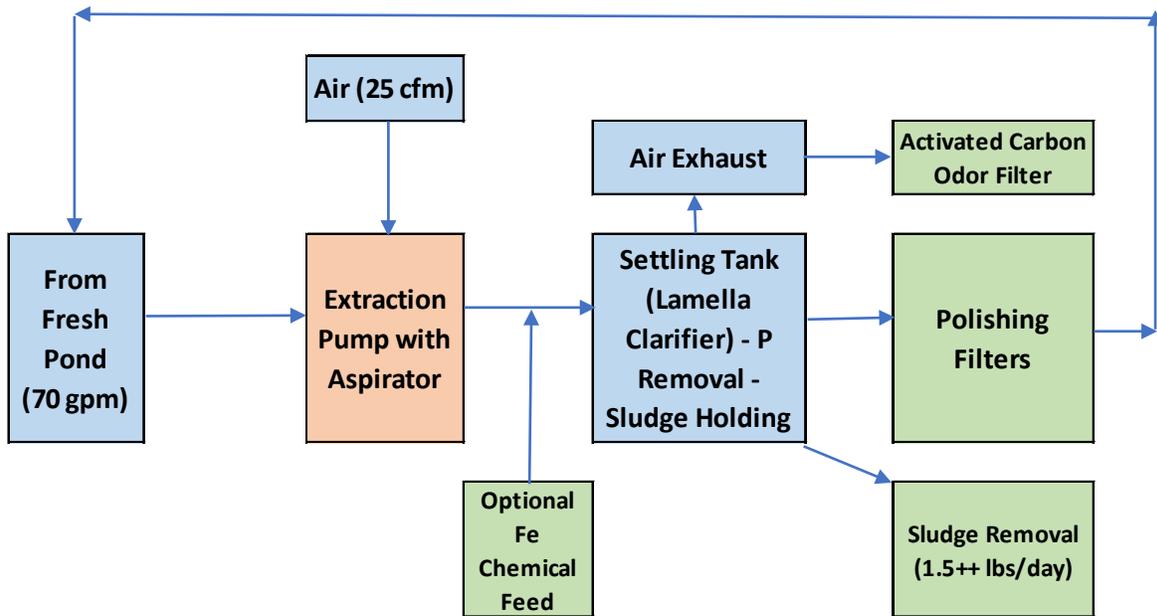


Figure 9-5 Hypolimnetic Withdrawal System – Process Flow Diagram



Figure 9-6 Layout of Hypolimnetic Withdrawal, Treatment & Pond Return System

Table 9-2 Hypo Withdraw Capital and Annual O&M Cost Estimates

Full Scale Fresh Pond Hypolimnetic Withdrawal - Opinion of Probable Capital Cost				
Activity	Quantities	Units	Unit Cost	Activity Costs
Mobilization / Demob	1	LS	\$15,000	\$15,000
Platform on Fresh Pond	30' x 30'	LS	\$25,000	\$25,000
Extraction & Disposal Piping	installed in pilot phase			\$0
Water Treatment System (Furnish & Install)	1	LS	\$150,000	\$150,000
Sediment characterization	1	LS	\$15,000	\$15,000
Subtotal - HW Construction Costs				\$205,000
Miscellaneous	10%	%	\$205,000	\$20,500
Contingency	20%	%	\$205,000	\$41,000
Engineering, Permitting & Admin	1	LS	\$68,000	\$68,000
Total - HW Capital Costs (2022 \$)				\$334,500
Total - HW Capital Costs (2024 \$)				\$367,950
				\$299,950
Full Scale Fresh Pond Hypolimnetic Withdrawal - Opinion of Probable Annual O&M Cost				
Activity	Quantities	Units	Unit Cost	Activity Costs
Electricity	13,140	kwh	\$0.24	\$3,154
Labor	36	days	\$800	\$28,800
Lab costs	1	LS	\$9,250	\$9,250
Misc. / Contingency / Equip. Repair	1	LS	\$5,000	\$5,000
Professional Oversight	1	LS	\$15,000	\$15,000
Subtotal - HW Annual O&M Costs (2023)				\$61,204
Total 8 Years HW Annual O&M Costs with 5% inflation allowance				\$514,110

9.3 TECHNOLOGY SELECTION

The Town of Shelter Island and project stakeholders have selected the hypolimnetic withdrawal (HW) technique for restoring Fresh Pond's water quality based upon the following criteria:

1. Provides a significantly long-term solution
2. Cost is comparable to oxygenation
3. Avoids risks of poor performance associated with oxygenation
4. Low impact on the pond and adjacent properties

9.4 CAVEATS AND RECOMMENDATIONS

While the Fresh Pond HW approach relies upon well-established scientific principles, it is a unique combination of engineering and science techniques. Consequently, to minimize risks and costs and to enable design and operational optimization, a brief, low cost proof of concept project and pilot project are proposed to demonstrate the efficacy of the proposed scientific and engineering

methods and finalize design criteria for a full-scale application. The proof of concept and pilot project details are presented in Section 10.1.

A benefit of the HW-P removal approach is that ammonia is expected to be converted to nitrate in the treatment unit. Typical hypolimnetic withdrawal involves discharge of poor quality water downgradient of the Pond, whereas the proposed system treats the hypolimnetic water and puts a better quality water discharge back into the Pond. This has been done in some other cases but is not a typical HW application. Returning the treated waters into the hypolimnion anaerobic waters is expected to result in the nitrate-nitrogen being converted to nitrogen gas and escape the Pond to the atmosphere. It is estimated that approximately 260 kg-N/year would be removed – which is the equivalent of approximately 23 individual I/A systems being implemented. At a cost of \$30,000 per I/A nitrogen removing system, the “value” of this nitrogen removal could potentially be \$690,000+/- . In addition to denitrification to remove nitrogen, the use of the oxygen that is associated with nitrate will provide approximately 5 kg/day of oxygen to the hypolimnion. With an hypolimnion oxygen demand of 65 kg/day, the nitrate – oxygen will satisfy approximately 8% of the oxygen demand in the Pond. While this may allow an increase in deep-water oxygen, may slow the release of P from the sediment and may provide faster benefits in that regard than just removing the high-P water, the magnitude of nitrate-oxygen availability is not considered significant for design purposes.

10. ENGINEERING PLAN OF PREFERRED REMEDIATION ALTERNATIVE

For the Town selected Preferred Alternative of Hypolimnetic Withdrawal on a platform on Fresh Pond at the end of Fresh Pond Road (see Figure 9-6), this section presents the proposed project Engineering Plan, which consists of:

1. Equipment Sizing and Engineering Layout
2. Capital and O&M Cost Estimates
3. Permitting Requirements
4. Implementation Plan / Schedule

To minimize project risks/uncertainties, project implementation is proposed to consist of the following phases:

- I. Proof of Concept Program
- II. Pilot Program
- III. Full Scale System

The objectives of the various phases are:

Proof of Concept Program	- Document scientific validity of phosphorus removal technique
Pilot Program	- Document treatment system equipment performance; collect data to minimize full scale system capital and O&M cost
Full Scale System	- Restore Pond water quality – optimize operation to minimize time to full remediation

10.1 EQUIPMENT SIZING AND ENGINEERING LAYOUT

I Proof of Concept Testing Program

Prior to implementing the pilot facilities, a three (3) “benchtop” tests, on different dates to allow data analysis and review, will be performed to verify that the concept achieves the expected phosphorus removal and determines the effluent phosphorus and nitrogen quality of the treated water. This will be accomplished by the following activities:

- Extract HW water using a small, variable speed peristaltic pump and store in air tight ~2-gallon containers (i.e., carboys)
- Sample extracted water for Table 10-1 constituents
- Withdraw water from containers at a rate of 0.5-gpm with venturi injector fitted on the pump discharge. Size venturi injector to provide air at the same concentration as proposed for the pilot system
- Collect pump discharge (i.e., treated water), allow to settle for 15-minutes, then
 - sample settled water & analyze for Table 1 constituents
 - filter settled treated water with multi-media or 10-micron filter and analyze for Table 10-1 constituents

A Report on the Findings of the Proof-of-Concept Testing Program will be prepared. The proof-of-concept testing program will provide lab verified data on the phosphorus removal capabilities of the proposed HW treatment system.

Table 10-1 HW Treatment Program Influent & Effluent Constituents for Lab Analysis

Soluble Reactive phosphorus (SRP)
Total Phosphorus (TP)
TKN
NH₄-N
NO₂-N
NO₃-N
Total Nitrogen (TN)
Total Iron
Ferrous Iron
Ferric iron
TS
TDS
Alkalinity
BOD₅

II Pilot Scale

Following a successful Proof-of-Concept Testing Program, a pilot scale HW treatment will be implemented. The Pilot Scale system will treat ~10% of the full design flow (i.e., 7 gpm), using the same type of injector, clarifier and polishing filter as the proposed full-scale system. Table 10-1 lab testing will be conducted on the influent and effluent of the pilot system.

Figure 10-1 presents the process flow diagram and equipment layout for the proposed pilot scale HW and phosphorus removal system. The pilot system size is ~ 10% of the full-scale system size with a footprint of approximately 8 feet x 35 feet and would be installed / located at the end of Fresh Pond Road, see Figure 10-2.

The pilot project is proposed to be a skid mounted unit that is assembled off-site and brought to the Fresh Pond Road site at which independent electricity would be provided along with piping / appurtenances associated with the Pond water withdrawal and return discharge system.

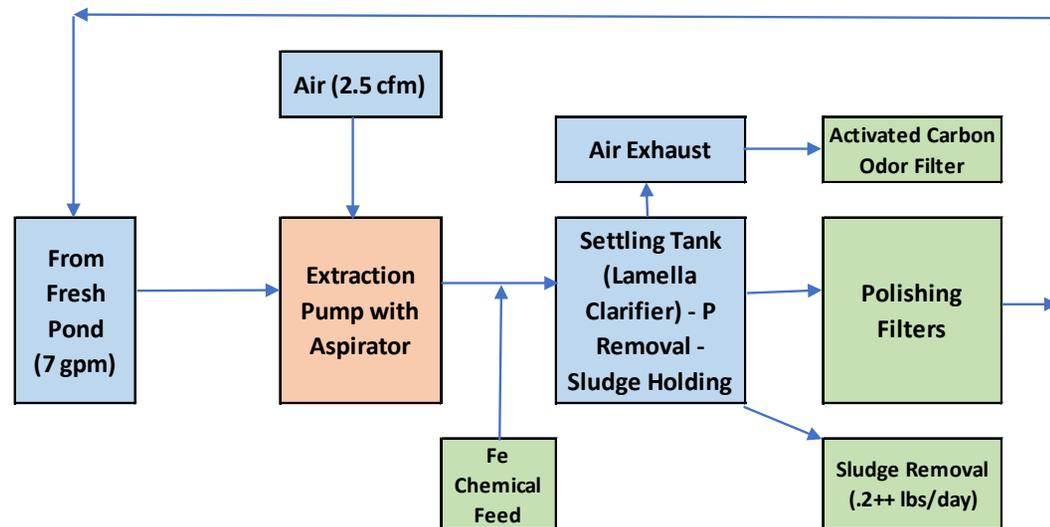
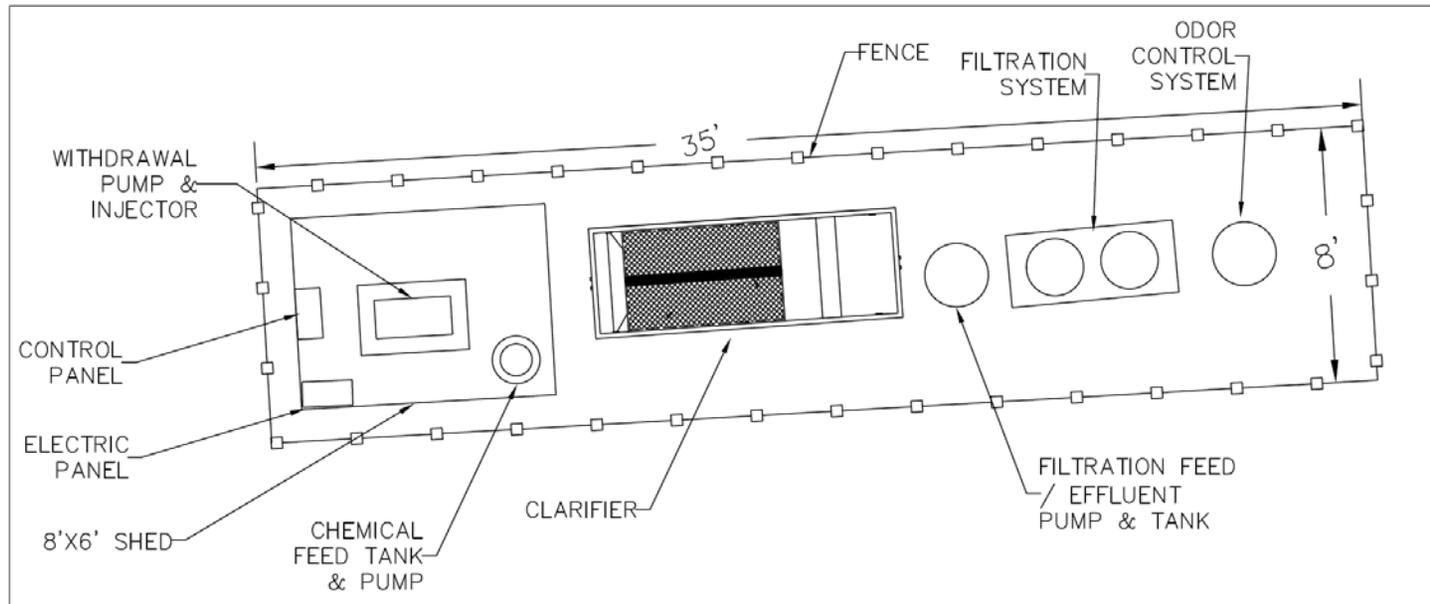


Figure 10-1 Pilot Scale HW-P Removal System – Process Flow Diagram & Layout

Pilot Operations

It is proposed that the pilot would operate for up 8 weeks with operator oversight as follows:

8 hours/day, 5 days / week	1 st two (2) weeks
4 hours/day, 3 days / week	six (6) weeks

Figure 10-2 presents the layout for both the pilot and full-scale systems.



Figure 10-2 Pilot & Full Scale HW-P Removal Systems Plan

Pilot System Equipment to be installed will include:

1. Skid mounted pilot treatment system
2. Water extraction system, as shown on Figure 10-3 and described in Full Scale section below, modified for lower pilot system flow, consisting of Pond Platform at Buoy, Davit Arm Lifting System and piping system
3. Treated water discharge piping to location as shown on Figure 9-6.

Operator activities will include:

1. Collecting influent and effluent samples and analyzing for Table 10-1 constituents using benchtop sampling equipment daily and NYSDoH certified lab analysis 2 times per week

2. Collecting Pond samples at 5 foot intervals (total 9 samples) and measuring for TP, SRP, ammonia-N, nitrate-N, total iron, COD – once per week using benchtop sampling equipment and NYSDoH certified lab
3. Maintaining pilot system equipment
4. Sludge measurements, collection and disposal at landfill

III Full Scale

The full-scale system will have the same process flow as the pilot system, modified based upon pilot testing results. Figure 10-3 presents the process flow diagram and equipment layout for the proposed full scale HW and phosphorus removal system. The full-scale system will be installed on a platform on Fresh Pond with an access ramp down to the pond shore. A privacy / security fence will be on the WWTF platform with a locked gate for operator access. The size of the WWTF platform is approximately 30 feet x 30 feet, as shown on Figure 10-2. A floating platform with a davit arm lifting system will be installed at the buoy above the deepest portion of Fresh Pond where HW water will be pumped from. Initially it is proposed that HW will be extracted from depths of 30 – 45 feet +/-.

The following is a preliminary equipment list for the full-scale facility:

- Goulds 3656 suction lift pump, 3-hp
- Mazzei Injector #2081
- Chemical Feed Pump – Stenner Peristaltic (TBD)
- Chemical storage tank (55-gallon drum + containment area)
- 100-gpm GWTT Clarifier
- Pump Station Tank & Pump for Multi-Media Filter (TBD)
- Multi-Media Filter – 4-ft Diameter (TBD)
- Activated Carbon Drums (4-ft Diameter, 2 in series)
- Control Panel / Remote Monitoring System
- Enclosure / Shed for suction lift pump, control system & Chemical feed pump
- WWTF Platform, Fence and Ramp

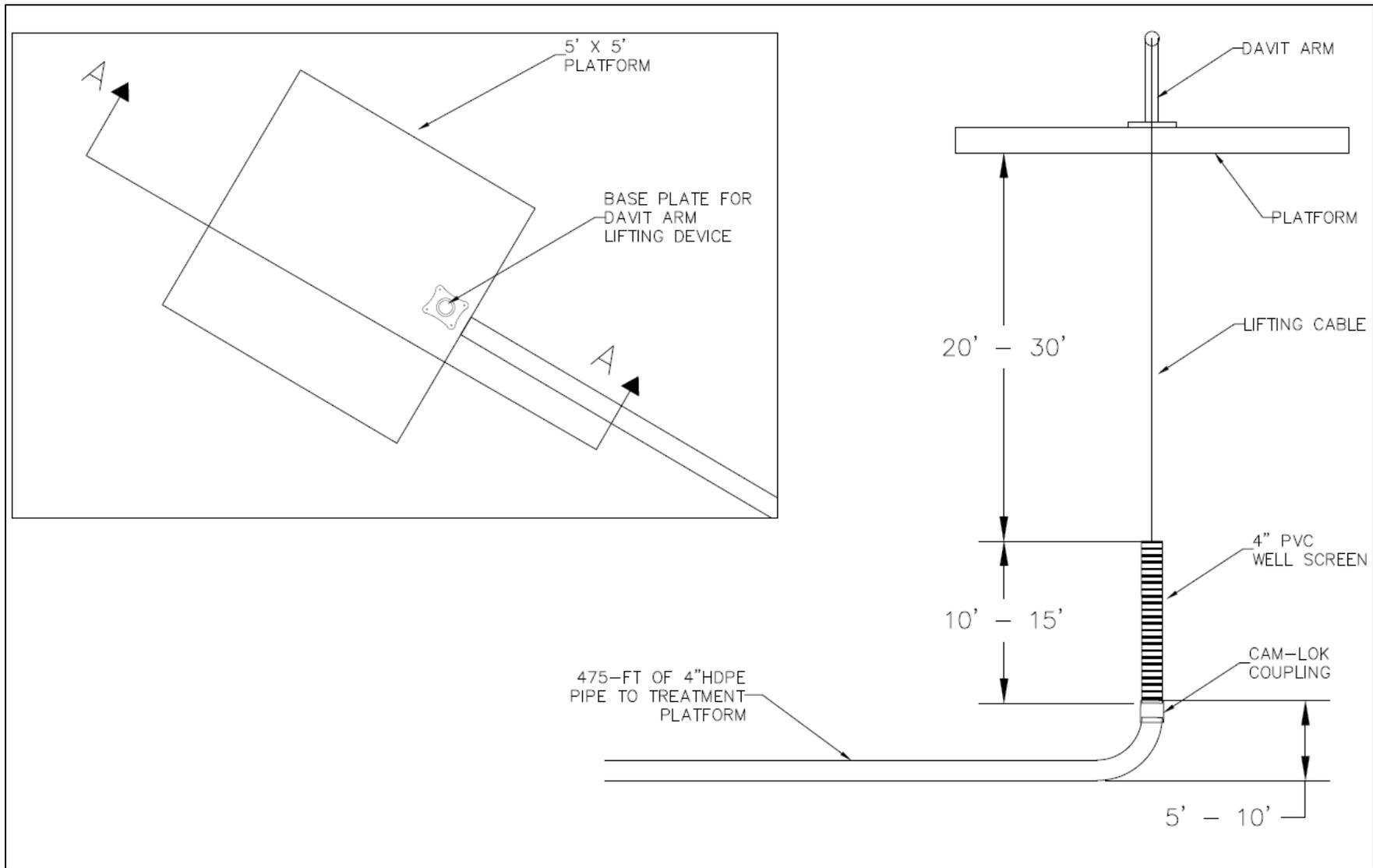


Figure 10-3 Water Withdrawal Piping Section and Platform Plan View for Control of Water Elevation Extraction

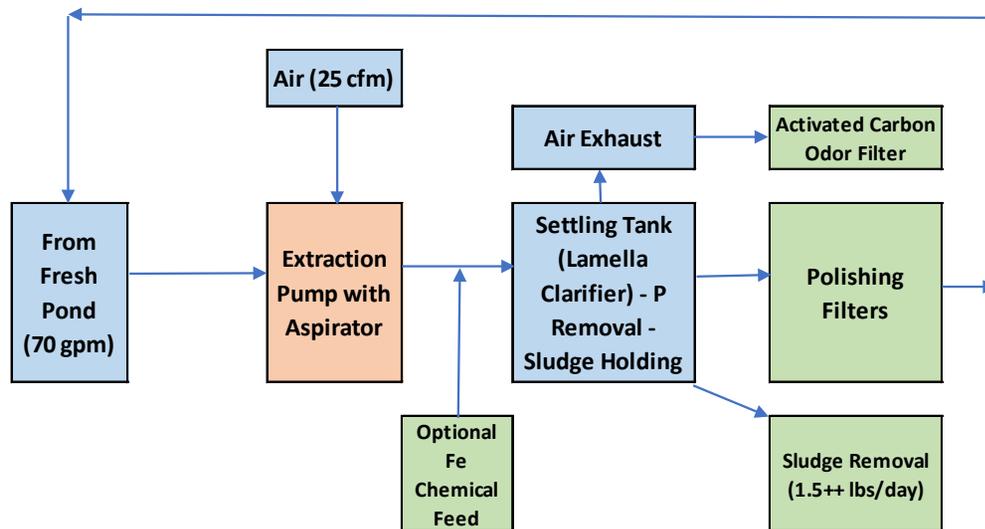
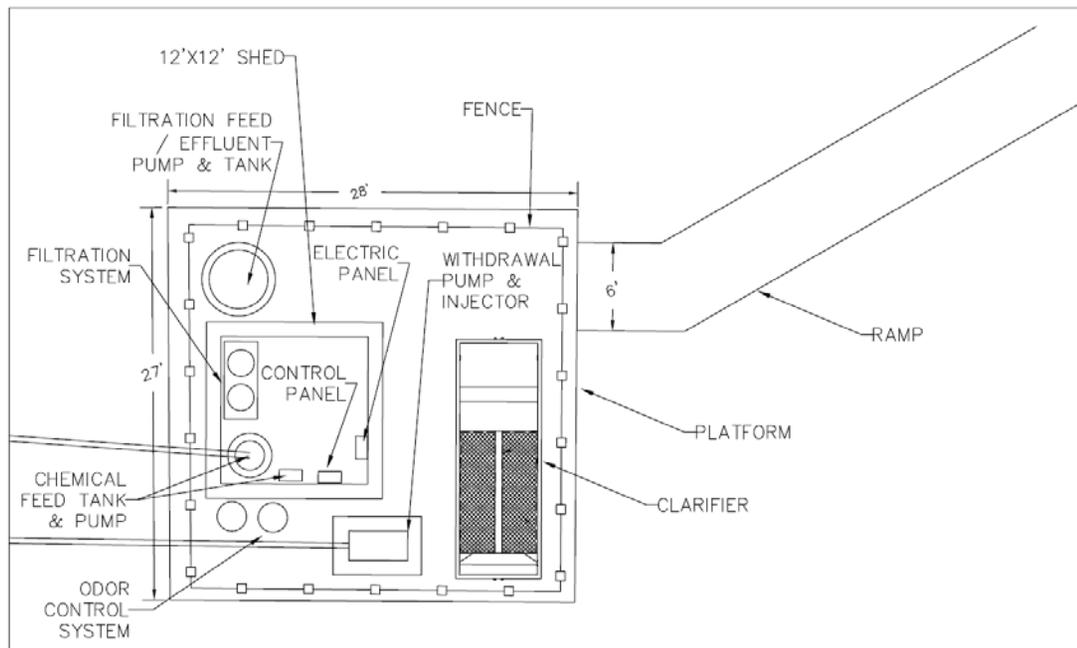


Figure 10-4 Full Scale HW-P Removal System – Process Flow Diagram & Layout

10.2 CAPITAL & O&M COST ESTIMATES

Tables 10-2 presents a summary by labor, expenses and equipment categories for the project phases of I. Proof of Concept Program; II. Pilot Program; III. Full Scale System and Operations for 8 years.

Table 10-2 Cost Summary for Project Phases

Task #	Task Description	Budget	Labor	Expenses (lab, etc.)	Equipment	Engineering & Admin	Total
1	Proof of Concept	\$49,761	\$ 21,780	\$ 12,381	\$ 12,600	\$ 3,000	\$ 49,761
2	Pilot Scale System	\$226,166	\$ 33,210	\$ 35,456	\$ 127,500	\$ 30,000	\$226,166
3	Full Scale System	\$367,950					
4	8 Years O&M	\$514,110					
	Total	\$1,157,987					

The pilot scale costs include extraction and disposal piping which would be used for the full-scale system. Table 10-3 (same as Table 9-2) presents the capital and annual O&M cost estimates for the full scale HW Treatment System.

Table 10-3 Capital and Annual O&M Cost Estimates - Full Scale HW Treatment System

Full Scale Fresh Pond Hypolimnetic Withdrawal - Opinion of Probable Capital Cost				
Activity	Quantities	Units	Unit Cost	Activity Costs
Mobilization / Demob	1	LS	\$15,000	\$15,000
Platform on Fresh Pond	30' x 30'	LS	\$25,000	\$25,000
Extraction & Disposal Piping	installed in pilot phase			\$0
Water Treatment System (Furnish & Install)	1	LS	\$150,000	\$150,000
Sediment characterization	1	LS	\$15,000	\$15,000
Subtotal - HW Construction Costs				\$205,000
Miscellaneous	10%	%	\$205,000	\$20,500
Contingency	20%	%	\$205,000	\$41,000
Engineering, Permitting & Admin	1	LS	\$68,000	\$68,000
Total - HW Capital Costs (2022 \$)				\$334,500
Total - HW Capital Costs (2024 \$)				\$367,950
				\$299,950
Full Scale Fresh Pond Hypolimnetic Withdrawal - Opinion of Probable Annual O&M Cost				
Activity	Quantities	Units	Unit Cost	Activity Costs
Electricity	13,140	kwh	\$0.24	\$3,154
Labor	36	days	\$800	\$28,800
Lab costs	1	LS	\$9,250	\$9,250
Misc. / Contingency / Equip. Repair	1	LS	\$5,000	\$5,000
Professional Oversight	1	LS	\$15,000	\$15,000
Subtotal - HW Annual O&M Costs (2023)				\$61,204
Total 8 Years HW Annual O&M Costs with 5% inflation allowance				\$514,110

Capital cost estimates for the Proof of Concept and Pilot Scale project phases are presented on Tables 10-4 and 10-5, respectively. Proof of Concept and Pilot Scale O&M cost estimates are presented on Table 10-2.

Table 10-4 Capital Cost Estimates - Pilot Scale HW Treatment System

Pilot Project Fresh Pond HW - Opinion of Probable Cost				
Activity	Quantities	Units	Unit Cost	Activity Costs
Mobilization / Demob	1	LS	\$8,000	\$8,000
Extraction & Disposal Piping	1,000	LF	\$25	\$25,000
Water Treatment System (Furnish & Install)	1	LS	\$52,000	\$52,000
Subtotal - HW Construction Costs				\$85,000
Miscellaneous	25%	%	\$85,000	\$21,250
Contingency	25%	%	\$85,000	\$21,250
Engineering, Permitting & Admin	1	LS	\$30,000	\$30,000
Total - HW Capital Costs (2023 \$)				\$157,500

Table 10-5 Capital Cost Estimates – Proof of Concept HW Treatment System

Fresh Pond HW Proof Concept - Opinion of Probable Cost				
Activity	Quantities	Units	Unit Cost	Activity Costs
Mobilization / Demob	1	LS	\$4,000	\$4,000
Sampling & Testing Equipment	1	LF	\$5,000	\$5,000
Subtotal - HW Construction Costs				\$9,000
Miscellaneous	20%	%	\$9,000	\$1,800
Contingency	20%	%	\$9,000	\$1,800
Engineering, Permitting & Admin	1	LS	\$3,000	\$3,000
Total - HW Capital Costs (2023 \$)				\$15,600

10.3 PERMITTING REQUIREMENTS

Project permitting would be by NYSDEC for the following permits as described at <https://www.dec.ny.gov/permits/96314.html>:

- ✓ Protection of Waters Permit and/or Water Quality Certificate
- ✓ Freshwater Wetland Permit

10.4 IMPLEMENTATION PLAN, SCHEDULE & FUNDING

Table 10-4 presents the proposed program schedule by phase. The project would be implemented by the Town of Shelter Island with oversight/project management by the Town Engineer.

It is expected that the Fresh Pond remediation project funding would come in part from the New York State Department of Environmental Conservation (NYSDEC) Water Quality Improvement Program (WQIP), <https://www.dec.ny.gov/pubs/4774.html>. The project's local share would be provided through the Town's Community Preservation Funds (CPF) and private contributions via the Fresh Pond Neighborhood Association (FPNA). Both the Town and FPNA provided funding for this Report.

10.5 LONG TERM OPERATIONS & MAINTENANCE

The Town of Shelter Island will provide long term Operations & Maintenance (O&M) through the Town Engineer. It is expected that a private contractor will be retained by the Town to provide project engineering oversight and O&M. Yearly reports will be issued on the operations of the HW treatment system and providing documentations on any Fresh Pond water quality improvements.

10.6 MISCELLANEOUS

As noted in this Report, internal load represents >80% of the total. Therefore, external sources of nutrients are a minor component of the Pond's nutrient budget. Consequently, no controls of external nutrient sources are needed. This Report identifies significant internal waterbody loading and justification for use of the BMP of hypolimnetic withdrawal.

Table 10-4 HW Treatment Program Schedule

Schedule		Fresh Pond Shelter Island In-Waterbody Control for Nutrients - Corrective Action Implementation											
Months after Receipt of Authorization to Proceed		1	2	3	4	5	6	7	8	9	10		
Phase	Activity Description	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23		
1	Proof of Concept												
2	Pilot Project												
3	Full Scale Project	11	12	13	14	15	16	17	18	19	20	21	22
		Nov-23	Dec-23	Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24	Oct-24
3a	Design												
3b	Construction Bidding Process												
3c	Construction / System Install												
3d	System Start-Up Performance Testing												
3e	1st Full Year operation	27	28	29	30	31	32	33	34	35			
		Mar-25	Apr-25	May-25	Jun-25	Jul-25	Aug-25	Sep-25	Oct-25	Nov-25			
3f	Annually Years 2 - 8 +/- operation	March	April	May	June	July	August	Sept	Oct	Nov			

10.7 LYNGBYA BLOOM AREA MANAGEMENT

Techniques that can control the Lyngbya/Microseira mats include:

1. Algaecides
2. Physically rake the mats and dispose of on land
3. Use a suction device to remove them and then bag them for disposal

There are multiple filamentous green algae that form mats in the pond, especially in that area adjacent to the primary public access where the Lyngbya/Microseira has been found. These are not toxic, but are unsightly, can produce odors, and are not conducive to the best recreational experience. Such mats can also be controlled by the above approaches.

Algaecides are usually copper- or peroxide-based and are commonly permitted and applied for the control of algae, planktonic blooms or benthic mats. It is preferable to treat before the algae become abundant, limiting release of decay products including oxygen-demanding substances, and a well-timed algaecide treatment can prevent mats or blooms from forming. This requires monitoring and vigilance; treatment after mats have formed will be less effective, as it is difficult to get the algaecide in contact with the whole algae mass. Often the outer layer of a mat is killed but inner cells remain viable and rejuvenate the mat. Early treatment when mats are starting to form is therefore highly recommended. Algaecide treatment is inexpensive, typically <\$100/acre, although the mobilization cost associated with reaching Fresh Pond may be substantial if a local contractor is not available. A cost of <\$1,000 is anticipated per treatment, and a single treatment in any year should be sufficient if timed well and performed properly.

Algal mats can be physically raked and collected for disposal. This is laborious over any substantial area but could be workable for just the small area adjacent to the public access point. Long-handled rakes for this purpose can be purchased for <\$250 and raked material can be left to dry near the pond or trucked to a disposal site. The cost will depend on labor rates and distance to a disposal site but should not be more than about \$2,000 for a thorough removal operation in that small area. Removal by this approach will not likely be complete, so some regrowth is to be expected and the process may have to be repeated, at least annually but possibly twice per summer.

Using a suction device to remove algal mats is more efficient than raking and would move mats to some form of container suitable for transport to a disposal site. Addressing the target area would only take about 4 hours with appropriate equipment, such as a modified catch basin cleaner or what is commonly called a trash pump. While there is some labor cost, the primary investment is in the proper suction equipment, which could range from <\$1,000 to over \$100,000 if a catch basin cleaning truck is employed. If the Town owns such equipment, this could be a very economical approach and could greatly enhance the appearance as well as safety of the target area. A suction hose extending from the pump would be used by someone wading or in a boat to suck up the mats, routing them to either a water-tight container or preferably a fine mesh bag that would capture the mat material but allow water to drain. If allowed to stand undisturbed for a few days, the actual mass of algae mat to be disposed of could be very small, algae being typically >80% water.

APPENDIX A SHELTER ISLAND GROUNDWATER DATA

<u>Figure</u>	<u>Description</u>
A-1	Active USGS Shelter Island Groundwater Wells
A-2	Active USGS S 38461.1 Well Groundwater Elevations
A-3	Active USGS S 90279.1 Well Groundwater Elevations
A-4	Active USGS S 51177.1 Well Groundwater Elevations
A-5	Active USGS S 51176.1 Well Groundwater Elevations
A-6	Inactive USGS Shelter Island Groundwater Wells

<u>Table</u>	<u>Description</u>
A-1	Groundwater Quality Data - USGS S 51177.1 Well
A-2	Groundwater Quality Data - USGS S 52050.1 Well
A-3	Groundwater Quality Data - USGS S 51175.1 Well
A-4	Groundwater Quality Data - USGS S 90279.1 Well

Table A-1 GW Well Locations

Active Wells

- S 38461.1** Lat 41°04'01.3", Long 72°19'51.7" NAD83. Land-surface elevation 12.0 feet above NGVD29. Congon Road at South Ferry Road
- S 51177.1*** Lat 41°03'16.5", Long 72°19'27.8" NAD83. Well depth: 39. Feet, Land surface altitude: 17.5 feet above NGVD29. South Ferry Road at Valley Road.
- S 90279. 1**** Lat 41°02'52.4", Long 72°19'32.7" NAD83. Land-surface elevation 20.0 feet above NGVD29. The depth of the well is 22.5 feet below land surface. Osprey Road at Heron Lane
- S 51176.1*** Lat 41°04'30.6", Long 72°20'22.4" NAD83. Land-surface elevation 39.6 feet above NGVD29. The depth of the well is 59 feet below land surface. North ferry Road at Manwaring Road (IGA).

* Limited historical water quality data exists

** 2018 data

Figure A-1 Active USGS Shelter Island Groundwater Wells



* Limited historical water quality data exists

**2018 water quality data

Figure A-2 Active USGS S 38461.1 Well Groundwater Elevations

USGS 410400072195301 S 38461. 1

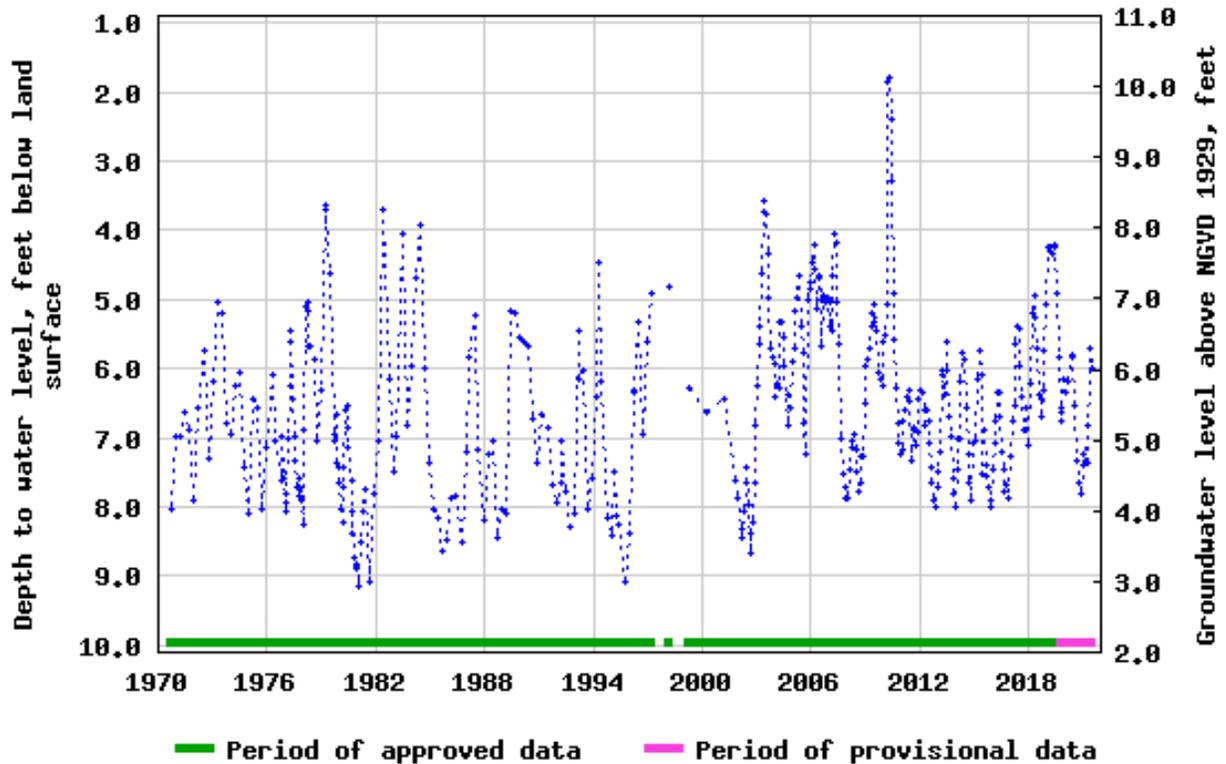


Figure A-3 Active USGS S 51177.1 Well Groundwater Elevations

USGS 410316072192901 S 51177. 1

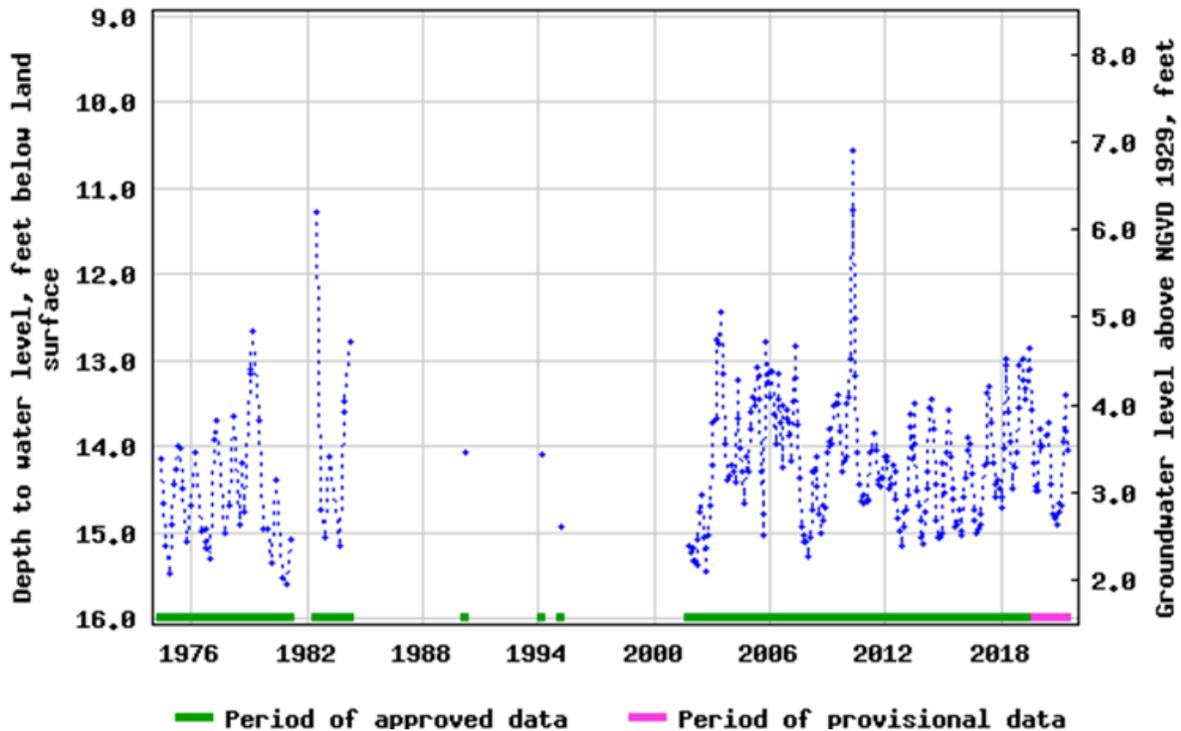


Figure A-4 Active USGS S 90279.1 Well Groundwater Elevations

USGS 410253072192601 S 90279. 1

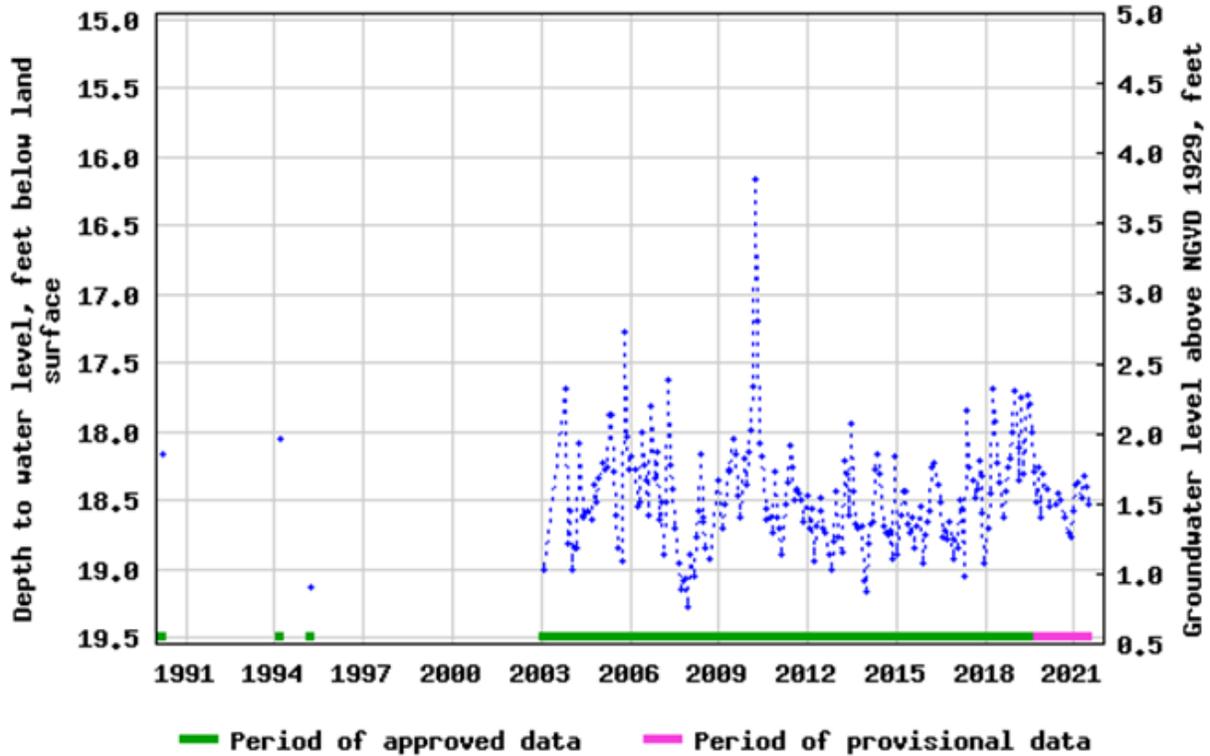


Figure A-5 Active USGS S 51176.1 Well Groundwater Elevations

USGS 410430072202301 S 51176. 1

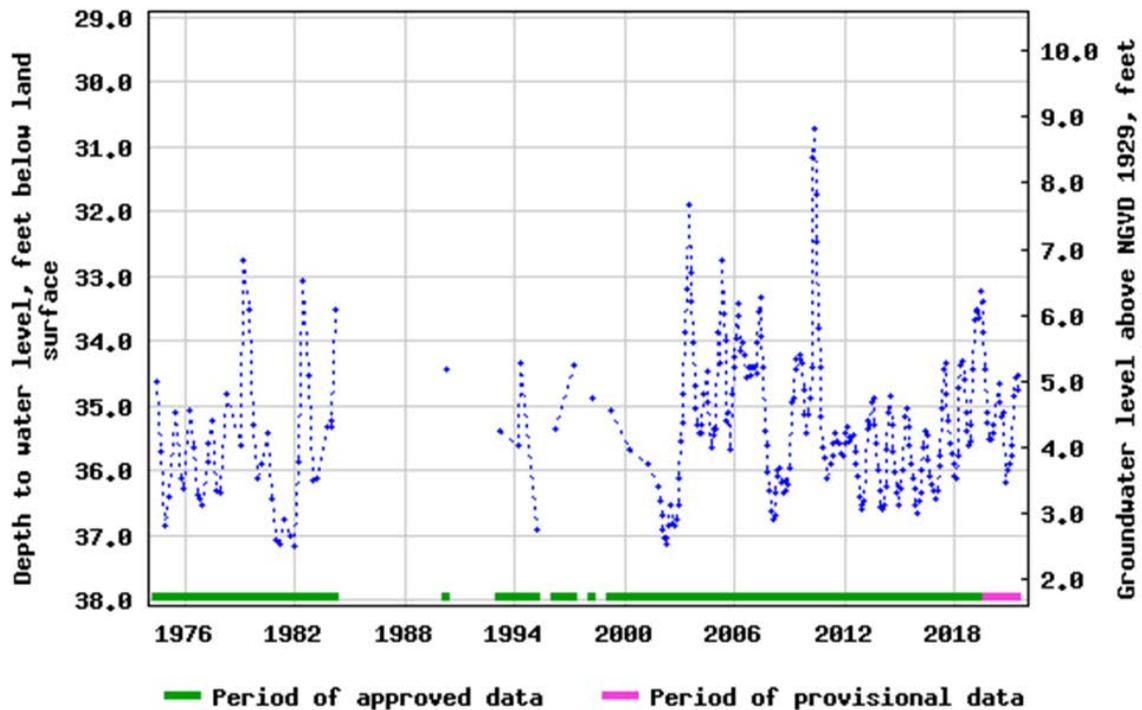


Figure A-6 Inactive USGS Shelter Island Groundwater Wells

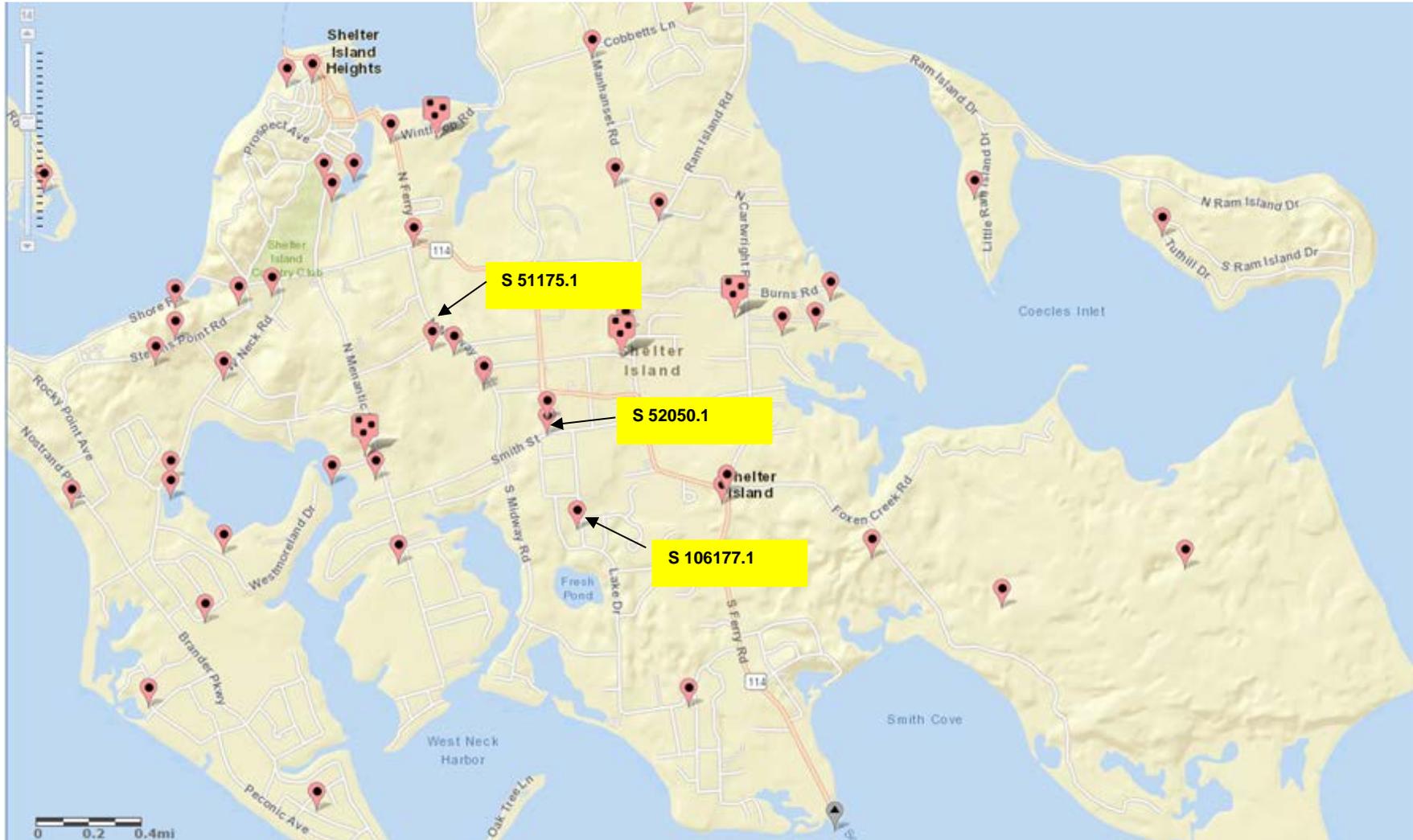


Table A-1 Groundwater Quality Data - USGS S 106177.1 Well

Ground Water Quality Data - USGS Well		# S106177.1	
Latitude 41°03'40", Longitude 72°20'12" NAD27			
Land-surface elevation 30.3 feet above NGVD29			
Well depth is 70 feet below land surface. Hole depth 73 bls			
Location: on ~ 30 Baldwin Road north of Strawberry Lane			
Constituent \ Date	12/2/2016	11/8/2017	9/27/2018
Temp (°C)	12.8	13.0	13.9
Specific Cond (us/cm)	206	202	189
D.O. (mg/L)	9.0	7.8	6.8
pH	6.6	5.8	5.9
Organic N (mg/L)	0.33	0.09	
Ammonia-N (mg/L)	0.01	0.02	0.02
Nitrite-N + Nitrate-N (mg/L)	5.95	5.36	4.9
Ortho-phosphate-P (mg/L)	0.026	0.031	0.037
Iron (mg/L)	0.0118	<.010	0.0265
screen zone is 55-60 ft below top of the well casing (which is ~ 31). Therefore MW is 24 - 29' into GW			

Table A-2 Groundwater Quality Data - USGS S 52050.1 Well

Ground Water Quality Data - USGS Well #		# S52050.1	
Latitude 41°03'59", Longitude 72°20'20" NAD27			
Land-surface elevation 44.0 feet above NGVD29			
Well depth is 64 feet below land surface			
Location: 33 N Ferry Rd, School District Well			
Constituent \ Date	10/12/2016	11/17/2003	
Temp (°C)	15.3	15.1	
Specific Cond (us/cm)	480	512	
D.O. (mg/L)	6.1		
pH	5.7	5.5	
Organic N (mg/L)	0.71		
Ammonia-N (mg/L)	0.13	<0.04	
Nitrite-N + Nitrate-N (mg/L)	11.2	34.9	
Ortho-phosphate-P (mg/L)	0.004	<0.02	
Iron (mg/L)			

Table A-3 Groundwater Quality Data - USGS S 51175.1 Well

Ground Water Quality Data - USGS Well		# S51175.1	
Latitude 41°04'16", Longitude 72°20'51" NAD27			
Land-surface elevation 39.5 feet above NGVD29			
Well depth is 60 feet below land surface.			
Location: on ~ Bowditch Road at N. Midway Road			
Constituent \ Date	11/19/2018		
Temp (°C)	12.3		
Specific Cond (uS/cm)	470		
D.O. (mg/L)			
pH	6.6		
Organic N (mg/L)	0.34		
Ammonia-N (mg/L)	7.7		
Nitrite-N + Nitrate-N (mg/L)	5.22		
Ortho-phosphate-P (mg/L)	0.018		
Iron (mg/L)	0.200		

Table A-4 Groundwater Quality Data - USGS S 90279.1 Well

Ground Water Quality Data - USGS Well		S 90279.1	
Latitude 41°02'52.4", Longitude 72°19'32.7" NAD83			
Land-surface elevation 20.0 feet above NGVD29			
Well depth is 22.5 feet below land surface.			
Location: on			
Constituent \ Date	11/8/2017		
Temp (°C)	12.8		
Specific Cond (uS/cm)	230		
D.O. (mg/L)	<1.0		
pH	5.6		
Organic N (mg/L)	0.26		
Ammonia-N (mg/L)	0.07		
Nitrite-N + Nitrate-N (mg/L)	7.01		
Ortho-phosphate-P (mg/L)	0.024		
Iron (mg/L)			
N/P ratio by weight	306		

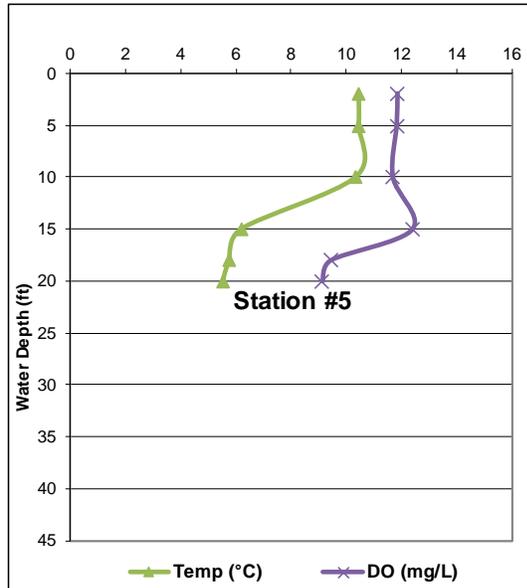
APPENDIX B FRESH POND TEMPERATURE & DISSOLVED OXYGEN DATA

Temperature and dissolved oxygen profiles for the stations shown on Figure 6-1 and listed on Table 6-1 on April 6, 19 and 30, 2021 and May 21, 2021 are presented in this Appendix.

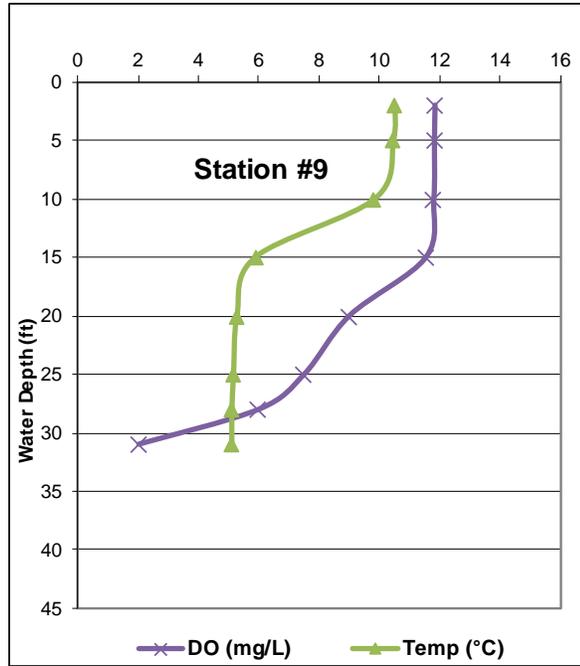
- Temperature, dissolved oxygen concentration and conductivity were measured with a YSI 626650 ProSolo Digital Water Quality Meter <https://www.ysi.com/prosolo>.
- Water depth was measured with HawkEye DepthTrax 1H Handheld Digital Depth Sounder <https://hawkeyelectronics.com/products/depthtrax-1h-handheld-depth-finder>.
- Location latitude / longitude was identified with a Garmin GPSMap 78S.
- Secchi disc measurements were made disc obtained from Nova-Tech International

APRIL 6, 2021

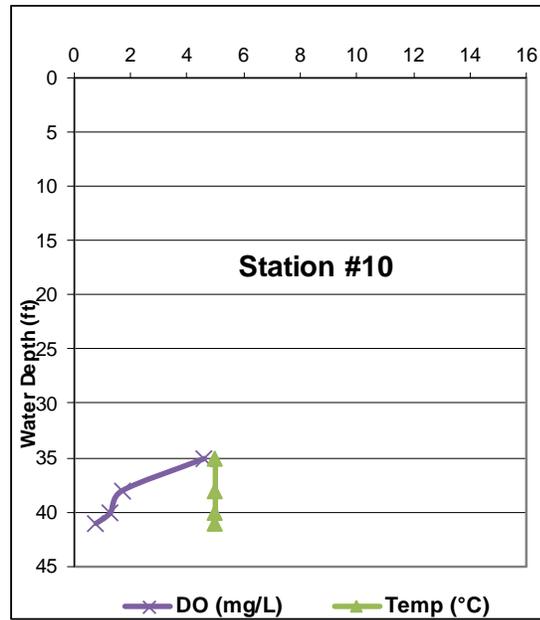
Station	5		Date
Bot. Depth (ft)	20.6		4/6/21
Lat. / Long.	41.057000	-72.335061	
Depth (ft)	Temp (°C)	Temp (°F)	DO (mg/L)
2	10.4	50.8	11.85
5	10.4	50.8	11.82
10	10.3	50.6	11.68
15	6.2	43.1	12.40
18	5.7	42.3	9.42
20	5.5	41.9	9.12



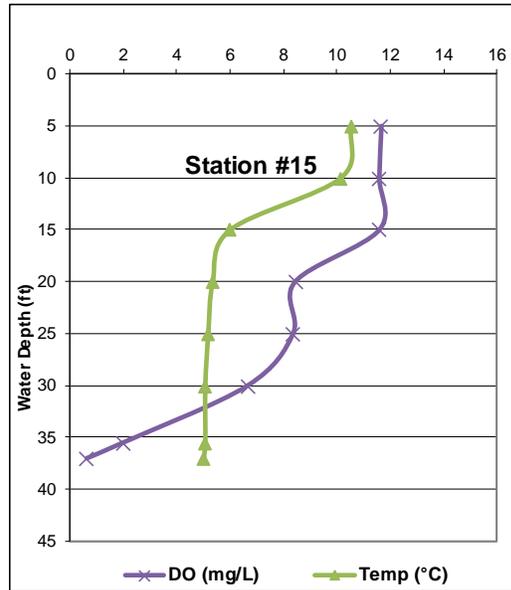
Station	9		Date
Bot. Depth (ft)	31.6		4/6/21
Lat. / Long.	41.057005	-72.335423	
Depth (ft)	Temp (°C)	Temp (°F)	DO (mg/L)
2	10.5	50.9	11.84
5	10.4	50.8	11.82
10	9.8	49.7	11.80
15	5.9	42.6	11.54
20	5.3	41.5	9.00
25	5.2	41.3	7.50
28	5.1	41.2	6.00
31	5.1	41.2	2.00



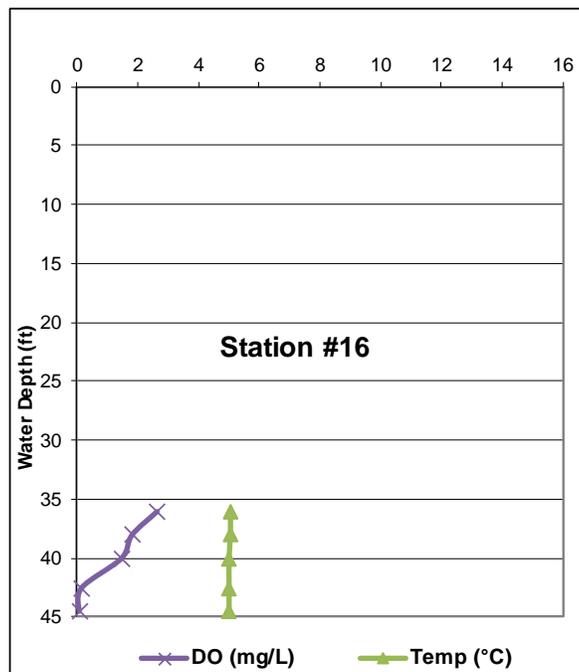
Station	10		Date
Bot. Depth (ft)	42		4/6/21
Lat. / Long.	41.057280	-72.335416	
Depth (ft)	Temp (°C)	Temp (°F)	DO (mg/L)
35	5.0	41.0	4.65
38	5.0	41.0	1.72
40	5.0	41.0	1.32
41	5.0	41.0	0.81



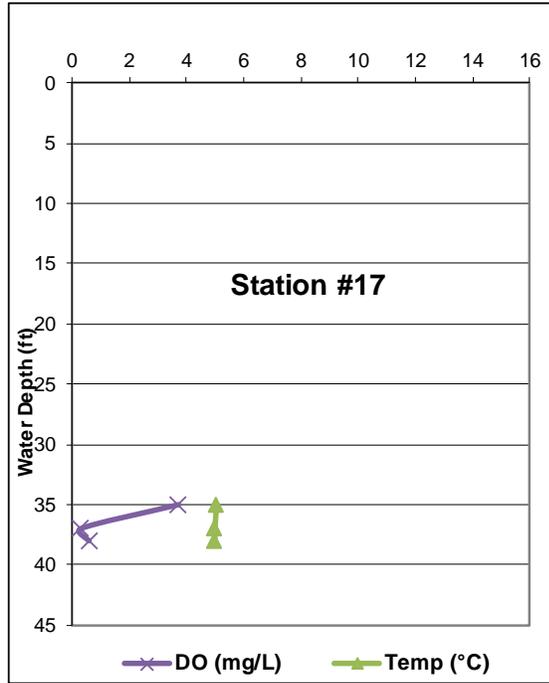
Station	15		Date
Bot. Depth (ft)	39.5		4/6/21
Lat. / Long.	41.057010	-72.335786	
Depth (ft)	Temp (°C)	Temp (°F)	DO (mg/L)
5	10.6	51.0	11.68
10	10.2	50.3	11.60
15	6.0	42.8	11.60
20	5.3	41.6	8.45
25	5.2	41.3	8.37
30	5.1	41.1	6.67
35.5	5.1	41.1	2.00
37	5.0	41.0	0.65



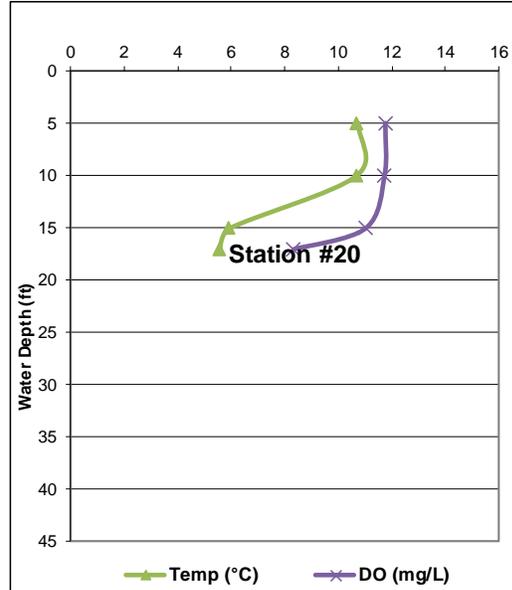
Station	16		Date
Bot. Depth (ft)	46.4		4/6/21
Lat. / Long.	41.057285	-72.335779	
Depth (ft)	Temp (°C)	Temp (°F)	DO (mg/L)
36	5.1	41.1	2.62
38	5.1	41.1	1.80
40	5.0	41.0	1.45
42.5	5.0	41.0	0.15
44.5	5.0	41.0	0.06



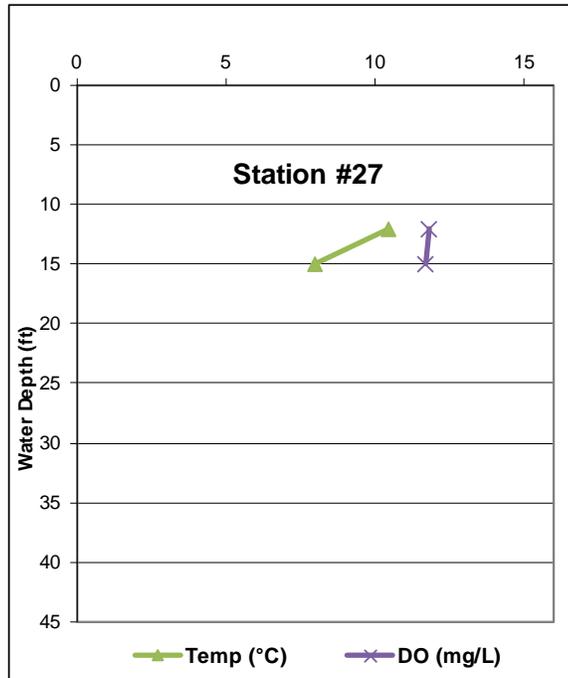
Station	17		Date
Bot. Depth (ft)	39.1		4/6/21
Lat. / Long.	41.057512	72.335800	
Depth (ft)	Temp (°C)	Temp (°F)	DO (mg/L)
35	5.1	41.1	3.75
37	5.0	41.0	0.30
38	5.0	41.0	0.60



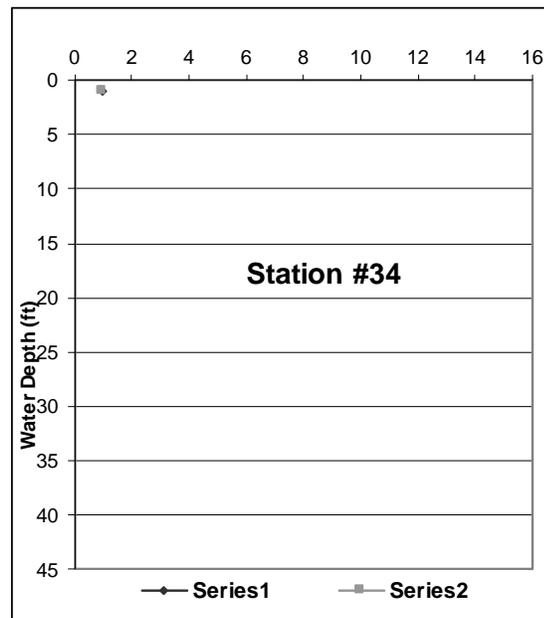
Station	20		Date
Bot. Depth (ft)	17.7		4/6/21
Lat. / Long.	41.056472	-72.336525	
Depth (ft)	Temp (°C)	Temp (°F)	DO (mg/L)
5	10.7	51.3	11.77
10	10.7	51.2	11.74
15	5.9	42.7	11.04
17	5.6	42.0	8.35



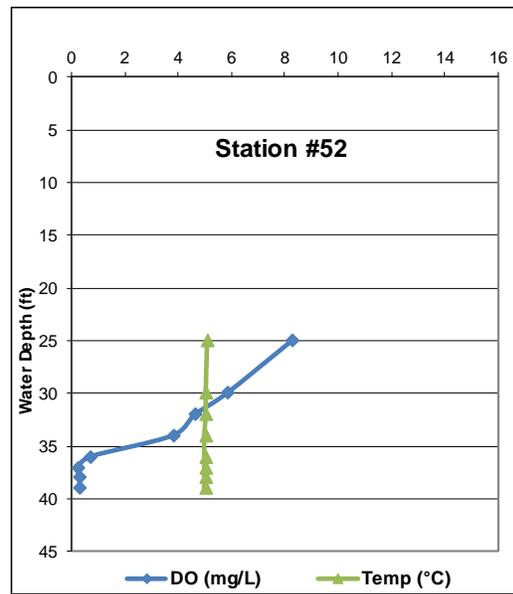
Station	27		Date
Bot. Depth (f)	15		4/6/21
Lat. / Long.	41.056477	-72.336887	
Depth (ft)	Temp (°C)	Temp (°F)	DO (mg/L)
12	10.5	50.9	11.80
15	8.0	46.4	11.70



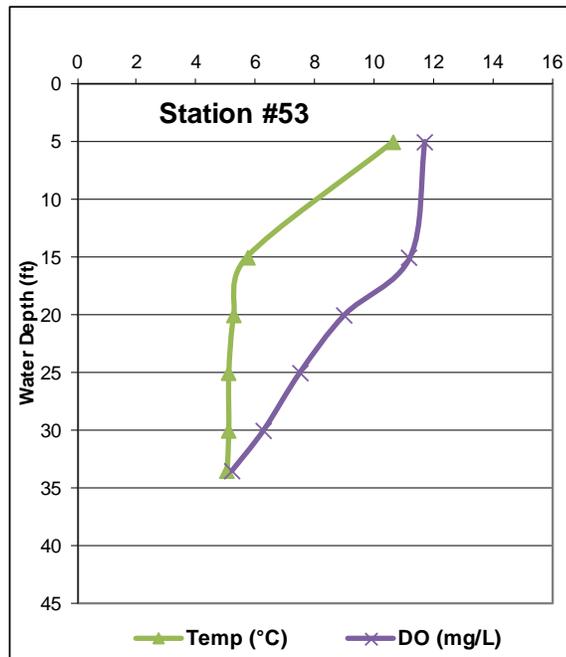
Station	34		Date
Bot. Depth (f)	5.6		4/6/21
Lat. / Long.	41.056482	-72.337250	
Depth (ft)	Temp (°F)	DO (mg/L)	
5	51.6	11.9	



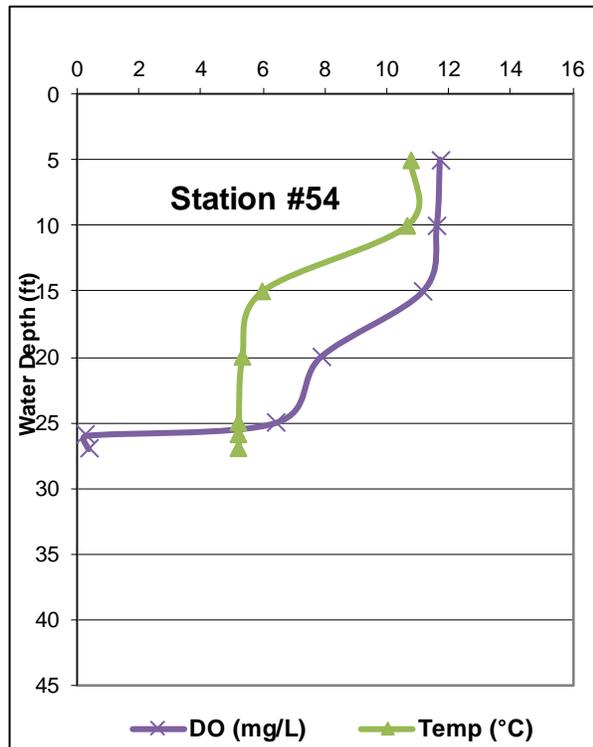
Station	52		Date
Bot. Depth (ft)	39.5		4/6/21
Lat. / Long.	41.057292	-72.336139	
Depth (ft)	Temp (°C)	Temp (°F)	DO (mg/L)
25	5.1	41.2	8.28
30	5.1	41.1	5.83
32	5.1	41.1	4.64
34	5.0	41.0	3.80
36	5.0	41.0	0.70
37	5.0	41.0	0.24
38	5.0	41.0	0.30
39	5.0	41.0	0.30



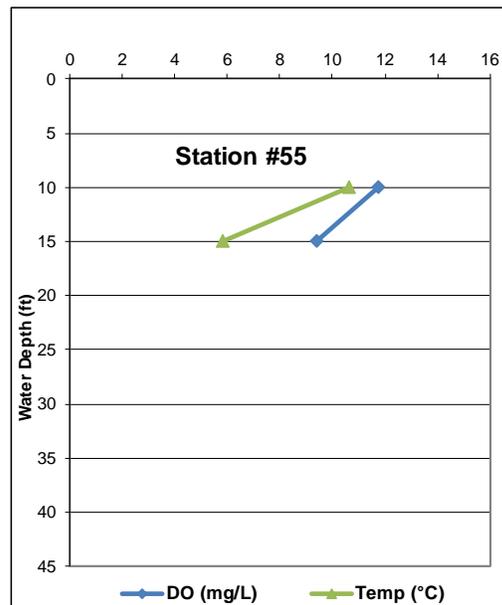
Station	53		Date
Bot. Depth (ft)	35.5		4/6/21
Lat. / Long.	41.057013	-72.336146	
Depth (ft)	Temp (°C)	Temp (°F)	DO (mg/L)
5	10.7	51.2	11.69
15	5.7	42.3	11.20
20	5.3	41.5	9.00
25	5.1	41.2	7.50
30	5.1	41.2	6.28
33.5	5.1	41.1	5.22



Station	54		Date
Bot. Depth (ft)	27.5		4/6/21
Lat. / Long.	41.056740	-72.336148	
Depth (ft)	Temp (°C)	Temp (°F)	DO (mg/L)
5	10.8	51.4	11.74
10	10.7	51.2	11.64
15	6.0	42.8	11.20
20	5.3	41.6	7.90
25	5.2	41.4	6.45
26	5.2	41.4	0.30
27	5.2	41.4	0.40

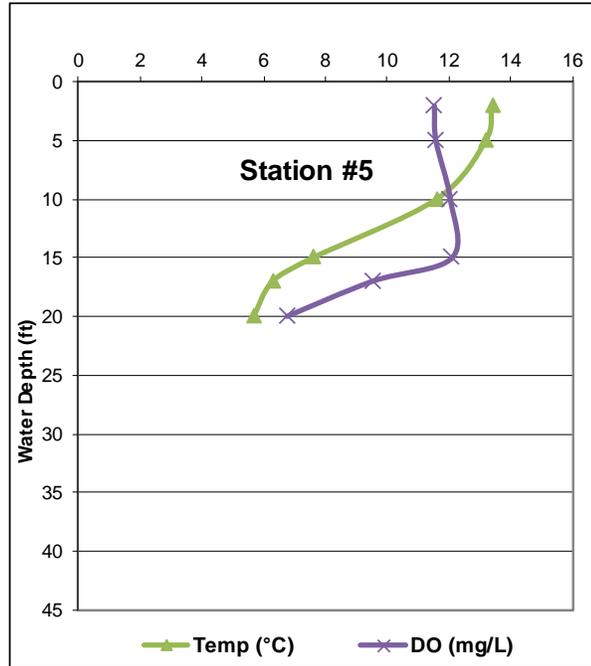


Station	55		Date
Bot. Depth (ft)	15.5		4/6/21
Lat. / Long.	41.056464	-72.336164	
Depth (ft)	Temp (°C)	Temp (°F)	DO (mg/L)
10	10.6	51.1	11.74
15	5.8	42.5	9.40

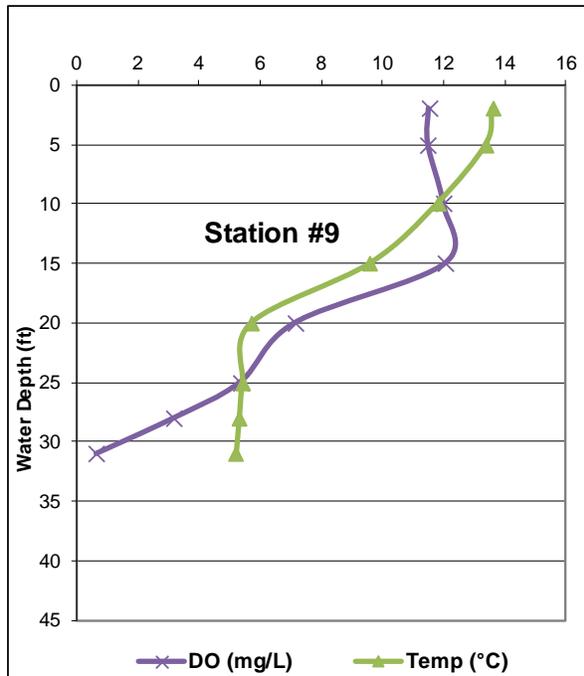


APRIL 19, 2021 DATA

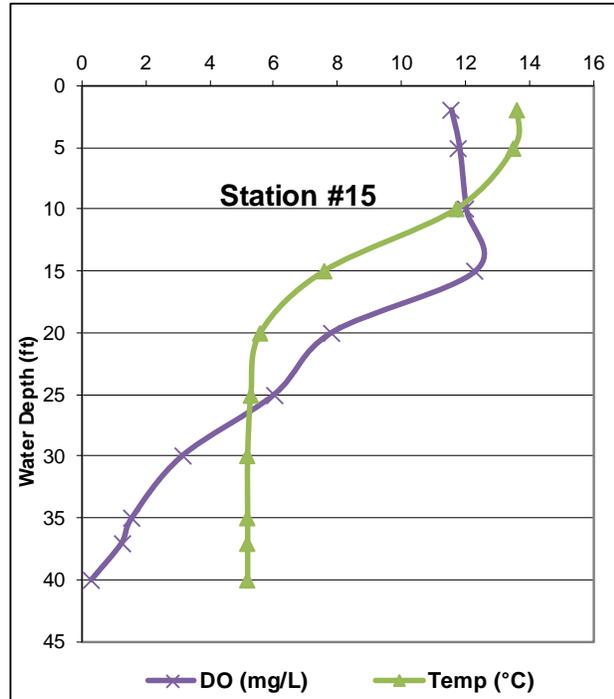
Station		5		Date
Bot. Depth (ft)	20.6		4/19/21	
Lat. / Long.	41.057000	-72.335061		
Depth (ft)	Temp (°C)	Temp (°F)	DO (mg/L)	
2	13.4		11.51	
5	13.2		11.56	
10	11.6		12.03	
15	7.6		12.08	
17	6.3		9.50	
20	5.7		6.73	



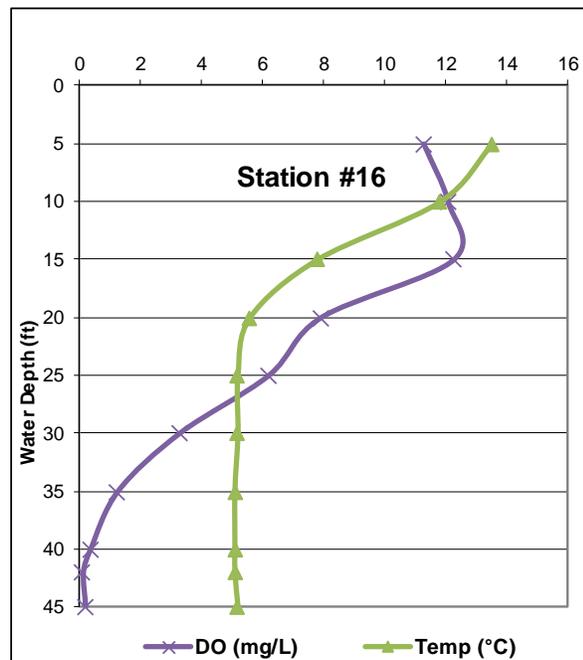
Station		9		Date
Bot. Depth (ft)	31.6		4/19/21	
Lat. / Long.	41.057005	-72.335423		
Depth (ft)	Temp (°C)	Temp (°F)	DO (mg/L)	
2	13.6		11.52	
5	13.4		11.50	
10	11.8		12.00	
15	9.6		12.07	
20	5.7		7.16	
25	5.4		5.36	
28	5.3		3.20	
31	5.2		0.66	



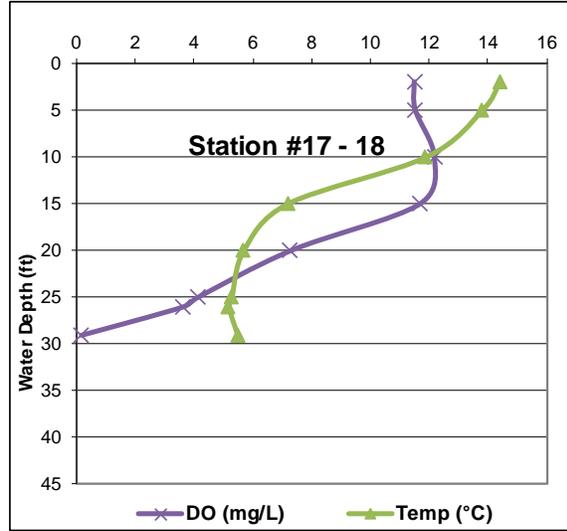
Station	15		Date
Bot. Depth (ft)	40.8		4/19/21
Lat. / Long.	41.057010	-72.335786	
Depth (ft)	Temp (°C)	Temp (°F)	DO (mg/L)
2	13.6		11.54
5	13.5		11.79
10	11.7		12.00
15	7.6		12.30
20	5.6		7.81
25	5.3		6.02
30	5.2		3.14
35	5.2		1.58
37	5.2		1.27
40	5.2		0.32



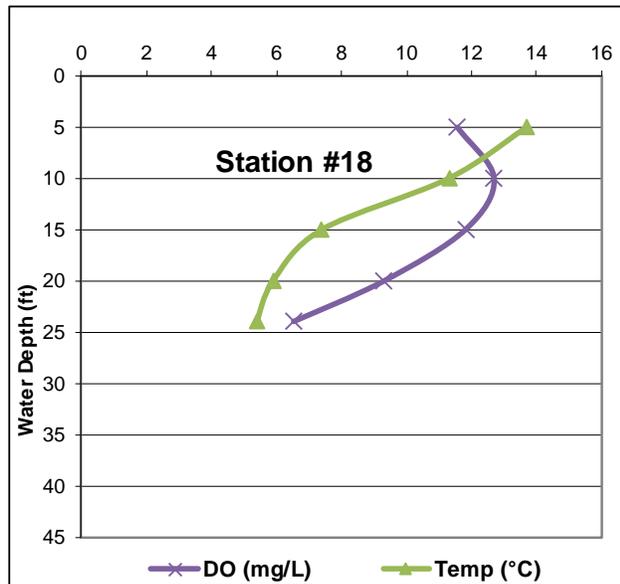
Station	16		Date
Bot. Depth (ft)	46.1		4/19/21
Lat. / Long.	41.057285	-72.335779	
Depth (ft)	Temp (°C)	Temp (°F)	DO (mg/L)
5	13.5		11.28
10	11.8		12.08
15	7.8		12.27
20	5.6		7.92
25	5.2		6.20
30	5.2		3.28
35	5.1		1.25
40	5.1		0.35
42	5.1		0.11
45	5.2		0.18



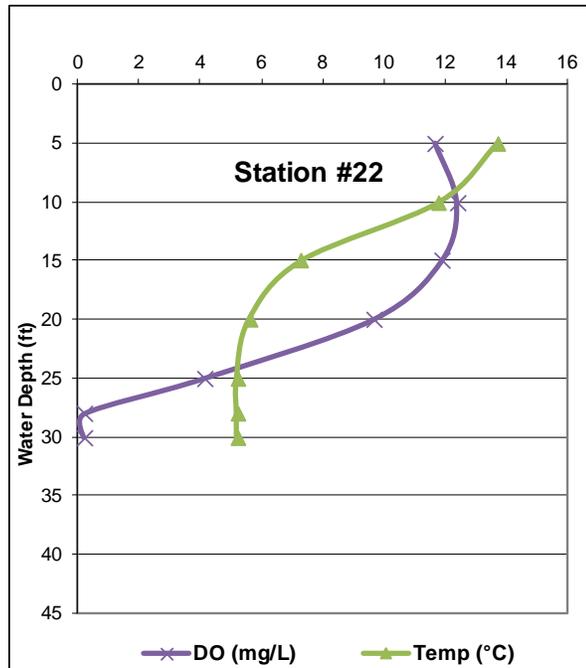
Station	17 - 18		Date
Bot. Depth (ft)	29.9		4/19/21
Lat. / Long.	41.057733	-72.335850	
Depth (ft)	Temp (°C)	Temp (°F)	DO (mg/L)
2	14.4		11.51
5	13.8		11.55
10	11.9		12.20
15	7.2		11.71
20	5.7		7.30
25	5.3		4.13
26	5.2		3.63
29	5.5		0.19



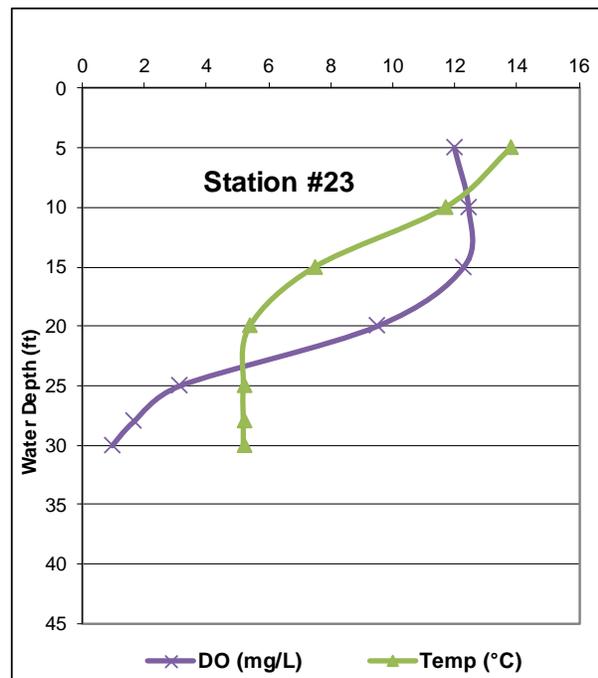
Station	18		Date
Bot. Depth (ft)	24.8		4/19/21
Lat. / Long.	41.057834	-72.335765	
Depth (ft)	Temp (°C)	DO (mg/L)	
5	13.7		11.57
10	11.3		12.70
15	7.4		11.82
20	5.9		9.32
24	5.4		6.51



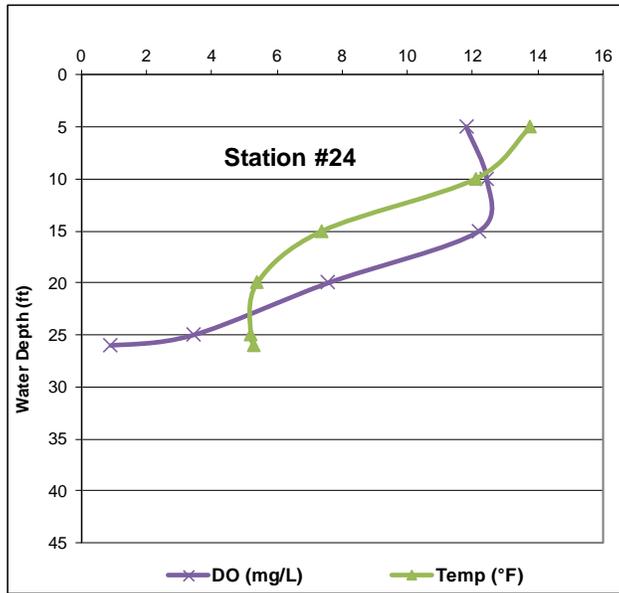
Station	22		Date
Bot. Depth (ft)	30.8		
Lat. / Long.	41.057021	-72.336511	
Depth (ft)	Temp (°C)		DO (mg/L)
5	13.7		11.70
10	11.8		12.40
15	7.3		11.92
20	5.6		9.68
25	5.2		4.14
28	5.2		0.22
30	5.2		0.19



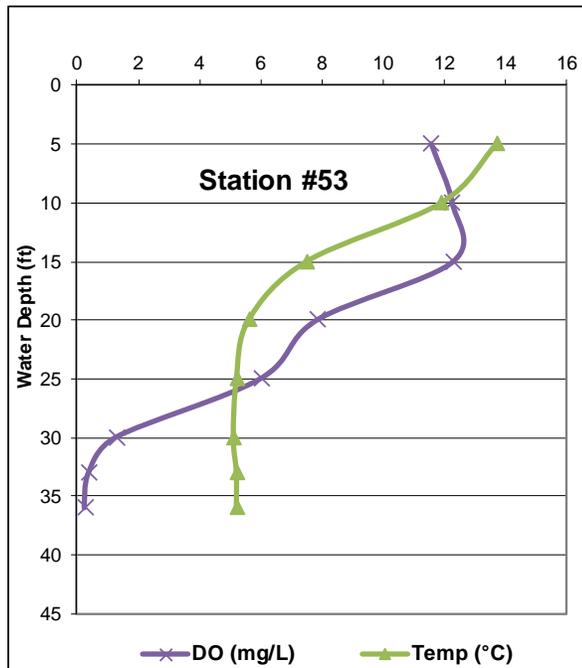
Station	23		Date
Bot. Depth (ft)	31.9		
Lat. / Long.	41.057295	-72.336504	
Depth (ft)	Temp (°C)		DO (mg/L)
5	13.8		11.99
10	11.7		12.45
15	7.5		12.30
20	5.4		9.49
25	5.2		3.13
28	5.2		1.65
30	5.2		0.96



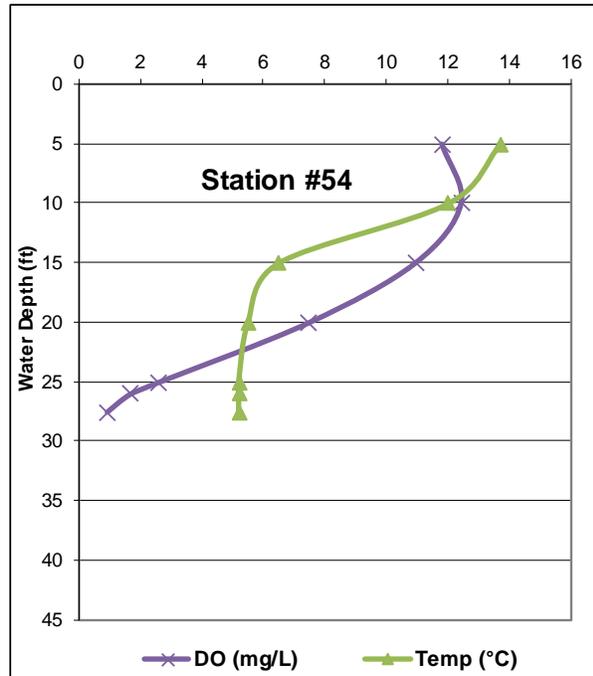
Station	24		Date
Bot. Depth (ft)	26.9		4/19/21
Lat. / Long.	41.057570	-72.336497	
Depth (ft)	Temp (°F)	DO (mg/L)	
5	13.8	11.82	
10	12.1	12.45	
15	7.4	12.22	
20	5.4	7.58	
25	5.2	3.45	
26	5.3	0.93	



Station	53		Date
Bot. Depth (ft)			4/19/21
Lat. / Long.	41.057570	-72.336497	
Depth (ft)	Temp (°C)	DO (mg/L)	
5	13.7	11.55	
10	11.9	12.23	
15	7.5	12.27	
20	5.6	7.83	
25	5.2	5.99	
30	5.1	1.28	
33	5.2	0.40	
36	5.2	0.26	

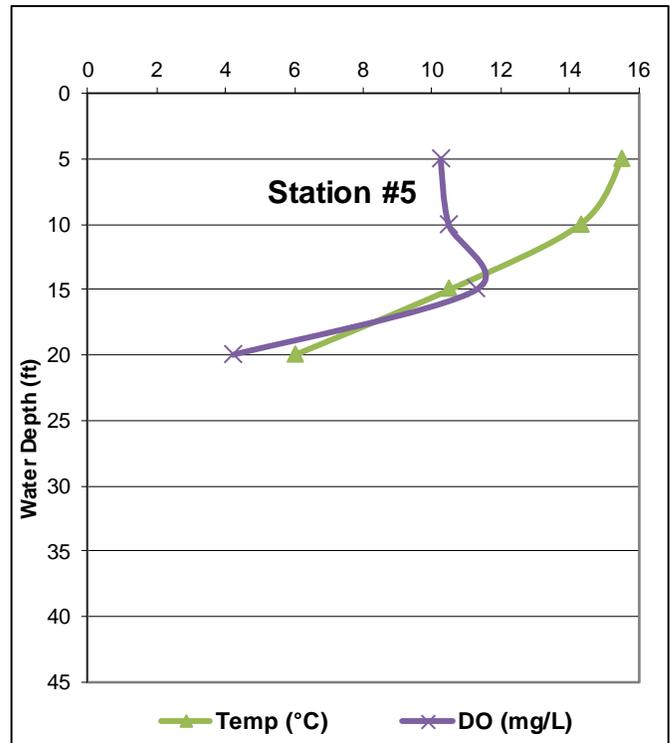


Station	54		Date
Bot. Depth (ft)	28.3		4/19/21
Lat. / Long.	41.056740	-72.336148	
Depth (ft)	Temp (°C)	Temp (°F)	DO (mg/L)
5	13.7		11.82
10	12.0		12.44
15	6.5		10.95
20	5.5		7.49
25	5.2		2.61
26	5.2		1.68
27.5	5.2		0.93

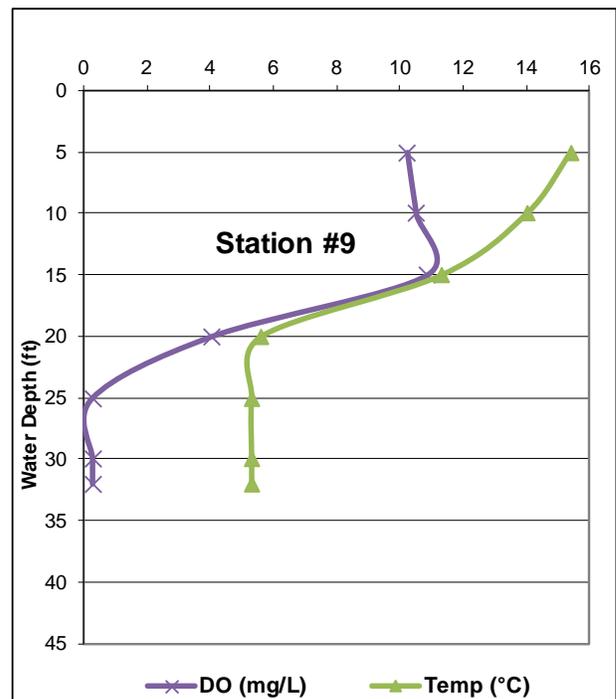


APRIL 30, 2021 DATA

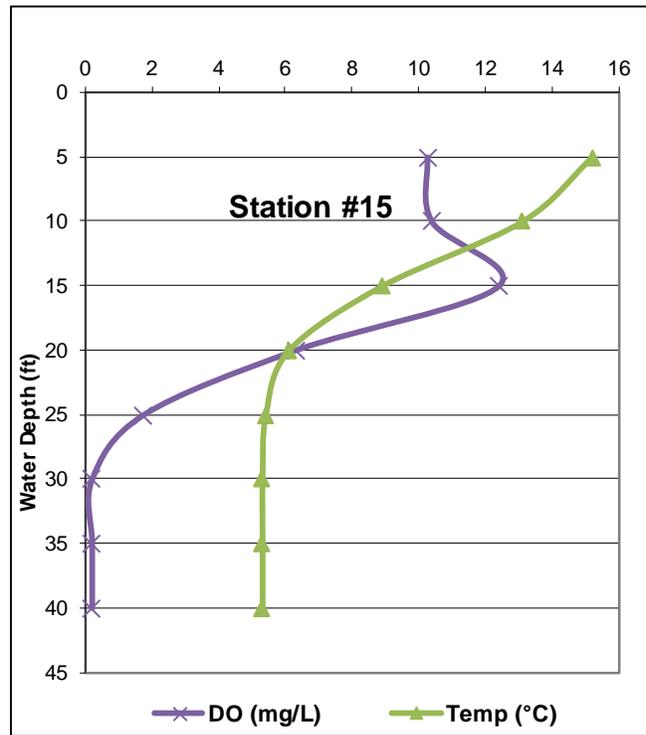
Station	5		Date
Bot. Depth (ft)	20		4/30/21
Lat. / Long.	41.057000	-72.335061	
Depth (ft)	Temp (°C)		DO (mg/L)
2			
5	15.5		10.25
10	14.3		10.48
15	10.5		11.30
20	6.0		4.20



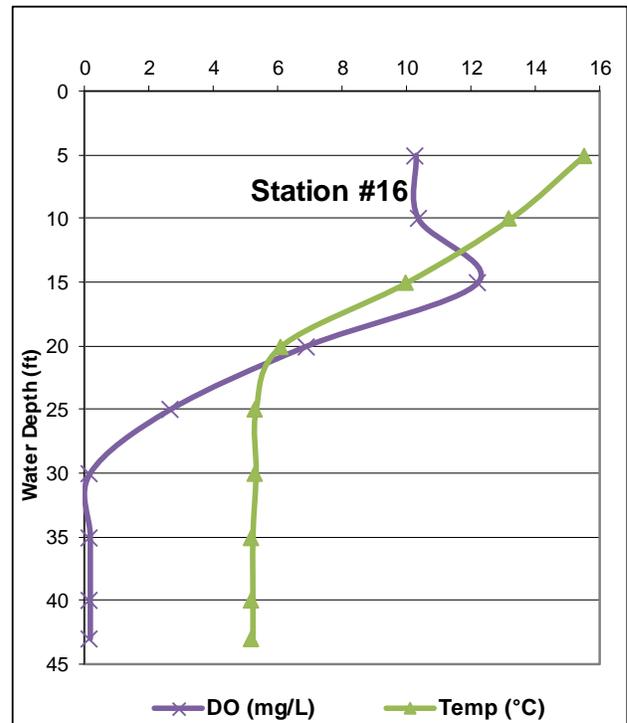
Station	9		Date
Bot. Depth (ft)	32		4/30/21
Lat. / Long.	41.057005	-72.335423	
Depth (ft)	Temp (°C)		DO (mg/L)
5	15.4		10.23
10	14.0		10.51
15	11.3		10.85
20	5.6		4.06
25	5.3		0.30
30	5.3		0.30
32	5.3		0.30



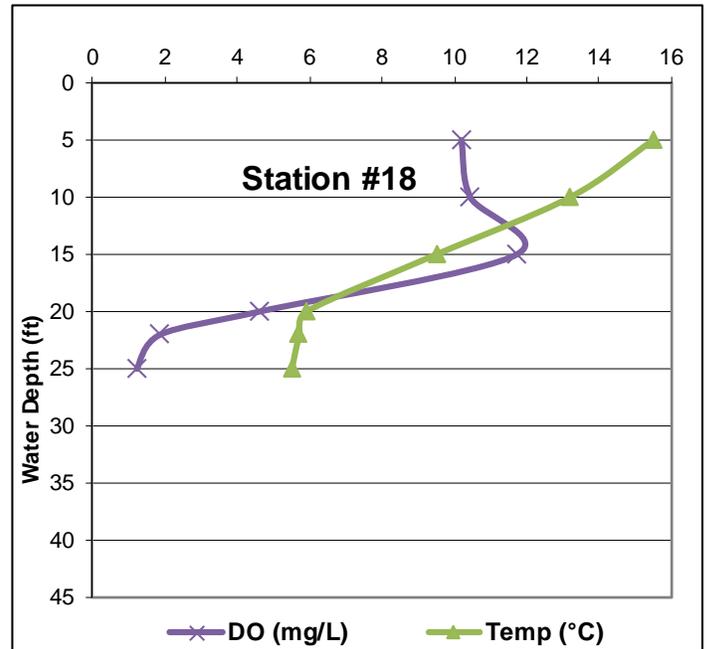
Station	15		Date
Bot. Depth (ft)	40.6		4/30/21
Lat. / Long.	41.057010	-72.335786	
Depth (ft)	Temp (°C)	DO (mg/L)	
5	15.2	10.25	
10	13.1	10.39	
15	8.9	12.40	
20	6.1	6.30	
25	5.4	1.75	
30	5.3	0.20	
35	5.3	0.20	
40	5.3	0.20	



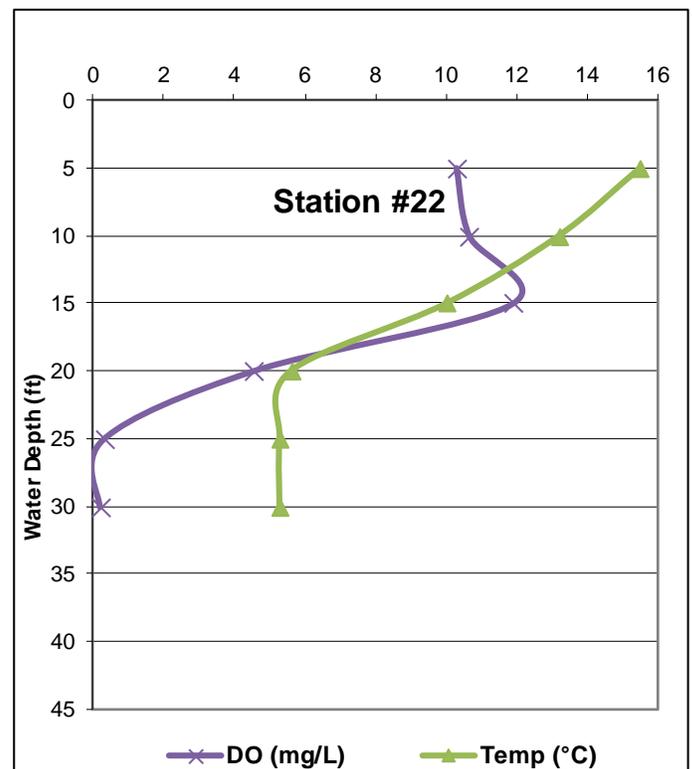
Station	16		Date
Bot. Depth (ft)	44		4/30/21
Lat. / Long.	41.057285	-72.335779	
Depth (ft)	Temp (°C)	DO (mg/L)	
5	15.5	10.28	
10	13.2	10.35	
15	10.0	12.20	
20	6.1	6.90	
25	5.3	2.65	
30	5.3	0.17	
35	5.2	0.17	
40	5.2	0.17	
43	5.2	0.17	



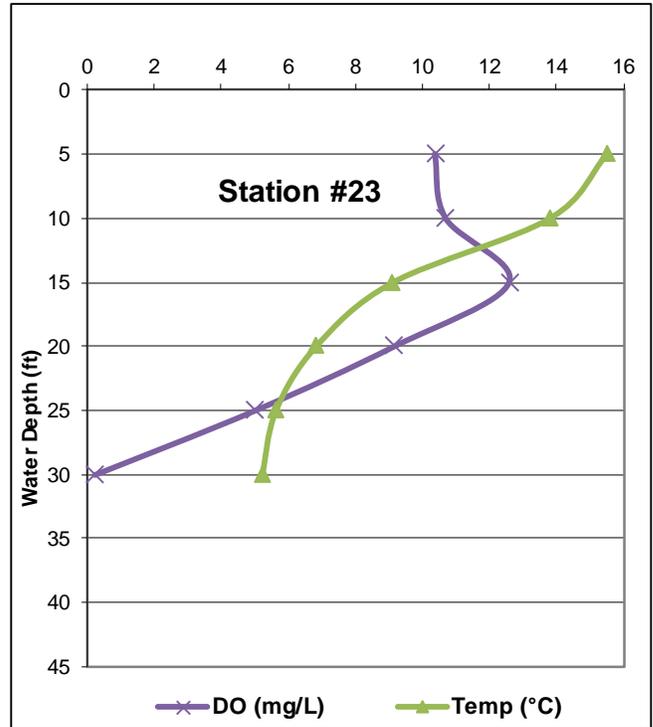
Station	18		Date
Bot. Depth (ft)	25		4/30/21
Lat. / Long.	41.057834	-72.335765	
Depth (ft)	Temp (°C)		DO (mg/L)
5	15.5		10.20
10	13.2		10.45
15	9.5		11.74
20	5.9		4.60
22	5.7		1.86
25	5.5		1.20



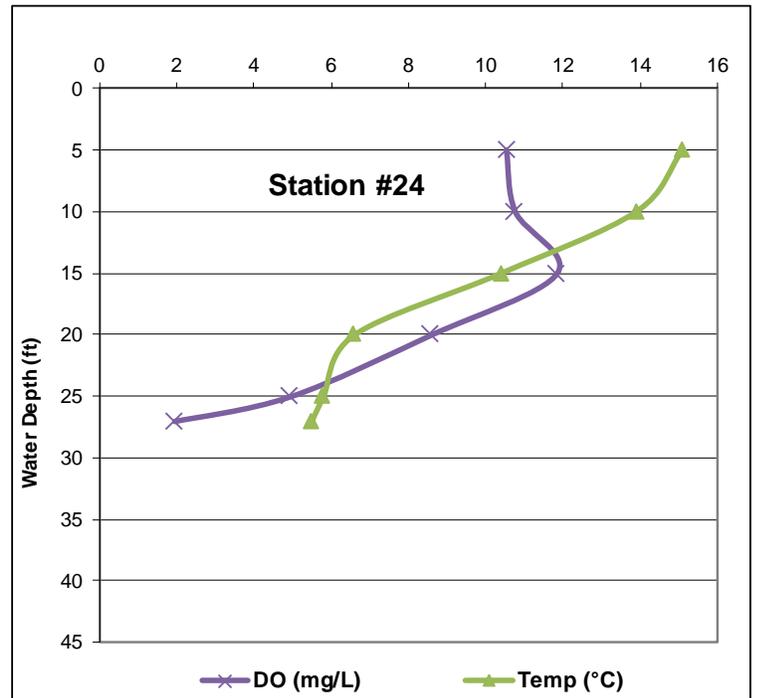
Station	22		Date
Bot. Depth (ft)	31		4/30/21
Lat. / Long.	41.057021	-72.336511	
Depth (ft)	Temp (°C)		DO (mg/L)
5	15.5		10.30
10	13.2		10.66
15	10.0		11.90
20	5.6		4.53
25	5.3		0.31
30	5.3		0.19



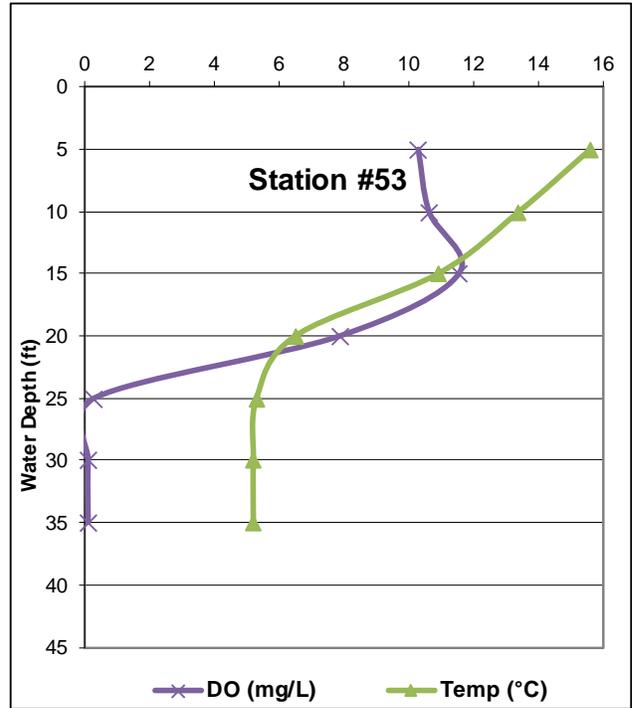
Station	23		Date
Bot. Depth (ft)	31		4/30/21
Lat. / Long.	41.057295	-72.336504	
Depth (ft)	Temp (°C)		DO (mg/L)
5	15.5		10.38
10	13.8		10.70
15	9.1		12.60
20	6.8		9.16
25	5.6		5.00
30	5.2		0.22



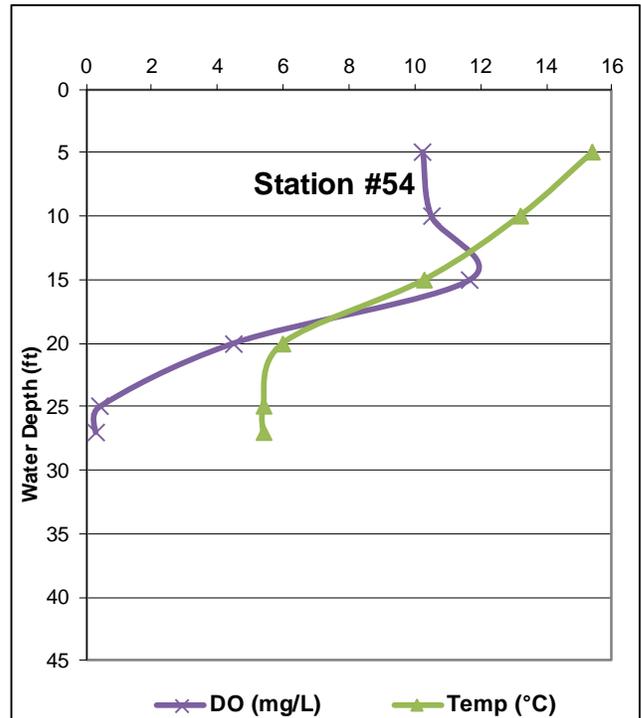
Station	24		Date
Bot. Depth (ft)	27.5		4/30/21
Lat. / Long.	41.057570	-72.336497	
Depth (ft)	Temp (°C)		DO (mg/L)
5	15.1		10.54
10	13.9		10.77
15	10.4		11.86
20	6.6		8.60
25	5.8		4.95
27	5.5		1.95



Station	53	Date	
Bot. Depth (ft)	38	4/30/21	
Lat. / Long.	41.057570	-72.336497	
Depth (ft)	Temp (°C)	DO (mg/L)	
5	15.6	10.28	
10	13.4	10.61	
15	10.9	11.53	
20	6.5	7.87	
25	5.3	0.30	
30	5.2	0.11	
35	5.2	0.11	

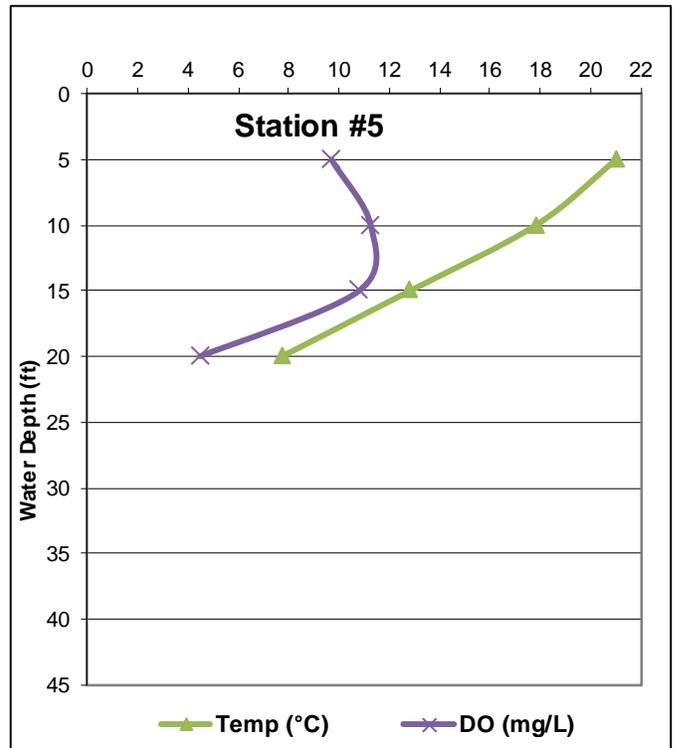


Station	54	Date	
Bot. Depth (ft)	28	4/30/21	
Lat. / Long.	41.056740	-72.336148	
Depth (ft)	Temp (°C)	DO (mg/L)	
5	15.4	10.25	
10	13.2	10.50	
15	10.3	11.70	
20	6.0	4.50	
25	5.4	0.40	
27	5.4	0.28	

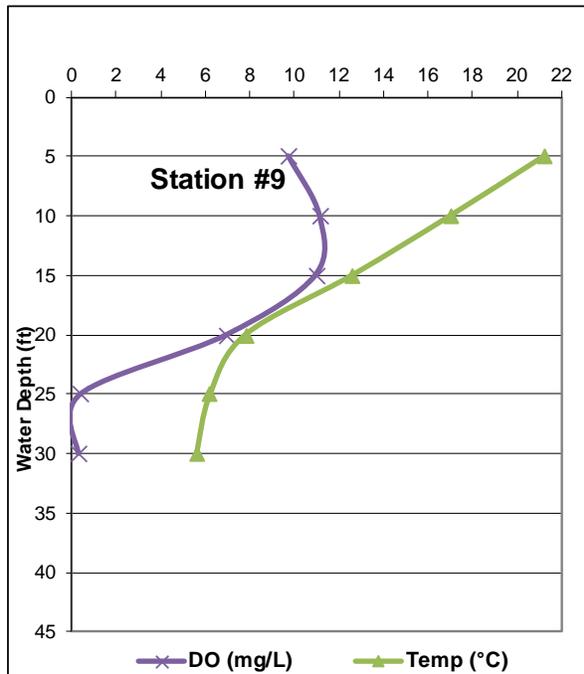


MAY 21, 2021 DATA

Station	5 Secchi (ft)		11
Bot. Depth (ft)	22		Date
Lat. / Long.	41.057000	-72.335061	5/21/21
Depth (ft)	Temp (°C)		DO (mg/L)
5	21.0		9.70
10	17.8		11.26
15	12.8		10.80
20	7.7		4.46



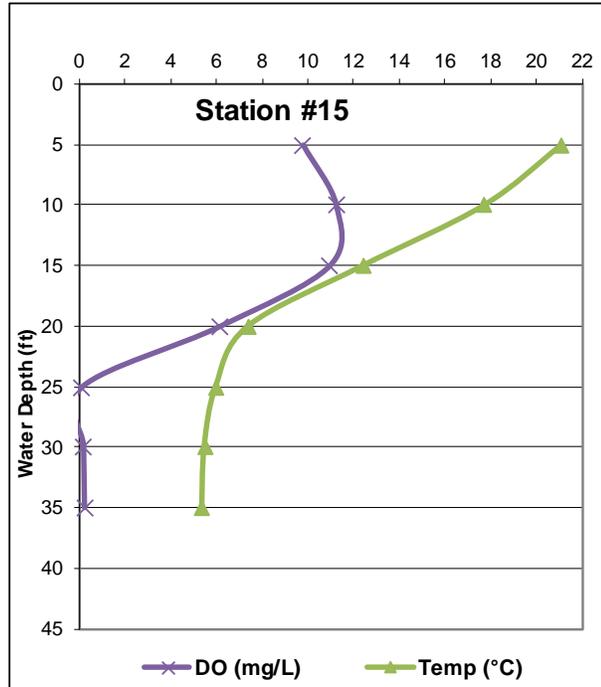
Station	9	Secchi (ft)	10
Bot. Depth (ft)	33		Date
Lat. / Long.	41.057005	-72.335423	5/21/21
Depth (ft)	Temp (°C)	Conductivity	DO (mg/L)
5	21.2	205.0	9.76
10	17.0		11.16
15	12.6		10.98
20	7.8		7.00
25	6.2		0.41
30	5.6		0.30



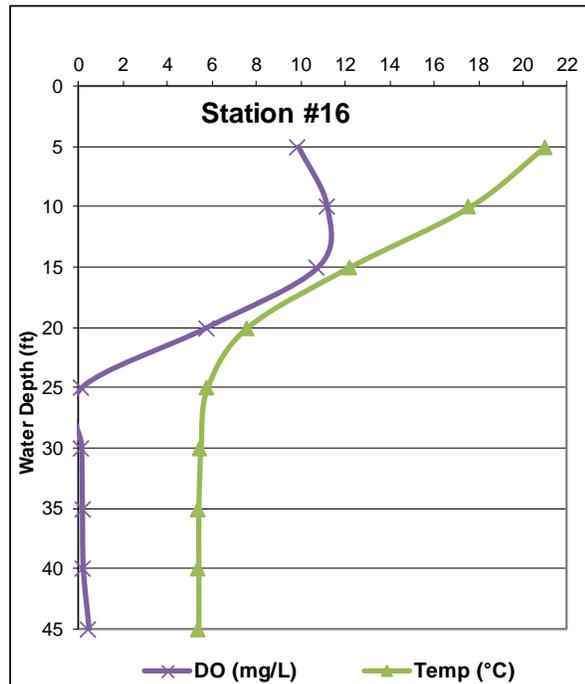
Conductivity in uS/cm

Station	15	Secchi (ft)	8.5
Bot. Depth (ft)	38.5		Date
Lat. / Long.	41.057010	-72.335786	5/21/21
Depth (ft)	Temp (°C)	Conductivity	DO (mg/L)
5	21.1		9.80
10	17.7		11.25
15	12.4		10.96
20	7.4		6.17
25	6.0	215.0	0.13
30	5.5		0.18
35	5.4	230.0	0.22

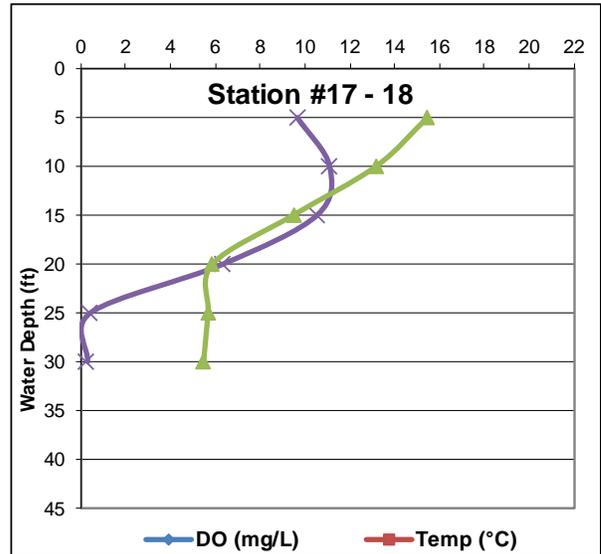
Conductivity in uS/cm



Station	16	Date	5/21/21
Bot. Depth (ft)	45		
Lat. / Long.	41.057285	-72.335779	
Depth (ft)	Temp (°C)	Cond	DO (mg/L)
5	21.0		9.90
10	17.6		11.20
15	12.2		10.77
20	7.6	213.0	5.77
25	5.8		0.14
30	5.5		0.15
35	5.4	227.0	0.18
40	5.4	230.0	0.22
45	5.4		0.48

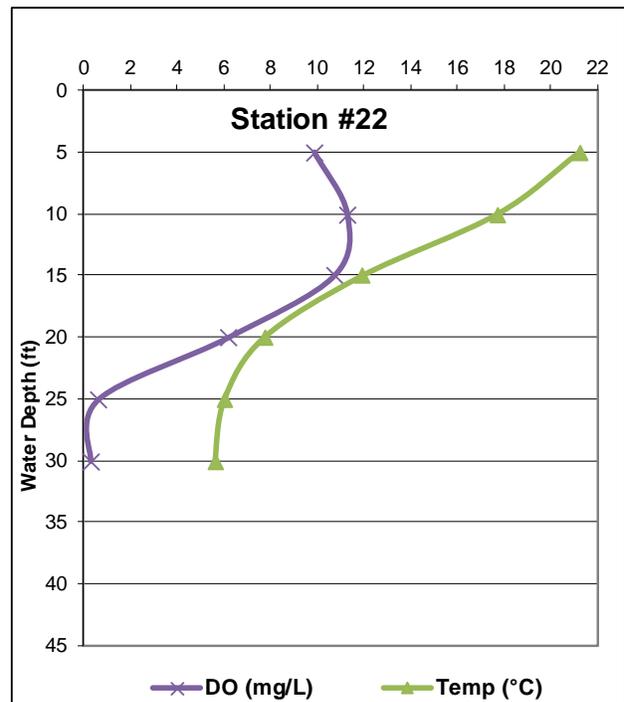


Station	17 - 18		Date
Bot. Depth (ft)	33		5/21/21
Lat. / Long.	41.057733	-72.335850	
Depth (ft)	Temp (°C)	DO (mg/L)	
5	21.2	9.67	
10	17.8	11.12	
15	12.9	10.56	
20	7.7	6.36	
25	5.9	0.42	
30	5.6	0.29	

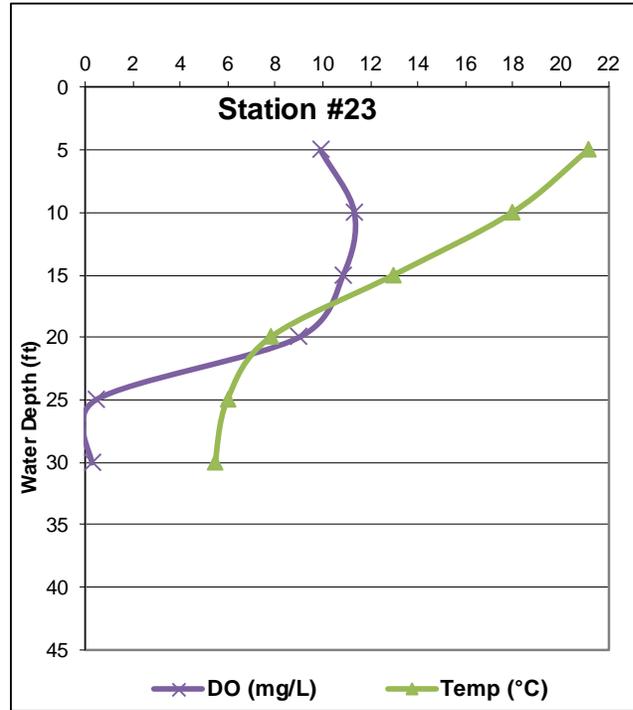


Station	22		Date
Bot. Depth (ft)	30		5/21/21
Lat. / Long.	41.057021	-72.336511	
Depth (ft)	Temp (°C)	Conductivity	DO (mg/L)
5	21.2	205.0	9.85
10	17.7		11.26
15	11.9		10.71
20	7.7		6.18
25	6.0		0.63
30	5.6		0.28

Conductivity in uS/cm

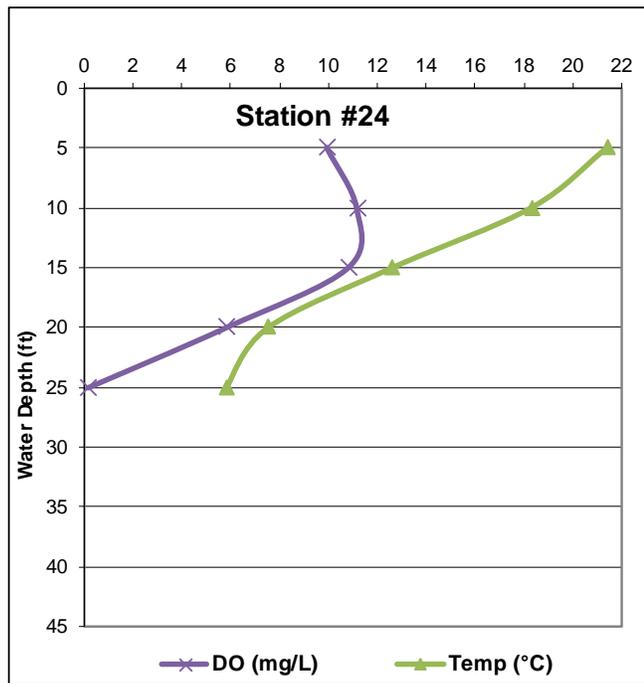


Station	23		Date
Bot. Depth (ft)	31		5/21/21
Lat. / Long.	41.057295	-72.336504	
Depth (ft)	Temp (°C)		DO (mg/L)
5	21.2		9.91
10	18.0		11.34
15	13.0		10.87
20	7.8		8.99
25	6.0		0.44
30	5.5		0.29

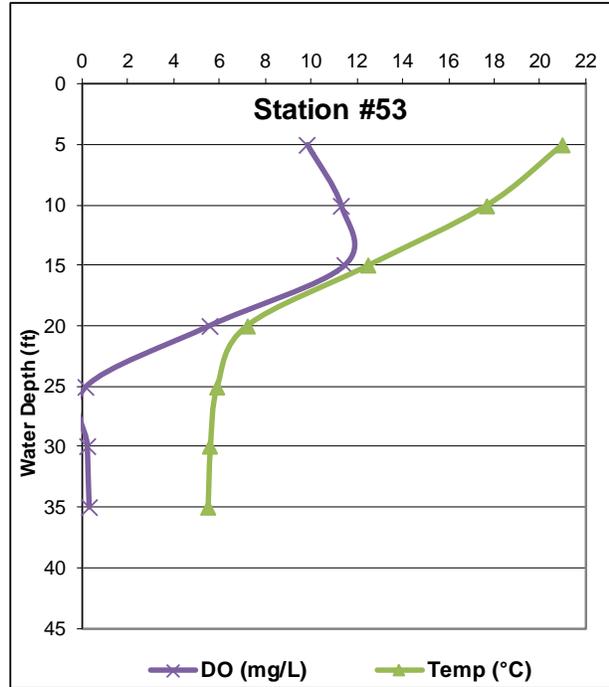


Station	24		Date
Bot. Depth (ft)	27.5		5/21/21
Lat. / Long.	41.057570	-72.336497	
Depth (ft)	Temp (°C)	Conductivity	DO (mg/L)
5	21.4		9.95
10	18.3		11.17
15	12.6		10.84
20	7.5		5.84
25	5.8	217.0	0.19

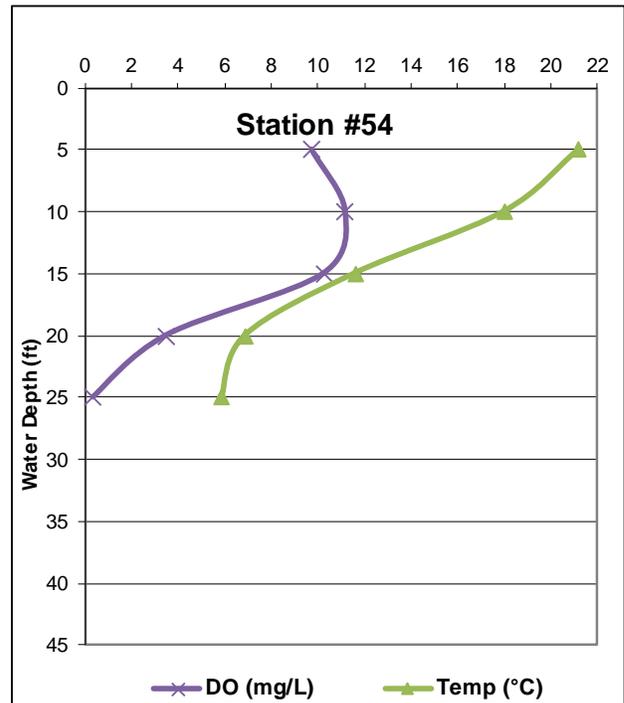
Conductivity in uS/cm



Station	53	Secchi (ft)	10
Bot. Depth (ft)	36	Date	5/21/21
Lat. / Long.	41.057570	-72.336497	
Depth (ft)	Temp (°C)	DO (mg/L)	
5	21.0	9.83	
10	17.7	11.30	
15	12.5	11.45	
20	7.2	5.55	
25	5.9	0.18	
30	5.6	0.22	
35	5.5	0.30	



Station	54	Date	5/21/21
Bot. Depth (ft)	28		
Lat. / Long.	41.056740	-72.336148	
Depth (ft)	Temp (°C)	DO (mg/L)	
5	21.2	9.73	
10	18.0	11.18	
15	11.6	10.25	
20	6.9	3.47	
25	5.9	0.31	



APPENDIX C SEDIMENT LAB ANALYSIS RESULTS



IEH ANALYTICAL LABORATORIES
LABORATORY & CONSULTING SERVICES
 3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
 PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	1723292A	PAGE	1
REPORT DATE:	07/14/21		
DATE SAMPLED:	05/01/21	DATE RECEIVED:	05/05/21
FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON SEDIMENT SAMPLES FROM WATER RESOURCE SERVICES			

CASE NARRATIVE

Six sediment samples were received by the laboratory in good condition and analyzed according to the chain of custody. Phosphorus fractions were determined according to the method of Rydin and Welch. Successive extractions with NH4Cl, Bicarbonate/Dithionate, NaOH, and HCL were performed and analyzed for phosphorus. One part of Organic P was determined by digesting the residue after the inorganic fractions were extracted. Organic P includes the P after the inorganic fractions plus Biogenic P. Total P is the sum of all fractions minus Biogenic P, which is part of the Organic P fraction. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows, while QA/QC data is contained on subsequent pages.

SAMPLE DATA - SEDIMENTS (DRY WT. BASIS)

SAMPLE ID	% SOLIDS	% WATER	TOTAL-P (mg/kg)	LOOSELY BOUND P (NH4CL) (mg/kg)	FE BOUND P (DITHIONATE) (mg/kg)	AL BOUND P (NAOH) (mg/kg)	BIOGENIC P (mg/kg)	CA BOUND P (HCL) (mg/kg)	ORGANIC P (mg/kg)
FP-1A	7.12%	92.9%	2582	<2.00	623	1027	676	63.8	868
FP-1B	7.17%	92.8%	2683	<2.00	649	1014	767	57.3	962
FP-2	7.87%	92.1%	2235	<2.00	526	874	622	55.2	780
FP-3	8.47%	91.5%	2003	<2.00	443	832	526	47.5	681
FP-4	42.3%	57.7%	307	<2.00	43.5	118	102	9.59	136
FP-5	14.4%	85.6%	1082	<2.00	269	407	261	35.2	371

% Solids	% Water	Total P (mg/kg) (mg/kg)	Loosely Bound P (NH4Cl) (mg/kg)	Fe Bound P (Dithionate) (mg/kg)	Al Bound P (NaOH) (mg/kg)	Biogenic P (mg/kg)	Ca Bound P (HCl) (mg/kg)	Organic P (mg/kg)
----------	---------	-------------------------------	---------------------------------------	---------------------------------------	---------------------------------	-----------------------	--------------------------------	----------------------

	LOOSELY BOUND P (NH ₄ CL) (mg/kg)	FE BOUND P (DITHIONATE) (mg/kg)	AL BOUND P (NAOH) (mg/kg)	BIOGENIC P (mg/kg)	CA BOUND P (HCL) (mg/kg)	ORGANIC P (mg/kg)
FP-1A	<2.00	623	1027	676	63.8	868
FP-1B	<2.00	649	1014	767	57.3	962
FP-2	<2.00	526	874	622	55.2	780
FP-3	<2.00	443	832	526	47.5	681
FP-4	<2.00	43.5	118	102	9.59	136
FP-5	<2.00	269	407	261	35.2	371



IEH ANALYTICAL LABORATORIES
LABORATORY & CONSULTING SERVICES
 3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
 PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	1723292A	PAGE	2
REPORT DATE:	07/14/21		
DATE SAMPLED:	05/01/21	DATE RECEIVED:	05/05/21
FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON SEDIMENT SAMPLES FROM WATER RESOURCE SERVICES			

QA/QC DATA- SEDIMENTS

QC PARAMETER	% SOLIDS	TOTAL-P (mg/kg)	LOOSELY BOUND P (NH4CL) (mg/kg)	FE BOUND P (DITHIONATE) (mg/kg)	AL BOUND P (NAOH) (mg/kg)	BIOGENIC P (mg/kg)	CA BOUND P (HCL) (mg/kg)	ORGANIC P (mg/kg)
METHOD	SM18 2540B	CALCULATED	SM18 4500PF	SM18 4500PF	SM18 4500PF	EPA 365.1	SM18 4500PF	EPA 365.1
DATE PREPARED	05/25/21	06/01/21	05/26/21	05/26/21	05/28/21	06/01/21	05/28/21	06/01/21
DATE ANALYZED	1.00%	5.00	2.00	2.00	2.00	2.00	2.00	2.00
DETECTION LIMIT								
DUPLICATE								
	FP-5	FP-5	FP-5	FP-5	FP-5	FP-5	FP-5	FP-5
SAMPLE ID	14.4%	1082	<2.00	269	407	261	35.2	371
ORIGINAL	14.5%	1038	<2.00	255	383	255	34.6	365
DUPLICATE	0.95%	4.23%	NC	5.02%	6.31%	2.39%	1.92%	1.66%
RPD								
SPIKE SAMPLE								
SAMPLE ID								
ORIGINAL								
SPIKED SAMPLE	NA	NA	NA	NA	NA	NA	NA	NA
SPIKE ADDED								
% RECOVERY								
QC CHECK (mg/l)								
FOUND			0.039	0.039	0.040	0.094	0.040	0.094
TRUE			0.039	0.039	0.039	0.094	0.039	0.094
% RECOVERY	NA	NA	100.00%	100.00%	102.56%	100.00%	102.56%	100.00%
BLANK	NA	NA	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00

RPD = RELATIVE PERCENT DIFFERENCE
 NA = NOT APPLICABLE OR NOT AVAILABLE
 NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT
 OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TO LOW RELATIVE TO SAMPLE CONCENTRATION

SUBMITTED BY:

Damien Gadomski

Damien Gadomski
 Project Manager



IEH ANALYTICAL LABORATORIES
LABORATORY & CONSULTING SERVICES
3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	1723292B	PAGE	1
REPORT DATE:	07/14/21		
DATE SAMPLED:	05/01/21	DATE RECEIVED:	05/05/21

**FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON
SEDIMENT SAMPLES FROM WATER RESOURCE SERVICES**

CASE NARRATIVE

Six sediment samples were received by the laboratory and analyzed according to the chain of custody. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows, while QA/QC data is contained on subsequent pages.

SAMPLE DATA - SEDIMENTS (DRY WT. BASIS)

SAMPLE ID	% SOLIDS	% WATER	ALUMINUM (mg/kg)	IRON (mg/kg)	CALCIUM (mg/kg)
FP-1A	7.12%	92.9%	12277	18045	3310
FP-1B	7.17%	92.8%	13796	20290	3473
FP-2	7.87%	92.1%	13364	17964	3402
FP-3	8.47%	91.5%	12704	15453	3077
FP-4	42.3%	57.7%	1559	1965	488
FP-5	14.4%	85.6%	5388	8876	3368



IEH ANALYTICAL LABORATORIES
 LABORATORY & CONSULTING SERVICES
 3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
 PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	1723292B	PAGE	2
REPORT DATE:	07/14/21		
DATE SAMPLED:	05/01/21	DATE RECEIVED:	05/05/21
FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON SEDIMENT SAMPLES FROM WATER RESOURCE SERVICES			

QA/QC DATA- SEDIMENTS

QC PARAMETER	% SOLIDS	ALUMINUM (mg/kg)	IRON (mg/kg)	CALCIUM (mg/kg)
METHOD	SM18 2540B	EPA 6020A	EPA 6020A	EPA 6020A
DATE ANALYZED	05/26/21	05/12/21	05/12/21	05/12/21
DETECTION LIMIT	1.00%	2.00	2.00	2.00
DUPLICATE				
SAMPLE ID	FP-5	BATCH	BATCH	BATCH
ORIGINAL	14.4%	<2.00	<2.00	<2.00
DUPLICATE	14.5%	<2.00	<2.00	<2.00
RPD	0.95%	NC	NC	NC
SPIKE SAMPLE				
SAMPLE ID				
ORIGINAL				
SPIKED SAMPLE				
SPIKE ADDED				
% RECOVERY	NA	NA	NA	NA
QC CHECK				
(mg/L)				
FOUND		0.549	0.496	9.29
TRUE		0.500	0.500	10.0
% RECOVERY	NA	109.80%	99.20%	92.90%
BLANK				
	NA	<2.00	<2.00	<2.00

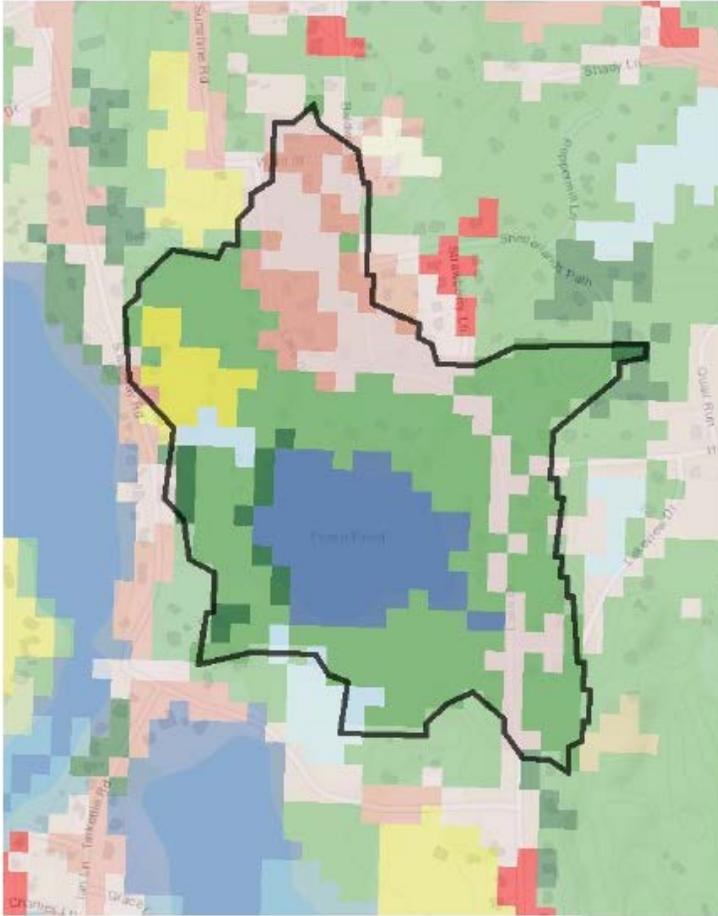
RPD = RELATIVE PERCENT DIFFERENCE
 NA = NOT APPLICABLE OR NOT AVAILABLE
 NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT
 OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION

SUBMITTED BY:

Damien Gadomski
 Project Manager

APPENDIX D FRESH POND CSLAP REPORT WITH 2019 DATA

D.1 FRESH POND CSLAP REPORT WITH 2020 DATA



Lake Characteristics

Surface Area (ac/ha)	14/6
Max Depth (ft/m)	45.9/14
Mean Depth (ft/m)	NA/NA
Retention Time (years)	1
Lake Classification	C
Dam Classification	

Watershed Characteristics

Watershed area (ac/ha) NA/NA

file:///C:/PG/FPNA/2020_CSLAPreport_Fresh Pond(1701FRE0468).html

2/18

Watershed/Lake Ratio	NA
Lake and Wetlands %	19.0%
Agricultural %	4.0%
Forest, Shrub, Grasses %	52.0%
Residential %	25.0%
Urban %	0.0%

CSLAP Participation

Years in CSLAP	2018-2020
Volunteers	Peter Grand, James Eklund, Peter Spacek

Trophic State	HABs Susceptibility	Invasive Vulnerability	PWL Assessment
Mesoeutrophic	Frequent Blooms, Moderate susceptibility	No invasives present, Low vulnerability	Unassessed

Fresh Pond – 2020 Sampling Season Results

“Seasonal change” shows the current year variability. Red shaded results indicate eutrophic water quality conditions. “Season Median” is the middle value (or average of the middle two values) of the current year’s data in order. “Decadal Median” is the median of the most recent ten years of water quality data. “Longterm Median” is the median of all years of water quality data. “Decadal Trend?” and “Longterm Trend?” indicate whether there was a statistically significant change in the water quality data over the most recent ten years and all years, respectively. In these columns, ‘No’ indicates there was no significant trend, ‘↑’ indicates there was a significant positive trend ($p < 0.05$), ‘↑↑’ indicates there was a strong significant positive trend ($p < 0.01$), ‘↓’ indicates there was a significant negative trend ($p < 0.05$), ‘↓↓’ indicates there was a strong significant negative trend ($p < 0.01$), and blank indicates there was insufficient data to identify a trend. In this report, seasonal trend analyses for individual sampling years and long term trend analyses show changes in key water quality indicators over a consistent index period (mid-June thru mid-September).

Open Water Indicators	2020 Sampling Results								Seasonal Change	Season Median	Decadal Median	Decadal Trend?	Longterm Median
	06-07	06-21	07-05	07-19	08-02	08-16	08-30	09-13					
Clarity (m)	3.5	2.6	1.4	1	2	1	2	2		2	2.1	no	2.1
Surface TP (mg/L)	0.025	0.024	0.025	0.035	0.026	0.018	0.018	0.022		0.024	0.023	no	0.023
Surface TDP (mg/L)	0.017	0.009	0.006	0.018	0.007	0.009	0.004	0.012		0.009	0.009	no	0.009
Deep TP (mg/L)	0.406	0.396	0.401	0.091	0.531	0.064	0.411	0.651		0.404	0.46	no	0.46
Deep TDP (mg/L)	0.046	0.02	0.035	0.02	0.016	0.022	0.007	0.035		0.021	0.035	no	0.035
TN (mg/L)	0.645	0.622	0.65	0.9	0.697	0.851	0.755	0.635		0.673	0.635	no	0.635
TDN (mg/L)	0.527	0.486	0.629	0.844		0.615	0.623	0.527		0.615	0.504	↑	0.504
TN:TP	26	26	26	25	27	47	41	28		27	27		27
Surface NH3 (mg/L)	0.022		0.025	0.021	0.019	0.021	0.032	0.022		0.022	0.024	no	0.024

Open Water Indicators	2020 Sampling Results								Seasonal Change	Season Median	Decadal Median	Decadal Trend?	Lo M
	06-07	06-21	07-05	07-19	08-02	08-16	08-30	09-13					
Deep NH3 (mg/L)	1.86			0.443	2.99	3.33		3.96		2.99	2.49	no	2.4
Chl.a (ug/L)	2	0.4	5		5.7	10.1		8.7		5.3	5	no	5
pH	7.4	7.8	7.3	9.2	7.5	7.9	7.6	7.6		7.6	7.2	no	7.2
Cond (uS/cm)	217	225	221	238	235	235	232	222		228	263		26
Surface Calcium (mg/L)					4					4	4		4
Surface Chloride (mg/L)		56		56		55		57		56	57	no	57
Deep Chloride (mg/L)		57		56		57		57		57	60	no	60
Upper Temp (degC)	23	25	27	28	28	26	26	24		26	25	no	25
Deep Temp (degC)	8	8	14	22	10	8	9	9		9	9	no	9
FP BG Chl.a (ug/L)	1.1	9.3	14.6	21.9	5	27.9	2.1	5.4		7.4	3.3	no	3.3

Fresh Pond – Lake Scorecard

Water Quality Indicators	Average Year	2020
Phosphorus	Eutrophic	Eutrophic
Chlorophyll A	Mesotrophic	Mesotrophic
Secchi	Mesotrophic	Eutrophic
Lake Perception	Good	Good
Harmful Algal Blooms	Poor	Fair
Open Water Algae Levels	Poor	Fair
Aquatic Invasive Species	Absent	

Fresh Pond – 2020 Lake Summary

Q. What is the condition of the lake?

A. Fresh Pond continues to be mesoeutrophic, or moderately unproductive, based on moderate water clarity, moderate algae levels (chlorophyll a), and high nutrient (phosphorous) levels. Soluble nutrients were analyzed in 2020. Some of the phosphorus in the lake is soluble, indicating some potential for more algae growth. Most of the nitrogen in the lake is soluble. The waterbody is slightly alkaline or basic, with intermediate hardness water, moderately low water color, and moderately high nitrogen levels.

Q. How did this year compare to previous years?

A. Compared to previous years, pH and total nitrogen were higher in 2020. Compared to previous years, conductivity and chloride were lower in 2020 and aquatic plant coverage was more favorable in 2020. Water clarity (secchi), total phosphorous, extracted chlorophyll a, color, surface water temperature, deep water temperature, water quality evaluation and recreational evaluation in 2020 were similar to previous years.

Q. How does this lake compare to other New York lakes?

A. Compared to other New York Lakes, this waterbody usually has higher total phosphorous, total nitrogen, conductivity, chloride and surface water temperature. Compared to other New York Lakes, this waterbody usually has lower deep water temperature and less favorable aquatic plant coverage. Compared to other New York Lakes, this waterbody usually has similar water clarity (secchi), extracted chlorophyll a, pH, color, water quality evaluation and recreational evaluation.

Q. Are there any (statistically significant) trends?

A. Over the past 3 years, total dissolved nitrogen has increased significantly. Over the past 3 years, conductivity has decreased significantly.

Q. Has the lake experienced harmful algal blooms (HABs)?

A. Water quality conditions generally indicate a moderate susceptibility to blooms, with frequent blooms along the shoreline or in the open water.

The open water algal community in the lake is usually comprised of low cyanobacteria levels. This community is dominated by *Ceratium* and *Coelastrum*. Typically, overall open water algae levels are high. Overall open water toxin levels are at times above recreational levels of concern.

This year, overall algae levels were high, with cyanobacteria the most common taxa in open water samples, and with intermediate cyanobacteria levels. Open water toxin levels were high this year.

Shoreline blooms were not reported and/or sampled this year.

Q. Have any aquatic invasive species (AIS) been reported?

A. No invasive species have been reported in this waterbody. This waterbody has high vulnerability for new invasives, based on calcium levels. For more information about invasive species in the area, or to report an invasive species observation, visit NY iMapInvasives at <https://www.nyimainvasives.org/> (<https://www.nyimainvasives.org/>).

NYHABs notifications

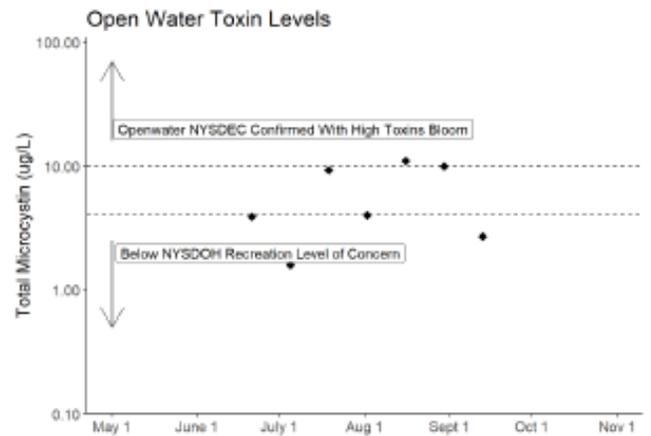
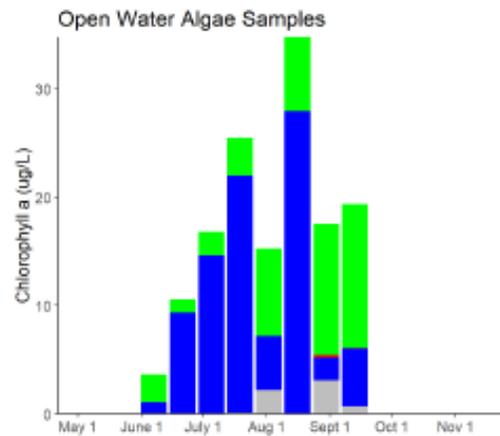
Were there any reported HABs this season? **Yes.**

Date of First Listing	Date of Last Listing	Number of Reports
07/05/2020	08/30/2020	55

Shoreline HAB Sample Dates 2020

There were no shoreline HAB samples taken this season.

Open Water Algae

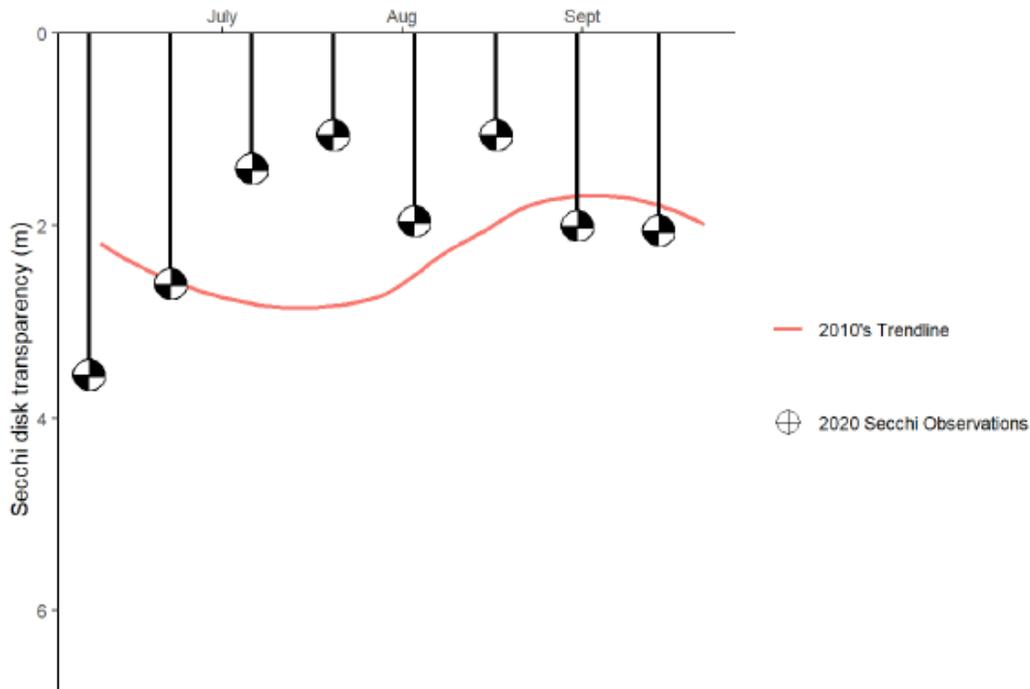


Shoreline Algae

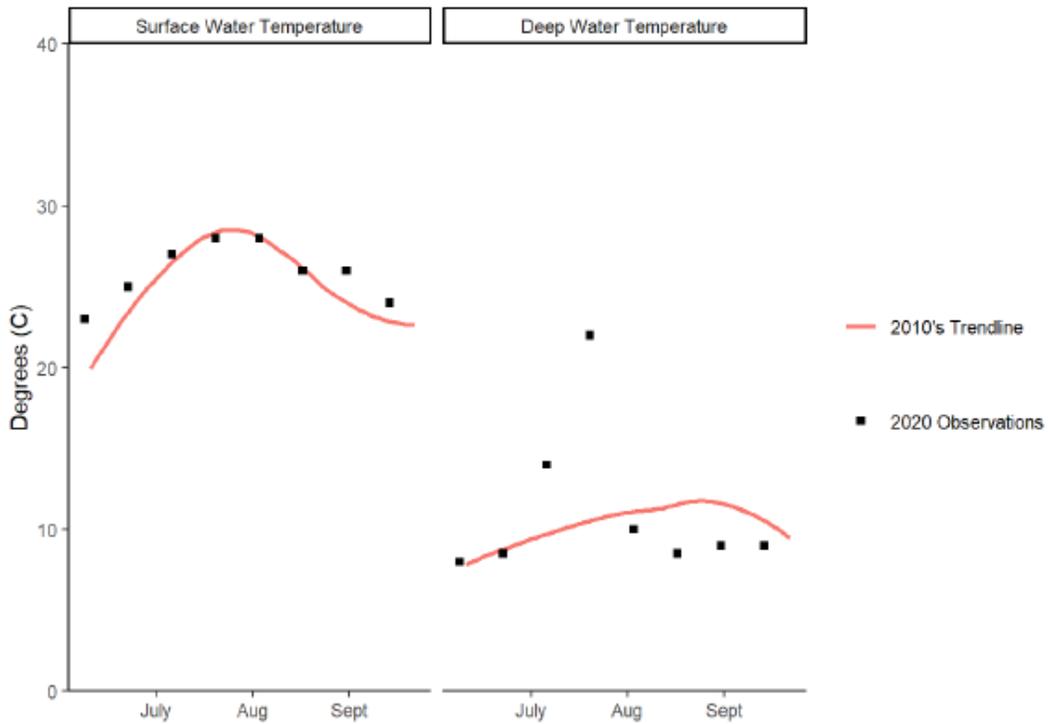
There is no shoreline algae or shoreline microcystin data to display from this year.

Fresh Pond - In-Season Trend Analysis

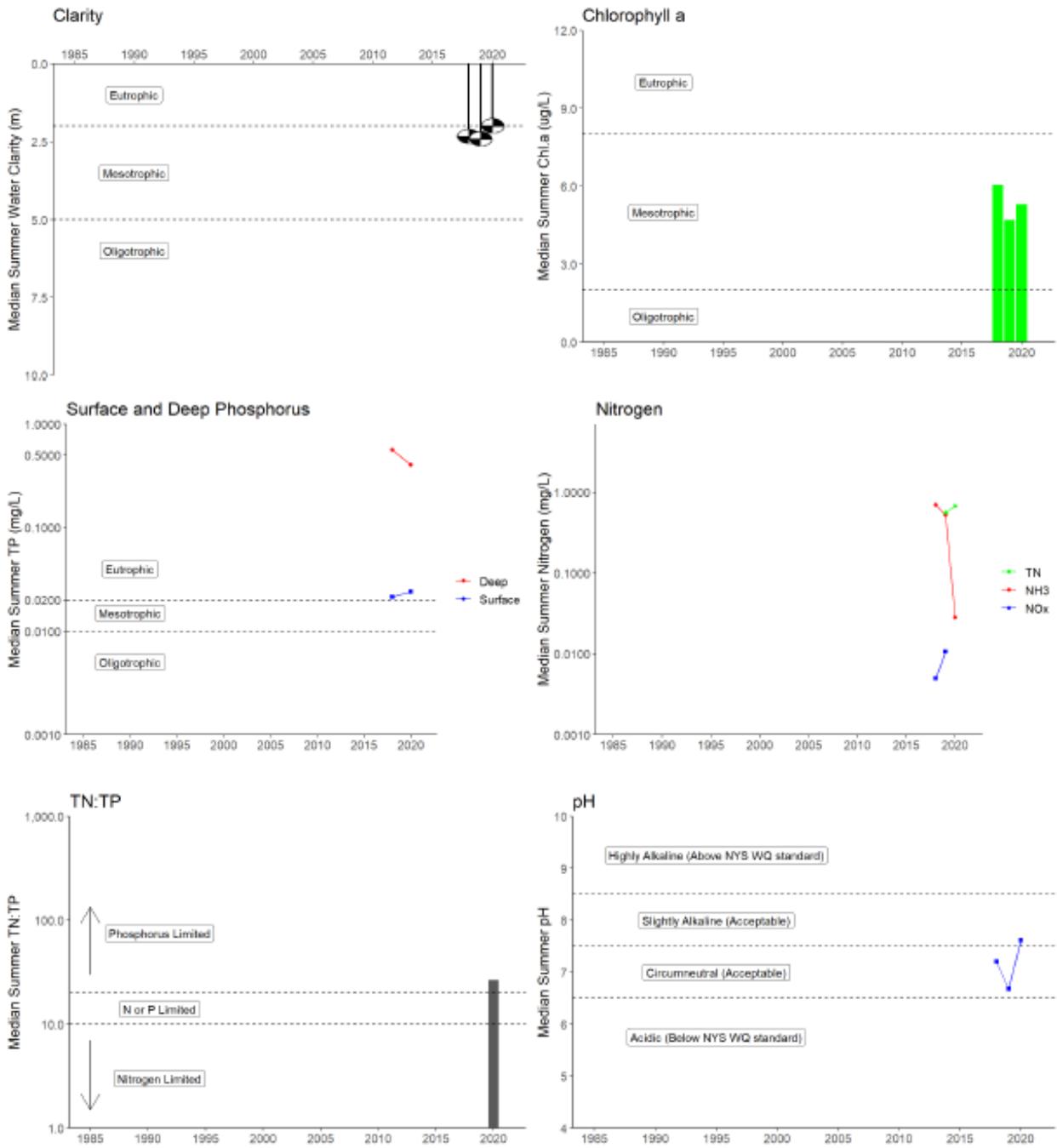
In Season Water Clarity

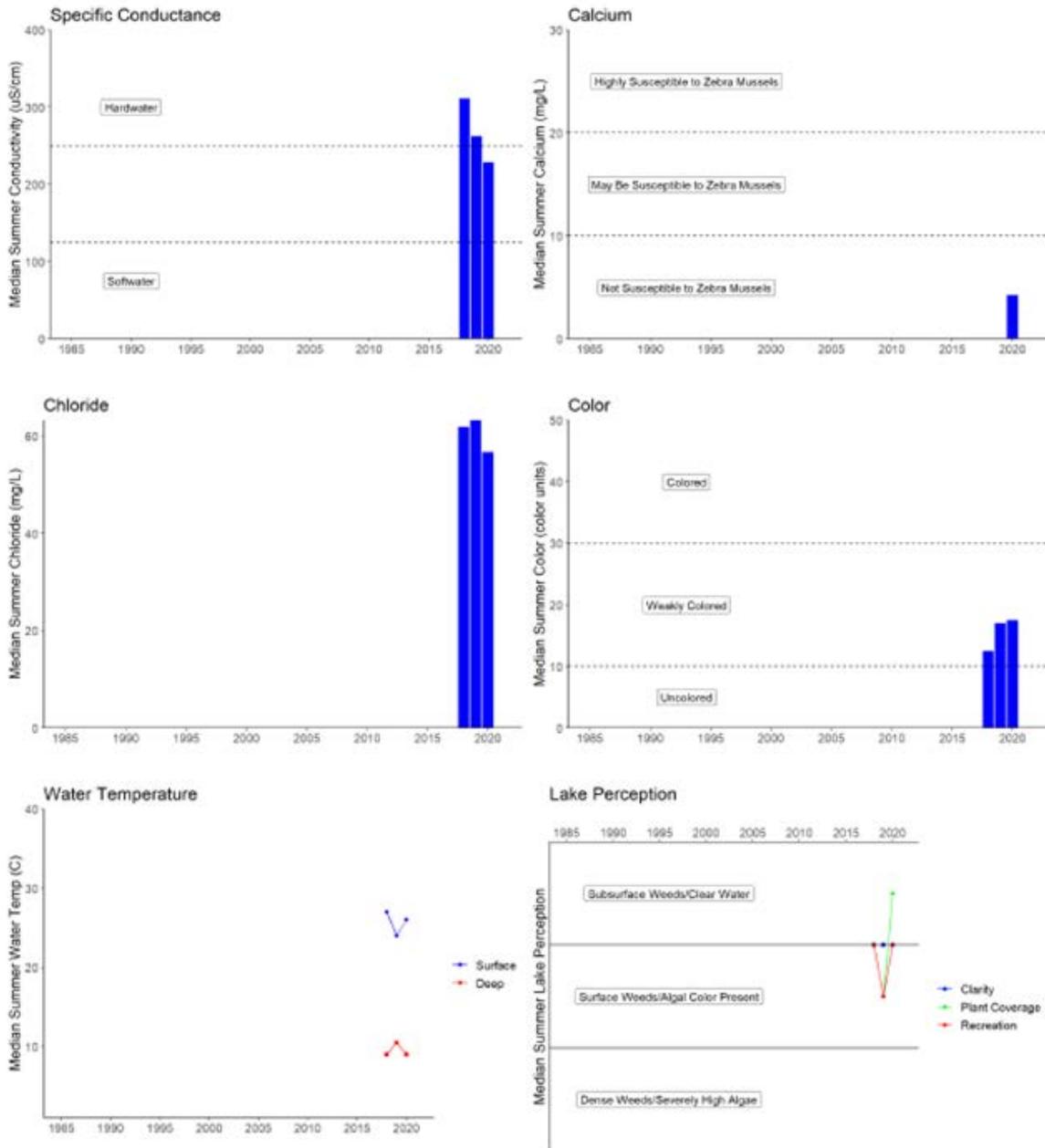


In Season Water Temperature



Fresh Pond Long-Term Trend Analysis





Water Quality Assessments

The Waterbody Inventory/Priority Waterbodies List (WI/PWL) is a statewide inventory of New York's water resources that is used to track a water's ability to support its best use(s), identify pollutant(s) causing impairment of best use(s), and follow the status of restoration, protection and other water quality activities and efforts. Data collected through CSLAP contributes to the WI/PWL. In order to be included as an assessment unit in the WI/PWL, a lake, pond, or reservoir must be at least 6.4 acres in size. To view current water quality assessment results:

- Visit <https://www.dec.ny.gov/pubs/109457.html> (<https://www.dec.ny.gov/pubs/109457.html>) - follow the link to launch the DECinfo Locator
- Search for waterbody name, address or nearby landmark in the search tool at the top of the left banner
- Click and Expand the 'DEC Information Layers' tab of the left banner
- Click and expand the 'Environmental Monitoring' tab of the left banner
- Check the 'Lakes and Reservoirs' layer
- Click on the waterbody of interest in the map view to display a pop-up with more information about the waterbody
- Follow the 'Fact Sheet' link in the pop-up to learn more about the current use assessment of the waterbody

Lake Stewardship Actions

Individual stewardship activities can help improve water quality: maintain your septic system, reduce fertilizer use, grow a buffer of native plants next to the lake shore, and reduce shoreline erosion and runoff into the lake. Visiting boats should be inspected to prevent the spread of invasive species, and continued community education about and monitoring for invasive species is recommended. Routine education about algae and harmful algal blooms (HABs) within your lake community is recommended; to learn more about HABs and see examples of HABs visit <http://www.dec.ny.gov/chemical/81962.html> (<http://www.dec.ny.gov/chemical/81962.html>). Occurrences of HABs can be reported to NYSDEC. For more information on keeping New York waters clean, visit <http://www.dec.ny.gov/public/43661.html> (<http://www.dec.ny.gov/public/43661.html>).

How to Read the Report

This guide provides a description of the CSLAP report by section and a glossary. The sampling site is indicated in the header for lakes with more than one routine sampling site.

Physical Characteristics influence lake quality:

- Surface area is the lake's surface in acres and hectares.
- Max depth is the water depth measured at the deepest part of the lake in feet and meters.
- Mean depth is either known from lake bathymetry or is 0.46 of the maximum depth.
- Retention time is the time it takes for water to pass through a lake in years. This indicates the influence of the watershed on lake conditions.
- Lake classification describes the "best uses" for this lake. Class AA, AAspec, and A lakes may be used as sources of potable water. Class B lakes are suitable for contact recreational activities, like swimming. Class C lakes are suitable for non-contact recreational activities, including fishing, although they may still support swimming. The addition of a T or TS to any of these classes indicates the ability of a lake to support trout populations and/or trout spawning.
- Dam classification defines the hazard class of a dam. Class A, B, C, and D dams are defined as low, intermediate, high, or negligible/no hazard dams in that order. "0" indicates that no class has been assigned to a particular dam, or that no dam exists.

Watershed characteristics influence lake water quality:

- Watershed area in acres and hectares
- Land use data come from the most recent (2011) US Geological Survey National Land Use Cover dataset

CSLAP Participation lists the sampling years and the current year volunteers.

Key lake status indicators summarize lake conditions:

- Trophic state of a lake refers to its nutrient loading and productivity, measured by phosphorus, algae, and clarity. An oligotrophic lake has low nutrient and algae levels (low productivity) and high clarity while a eutrophic lake has high nutrient and algae levels (high productivity) and low clarity. Mesotrophic lakes fall in the middle.
- Harmful algal bloom susceptibility summarizes the available historical HAB data and indicates the potential for future HAB events.
- Invasive vulnerability indicates whether aquatic invasive species are found in this lake or in nearby lakes, indicating the potential for further introductions.
- Priority waterbody list (PWL) assessment is based on the assessment of use categories and summarized as fully supported, threatened, stressed, impaired, or precluded. Aesthetics and habitat are evaluated as good, fair, or poor. The cited PWL assessment reflects the "worst" assessment for the lake.

Current year sampling results shows results for each of the sampling sessions in the year are in tabular form. The seasonal change graphically shows the current year results. Red shading indicates eutrophic readings.

- If there are more than ten shoreline bloom samples collected in a year, bloom sample information is instead summarized by month (May-Oct.) as minimum, average, and maximum values for blue-green algae and

The Lake Scorecard represents key water quality indicator results for this lake in an easy-to-read format, comparing information from the current year and historical average of the CSLAP data. Indicators include (1) trophic status of phosphorus, chlorophyll (or algae) and secchi (or clarity); (2) presence or absence of aquatic invasive plants or animals; (3) lake user perception based on perceived physical condition and recreational suitability of the lake; (4) harmful algal bloom samples or reports; and (5) algae levels in the open water of routinely sampled sites.

The Lake Summary reviews and encapsulates the data in the lake report, including comparisons to historical data from this lake, and results from nearby lakes.

Harmful Algal Blooms:

- HAB notification periods on the DEC website <http://www.dec.ny.gov/chemical/83310.html> (<http://www.dec.ny.gov/chemical/83310.html>)
- Shoreline HAB sample dates and results. Samples are collected from the area that appears to have the worst bloom. Red shading indicates a confirmed HAB.
- HAB sample algae analysis. Algae types typically change during the season. These charts show the amount of the different types of algae found in each mid-lake or shoreline sample. Samples with high levels of BGA are HABs. The second set of charts show the level of toxins found in open water and shoreline samples compared to NYSDOH and NYSDEC guidelines.

In-Season Trend Analysis shows water temperature and water clarity during the sampling season. These indicate seasonal changes and show the sample year results compared to the typical historical readings for those dates.

Long-Term Trend Analysis puts the current year findings in context. Summer averages (mid-June thru mid-September) for each of the CSLAP years show trends in key water quality indicators. The graphs include relevant criteria (trophic categories, water quality standards, etc.) and boundaries separating these criteria.

Glossary of Water Quality and HAB Indicators

Clarity (m): The depth to which a Secchi disk lowered into the water is visible, measured in meters. Water clarity is one of the trophic indicators for each lake.

TP (mg/L): Total phosphorus, measured in milligrams per liter at the lake surface (1.5 meters below the surface). TP includes all dissolved and particulate forms of phosphorus.

Deep TP: Total phosphorus measured in milligrams per liter at depth (1-2 meters above the lake bottom at the deepest part of the lake or a fixed depth in the hypolimnion of very deep lakes).

TN: Total nitrogen, measured in milligrams per liter at the lake surface. TN includes all forms of nitrogen, including NO_x (nitrite and nitrate) and NH₄ (ammonia).

N:P Ratio: The ratio of total nitrogen to total phosphorus, unitless (mass ratio). This ratio helps determine if a lake is phosphorous or nitrogen limited.

Chl.a (µg/L): Chlorophyll a, measured in micrograms per liter. Indicates the amount of algae in the water column. This is an extracted chlorophyll measurement.

pH: A range from 0 to 14, with 0 being the most acidic and 14 being the most basic or alkaline. A healthy lake generally ranges between 6.5 and 8.5.

Cond (µmho/cm): Specific conductance is a measure of the conductivity of water. A higher value indicates the presence of more dissolved ions. High ion concentrations (> 250) usually indicate hardwater, and low readings (< 125) usually show softwater.

Calcium (mg/L): Calcium, a component of lake buffering capacity (the ability to neutralize acid inputs), as measured in milligrams per liter at the lake surface (1.5 meters below the surface).

Chloride (mg/L): Chloride, or chloride ions, as measured in milligrams per liter at the lake surface (1.5 meters below the surface).

Upper Temp (°C): Surface temperature, measured in degrees Celsius.

Deep Temp (°C): Deep water temperature, measured in degrees Celsius.

BG Chl.a (µg/L): Chlorophyll a from blue-green algae, measured in micrograms per liter. This is an "unextracted" estimate using a fluoroprobe. This result is different from the extracted chlorophyll measurement described above.

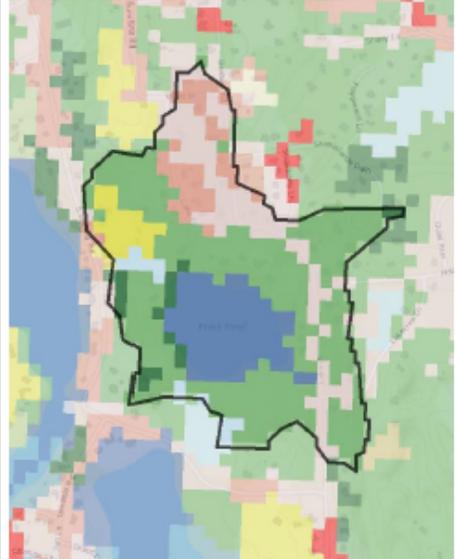
HABs: Harmful Algal Blooms. Algal blooms that have the appearance of cyanobacteria (BGA).

BGA: Blue-green algae, also known as cyanobacteria.

Microcystin (µg/L): The most common HAB liver toxin; total microcystin above 20 micrograms per liter indicates a "high toxin" bloom. However, ALL BGA blooms pose a potential health risk and should be avoided.

D.2 FRESH POND CSLAP REPORT WITH 2019 DATA

Following is data as collected and reported by NYSDEC CSLAP.

Fresh Pond		Fresh Pond Neighbors Association	Town of Shelter Island	Suffolk County
	Lake Characteristics		Surface area (ac/ha)	14 / 6
			Max depth (ft/m)	46 / 14
			Mean depth (ft/m)	21 / 6
			Retention time (years)	1.0
			Lake Classification	C
			Dam Classification	0
	Watershed Characteristics		Watershed area (ac/ha)	181 / 73
			Watershed / Lake ratio	13
			Lake & wetlands %	19%
			Agricultural %	4%
			Forest, shrub, grasses %	52%
			Residential	25%
	CSLAP Participation		Years	2008-2009, 2018-2019
Volunteers			Peter Grand, James Eklund	
Trophic state	HABs Susceptibility		Invasive Vulnerability	PWL Assessment
Mesoeutrophic	Few reported blooms, Moderate susceptibility		Invasives nearby, Some Vulnerability	Impaired

Fresh Pond – 2019 Sampling Season Results

“Seasonal change” shows current year variability. Light red color indicates eutrophic conditions in top table and bloom conditions in bottom table. Summer averages for each of the CSLAP years and long term trend analyses show trends in key water quality indicators over a consistent index period (mid-June thru mid-September).

Open Water Indicators	2019 Sampling Results								Seasonal change	Long Term Avg	Long Term Trend?	19 Diff from Avg
	6/16	6/30	7/14	7/28	8/11	8/25	9/8	9/22				
Clarity (m)	2.6	2.8	2.6	2.8	2.2	1.7	1.6	1.9		2.2	no	no
Surface TP (mg/l)								.01-.02		0.027	no	
Surface TDP (mg/l)								<0.01				
Deep TP (mg/l)							>0.02	>0.02		0.577	no	
Deep TDP (mg/l)							<0.01	>0.02				
TN (mg/l)	0.626	0.530		0.442	0.506	0.779	0.627	0.558		0.680	no	no
TDN (mg/l)	0.492	0.445	0.443	0.441	0.461	0.515	0.504	0.391				
N:P Ratio										35		
Deep/Surface NH4	26	28	61	201	173	50	56	167		95		
Chl.a (ug/l)	9.8	0.4	4.7	2.8	5.9	10.6		3.5		7.7	no	no
pH	6.7	6.6	7.2	7.1	6.4	6.7	6.7	6.7		7.2	no	no
Cond (umho/cm)		263	260	270						296	no	↓
Calcium (mg/L)	3				3					3	no	no
Chloride (mg/L)		56		59		60		64		38	no	no
Upper Temp (degC)	22	24	29	28	27	25	22	23		26	no	no
Deep Temp (degC)	8	11	10	11	19	9	14	9		10	no	no
FP BG Chl.a (ug/l)	3	1	1	1	5	9	6	4		6	no	no
HABs reported?	shore	shore	shore	shore	shore	no	shore	shore				

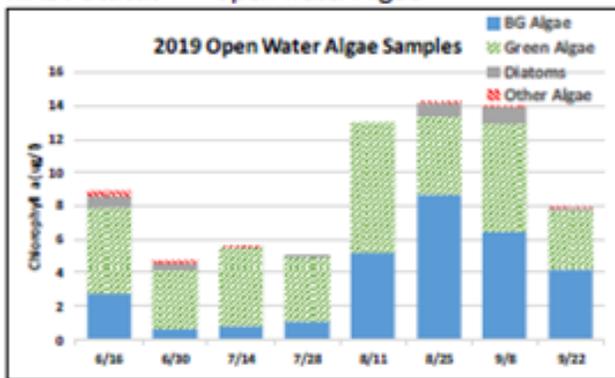
Shoreline bloom and HABs notifications

Date of first listing	Date of last listing
6/16/2019	9/22/2019

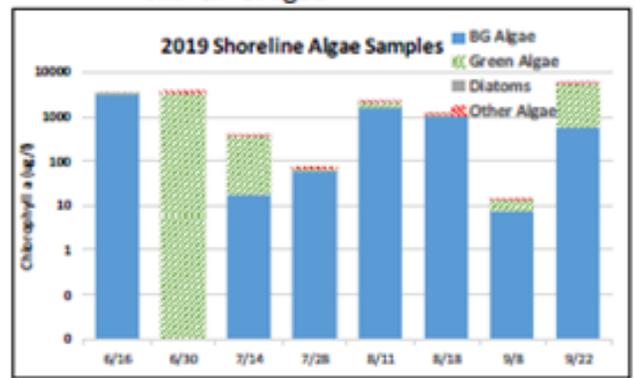
Shoreline HAB Sample Dates 2019

HAB Indicators	HAB criteria	6/16	6/30	7/14	7/28	8/11	8/18	9/8	9/22
BGA	25 - 30 ug/L	3268.3	0.0	18.1	60.5	1580.0	1056.5	7.6	611.2
Microcystin	20 ug/L	5.6	0.3	0.3	0.8	12.3	39.3	23.6	75.0
Microscopy	Dominant	filamentous green algae	filamentous green algae	Oedogonium		filamentous green algae, Microcystis	Planktothrix, Woronchinia	Microcystis, Ceratium	filamentous green algae

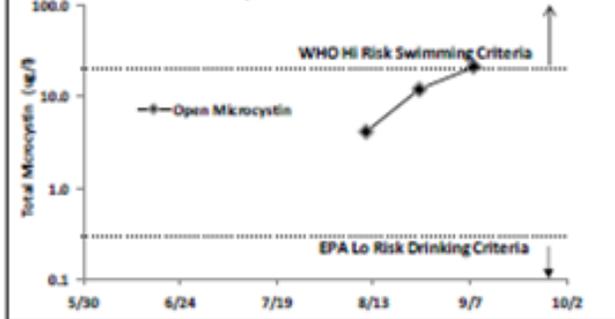
HABs Status Open water Algae



Shoreline Algae



2019 Open Water Toxin Levels

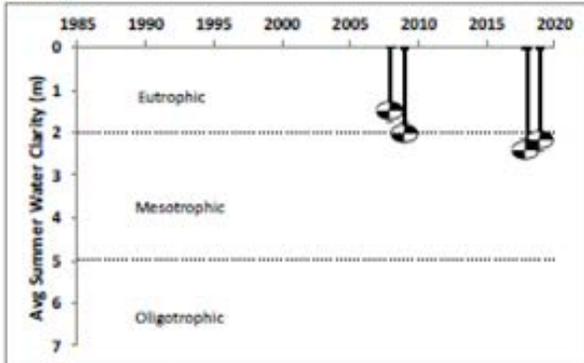


2019 Shoreline Toxin Levels

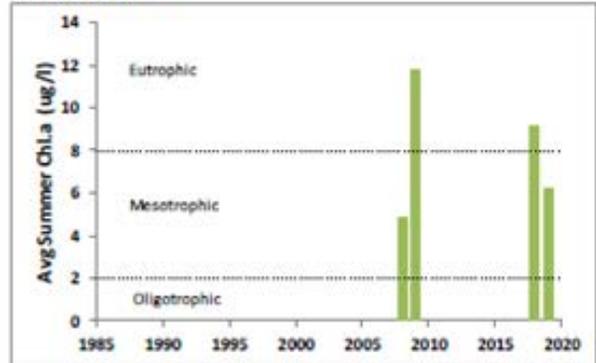


Fresh Pond – Long-Term Trend Analysis

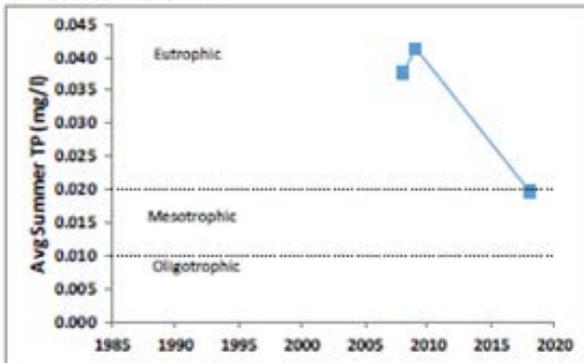
Clarity



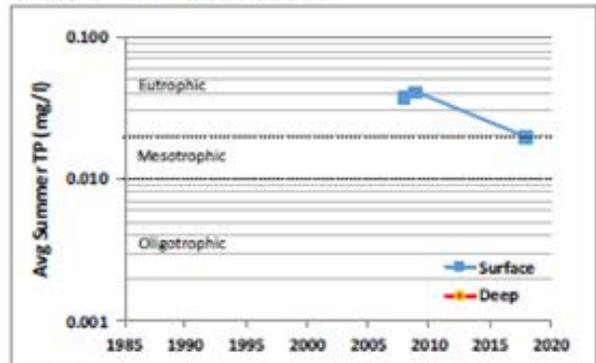
Chlorophyll *a*



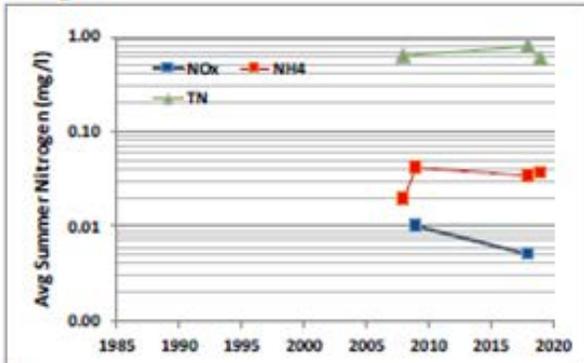
Surface Phosphorus



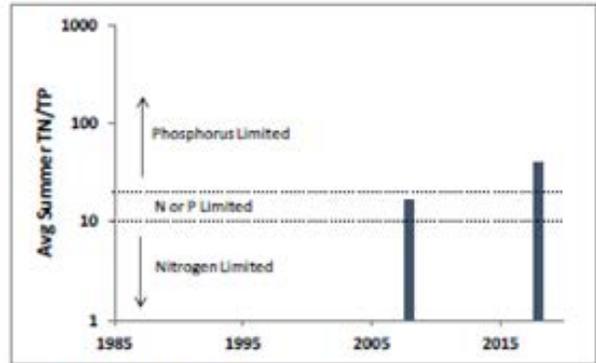
Surface and Deep Phosphorus



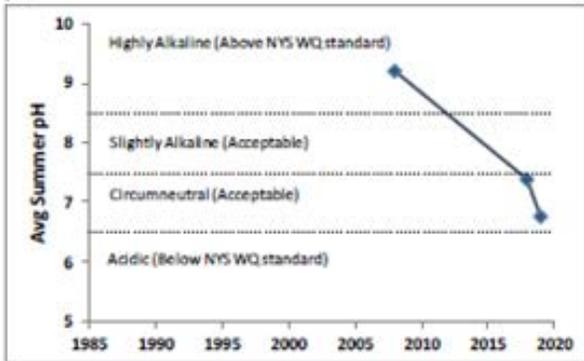
Nitrogen



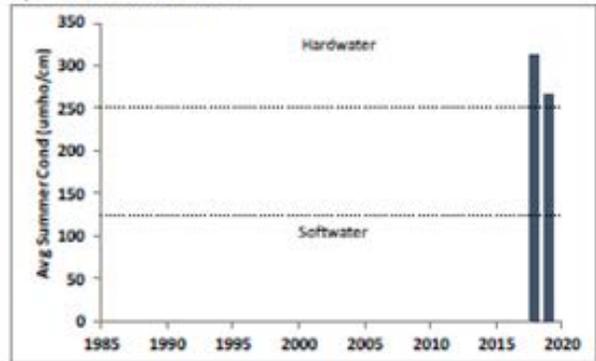
TN : TP



pH



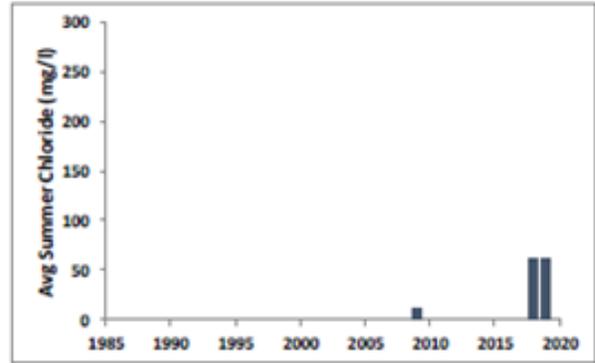
Specific Conductance



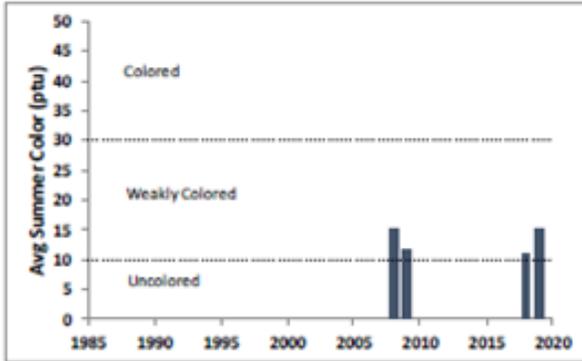
Calcium



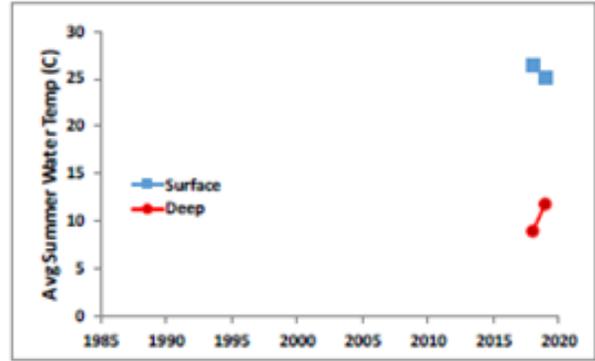
Chloride



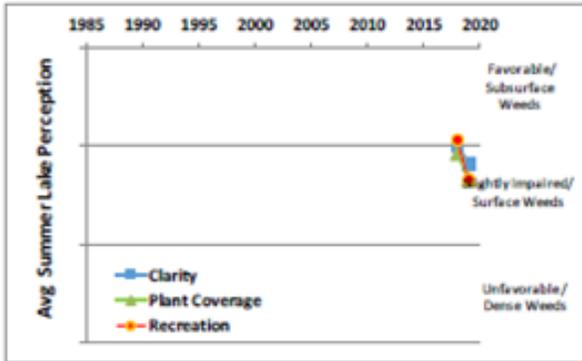
Color



Surface and Deep Temperature

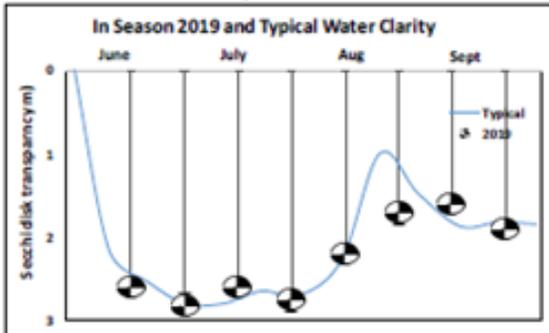


Lake Perception

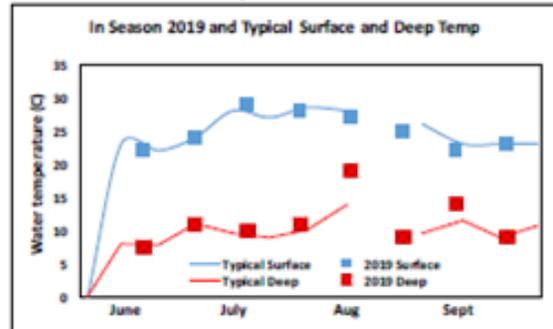


Fresh Pond – In-Season Analysis

In Season Water Clarity



In Season Water Temperature



Fresh Pond – Lake Scorecard

Water Quality Indicators		Average Year	2019
Trophic Status	Phosphorus	Eutrophic	Mesotrophic
	Chlorophyll A	Mesotrophic	Mesotrophic
	Secchi	Mesotrophic	Mesotrophic
Aquatic Invasive Species		Present	
Lake Perception		Fair	Poor
Harmful Algal Blooms		Poor	Poor
Open Water Algae Levels		Fair	Fair

Water Quality Assessments

The Waterbody Inventory/Priority Waterbodies List (WI/PWL) is a statewide inventory of New York's water resources that is used to track a water's ability to support its' best use(s), identify pollutant(s) causing impairment of best use(s), and follow the status of restoration, protection and other water quality activities and efforts. Data collected through CSLAP contributes to the WI/PWL. In order to be included as an assessment unit in the WI/PWL, a lake, pond, or reservoir must be at least 6.4 acres in size.

To view current water quality assessment results:

- Visit <https://www.dec.ny.gov/pubs/109457.html> - follow the link to launch the DECinfo Locator
- Search for waterbody name, address or nearby landmark in the search tool at the top of the left banner
- Click and Expand the 'DEC Information Layers' tab of the left banner
- Click and expand the 'Environmental Monitoring' tab of the left banner
- Check the 'Lakes and Reservoirs' layer
- Click on the waterbody of interest in the map view to display a pop-up with more information about the waterbody
- Follow the 'Fact Sheet' link in the pop-up to learn more about the current use assessment of the waterbody

Lake Stewardship Actions

Individual stewardship activities can help improve water quality: maintain your septic system, reduce fertilizer use, grow a buffer of native plants next to the lake shore, and reduce shoreline erosion and runoff into the lake. Visiting boats should be inspected to prevent the spread of invasive species, and continued community education about and monitoring for invasive species is recommended. Routine education about algae and harmful algal blooms (HABs) within your lake community is recommended; to learn more about HABs and see examples of HABs visit <http://www.dec.ny.gov/chemical/81962.html>. Occurrences of HABs can be reported to NYSDEC. For more information on keeping New York waters clean, visit <http://www.dec.ny.gov/public/43661.html>.

Fresh Pond - 2019 Lake Summary

Q. What is the condition of the lake?

A. Fresh Pond continues to be mesoeutrophic, or moderately to highly productive, based on moderate water clarity, moderate algae levels (chlorophyll a), and high nutrient (phosphorus) levels. Soluble nutrients were analyzed again 2019. Most of the nitrogen in the lake is soluble, indicating a potential for more algae growth. The lake has near neutral pH, hard water, moderately low water color, and moderately high nitrogen levels.

Q. How did 2019 compare to previous years?

A. Specific conductance readings were lower than normal in 2019. Each of the other water quality indicators was close to normal in 2019.

Q. How does this lake compare to other nearby lakes?

A. Compared to other nearby lakes, Fresh Pond usually has higher water clarity, and lower chlorophyll a levels, phosphorus readings, conductivity, calcium levels, and chloride levels. Fresh Pond usually has similar water quality assessments, similar recreational assessments, and similar aquatic plant coverage.

Q. Are there any (statistically significant) trends?

A. Since 2018, there have been no significant trends in water quality.

Q. Has the lake experienced harmful algal blooms (HABs)?

A. Water quality conditions generally indicate a moderate susceptibility to blooms, with frequent reported blooms along the shoreline or in the open water. The open water algal community in the lake is usually comprised of intermediate cyanobacteria levels. This community is dominated by *Microcystis*. Typically, open water algae levels are high. Overall open water toxin levels are at times above recreational levels of concern. Shoreline blooms have previously been documented in the lake, comprised primarily of green algae dominated by *Microcystis*. The shoreline algal community typically exhibits high toxin levels.

In 2019, overall algae levels were high, with green algae the most common taxa in open water samples, and with intermediate cyanobacteria levels. Open water toxin levels were high in 2018. Shoreline blooms in 2019 were documented in the lake, comprised primarily of cyanobacteria with high toxin levels. The most common taxa were *Microcystis*.

Q. Have any aquatic invasive species (AIS) been reported?

A. There are no invasive plants reported or present at Fresh Pond. Fresh Pond has high vulnerability for new invasives, based on calcium levels.

Glossary of water quality and HAB indicators

Clarity (m): The depth to which a Secchi disk lowered into the water is visible, measured in meters. Water clarity is one of the trophic indicators for each lake.

TP (mg/L): Total phosphorus, measured in milligrams per liter at the lake surface (1.5 meters below the surface). TP includes all dissolved and particulate forms of phosphorus. TSP, or total soluble phosphorus, was collected in 2018 and discussed in the lake narrative section.

Deep TP: Total phosphorus measured in milligrams per liter at depth (1-2 meters above the lake bottom at the deepest part of the lake)

TN: Total nitrogen, measured in milligrams per liter at the lake surface. TN includes all forms of nitrogen, including NO_x (nitrite and nitrate) and NH₄ (ammonia).

N:P Ratio: The ratio of total nitrogen to total phosphorus, unitless (mass ratio). This ratio helps determine if a lake is phosphorous or nitrogen limited.

Chl.a (µg/L): Chlorophyll a, measured in micrograms per liter. Indicates the amount of algae in the water column. This is an extracted chlorophyll measurement.

pH: A range from 0 to 14, with 0 being the most acidic and 14 being the most basic or alkaline. A healthy lake generally ranges between 6.5 and 8.5.

Cond (µmho/cm): Specific conductance is a measure of the conductivity of water. A higher value indicates the presence of more dissolved ions. High ion concentrations (> 250) usually indicate hardwater, and low readings (< 125) usually show softwater.

Upper Temp (°C): Surface temperature, measured in degrees Celsius

Deep Temp (°C): Bottom temperature, measured in degrees Celsius

BG Chl.a (µg/L): Chlorophyll a from blue-green algae, measured in micrograms per liter. This is an “unextracted” estimate using a fluoroprobe. This result is not as accurate as the extracted chlorophyll measurement described above.

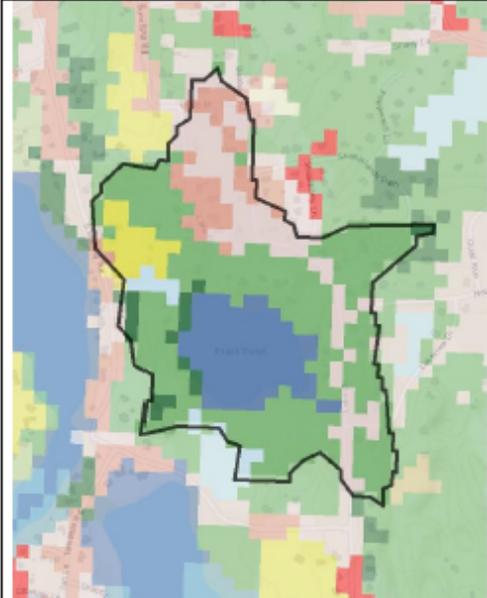
HABs: Harmful Algal Blooms. Algal blooms that have the appearance of cyanobacteria (BGA)

BGA: Blue-green algae, also known as cyanobacteria

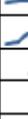
Microcystin (µg/L): The most common HAB liver toxin; total microcystin above 20 micrograms per liter indicates a “high toxin” bloom. However, ALL BGA blooms should be avoided, even if toxin levels are low.

Anatoxin-a (µg/L): A toxin that may be produced in a HAB which targets the central nervous system. Neither EPA nor NYS has developed a risk threshold for anatoxin-a, although readings above 4 micrograms per liter are believed to represent an elevated risk.

D.3 FRESH POND CSLAP 2018 DATA

Fresh Pond		Fresh Pond Neighbors Association	Town of Shelter Island	Suffolk County
	Lake Characteristics	Surface area (ac/ha)	14 / 6	
		Max depth (ft/m)	46 / 14	
		Mean depth (ft/m)	21 / 6	
		Retention time (years)	1.0	
		Lake Classification	C	
		Dam Classification	0	
	Watershed Characteristics	Watershed area (ac/ha)	181 / 73	
		Watershed / Lake ratio	13	
		Lake & wetlands %	19%	
		Agricultural %	4%	
		Forest, shrub, grasses %	52%	
		Residential	25%	
Urban	0%			
CSLAP Participation	Years	2018		
	Volunteers	Peter Grand and James and Andrew Eklund		
Trophic state	HABs Susceptibility		Invasive Vulnerability	PWL Assessment
Mesoeutrophic	Few reported blooms, Moderate susceptibility		Invasives nearby, Some Vulnerability	Impaired

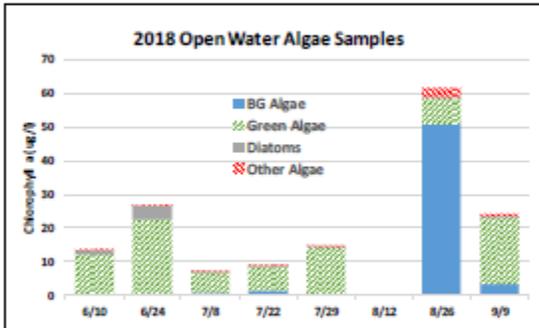
Water quality values for Fresh Pond for the 2018 sampling season. "Seasonal change" shows current year variability. Light red color indicates eutrophic conditions in top table and bloom conditions in bottom table. Summer averages for each of the CSLAP years and long term trend analyses show trends in key water quality indicators over a consistent index period (mid-June thru mid-September).

Open Water Indicators	2018 Sampling Results								Seasonal change	Long Term Avg	Long Term Trend?	18 Diff from Avg
	6/10	6/24	7/8	7/22	7/29	8/12	8/26	9/9				
Clarity (m)	2.2	2.3	3.0	3.0	2.7	2.4	1.3	2.2		2.2	no	no
Surface TP (mg/l)	0.030	0.025	0.028	0.010	0.018	0.016	0.022	0.021		0.027	no	no
Surface TDP (mg/l)	0.008	0.019	0.023	0.011	0.007	0.007	0.016	0.006		0.012	no	
Deep TP (mg/l)	0.377	0.664	0.462	0.566	0.682	0.638	0.769	0.460		0.577		
Deep/Surface TP	12	27	17	58	38	40	35	22		21		
TN (mg/l)	0.750	0.637	1.010		0.606	0.648	0.818	1.030		0.766	no	no
TDN (mg/l)	0.640	0.681	0.686		0.558	0.505	0.651	0.936				
N:P Ratio	25	26	36		34	41	37	50		35		
Deep/Surface NH4	58		99	37	30	608	119	58		144		
Chl.a (ug/l)		8.7		5.0	2.4	4.8	26.9	7.1		9.1	no	no
pH	7.2	8.0	7.0	7.2	7.2	7.0	8.5	6.8		7.6	no	no
Cond (umho/cm)	277	302	313	325	324	320	310	289		307	↑↑	no
Upper Temp (degC)	23	22	27	27	29	29	27	24		26	↑↑	no
Deep Temp (degC)	8	8	9	9	9	9	10	9		9		no
FP BG Chl.a (ug/l)	0	0	1	1	0		51	3		8	↑↑	no
HABs reported?	no	no	shore	shore	shore	shore	shore	shore				

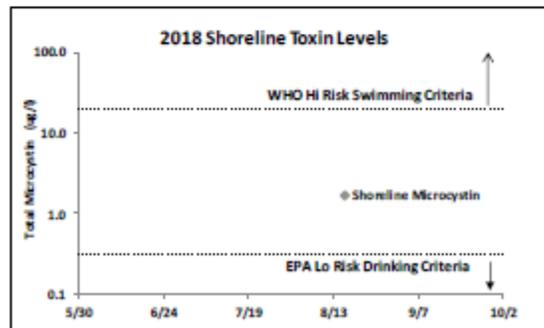
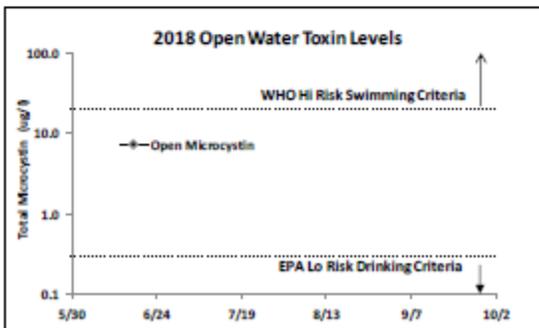
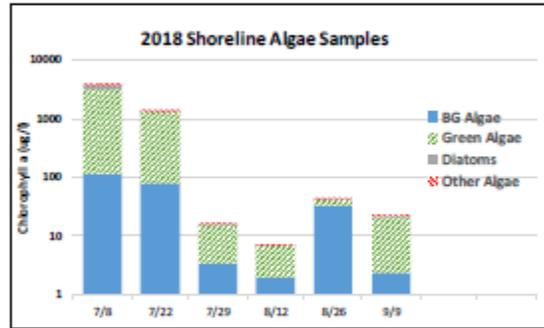
Shoreline bloom and HABs notifications

Date of first listing	Date of last listing	# weeks on the DEC notification list	# Weeks with updates				
7/13/2018	9/7/2018	5	3				
Shoreline HAB Sample Dates 2018							
HAB Indicators	HAB criteria	7/8/2018	7/22/2018	7/29/2018	8/12/2018	8/26/2018	9/9/2018
BGA	25 - 30 ug/L	115.8	80.5	3.3	2.0	33.5	2.3
microcystin	20 ug/L	ND	ND	ND	ND	ND	ND
anatoxin - a	4 ug/L						

HABs Status Open water Algae



Shoreline Algae



FRESH POND

(SEGMENT ID 1701-0241)

Waterbody Segment Assessment Factsheet Based on the 2021 CALM

Revised: December 07, 2021

IMPAIRED SEGMENT (IR CATEGORY 5)

Introduction

This is the most recent water quality assessment information for this waterbody segment. The assessment is based on water quality data that meet the quality assurance requirements of DEC's Division of Water. An outline of the process used to assess the quality of New York State waters is described in the DEC's Consolidated Assessment and Listing Methodology (CALM) (<https://www.dec.ny.gov/chemical/31290.html>). The CALM describes the assessment and listing process to improve the consistency of assessment and listing decisions.

WATERBODY INFORMATION

- **Water Index Number:** (MW6.3d) GB-SIS-SI-WNH-P458
- **Classification:** C
- **Waterbody Type:** Lake/Reservoir
- **Size:** 14.1 Acres
- **Drainage Basin:** Atlantic-Long Island Sound
- **Hydrologic Unit Code:** 0203020207
- **County:** Suffolk
- **Segment Description:** Entire lake

Assessment of Best Use

Background

New York State waterbodies are classified to reflect their best use(s) and the assessment of a waterbody is based on the ability of waters to support them. This section lists whether this waterbody segment supports its best use(s). View DEC's CALM (<https://www.dec.ny.gov/chemical/31290.html>) for more information about the terms used below.

Best Use	Use Assessment	Use Assessment Confirmation	Pollutant(s)	Integrated Reporting Category	303(d) Year
 Fishing	Unassessed	—	No Data	IR3	N/A for Assessment Category
 Secondary Contact Recreation	Impaired	Confirmed	Phosphorus	IR5	2012
 Primary Contact Recreation	N/A for Waterbody Class	—	—	—	—

<https://www.dec.ny.gov/data/WQP/PWL/1701-0241.html?req=26437>

1/2

Best Use	Use Assessment	Use Assessment Confirmation	Pollutant(s)	Integrated Reporting Category	303(d) Year
 Source of Water Supply	N/A for Waterbody Class	—	—	—	—
 Shellfishing	N/A for Waterbody Class	—	—	—	—
 EPA Appended Listing	N/A for Waterbody Class	—	—	—	—

Water Quality Monitoring Data Used

Background

Water quality monitoring data are collected by DEC's Division of Water and community partners. While data are evaluated to assess whether best use(s) are supported, they may not be reflected in the final assessment of best use(s) presented above. The process for conducting assessments of best use(s) is explained in DEC's CALM (<https://www.dec.ny.gov/chemical/31290.html>).

This section lists the data sources for the pollutants listed in the Assessment of Best Use table.

Pollutant(s)	Data Source	Years
Phosphorus	Historical Data Source	—

APPENDIX E 2021 ALGAE SPECIES IDENTIFICATION

Phytoplankton species, their density and biomass were determined by Dr. Ken Wagner based upon samples collected by Peter Grand.

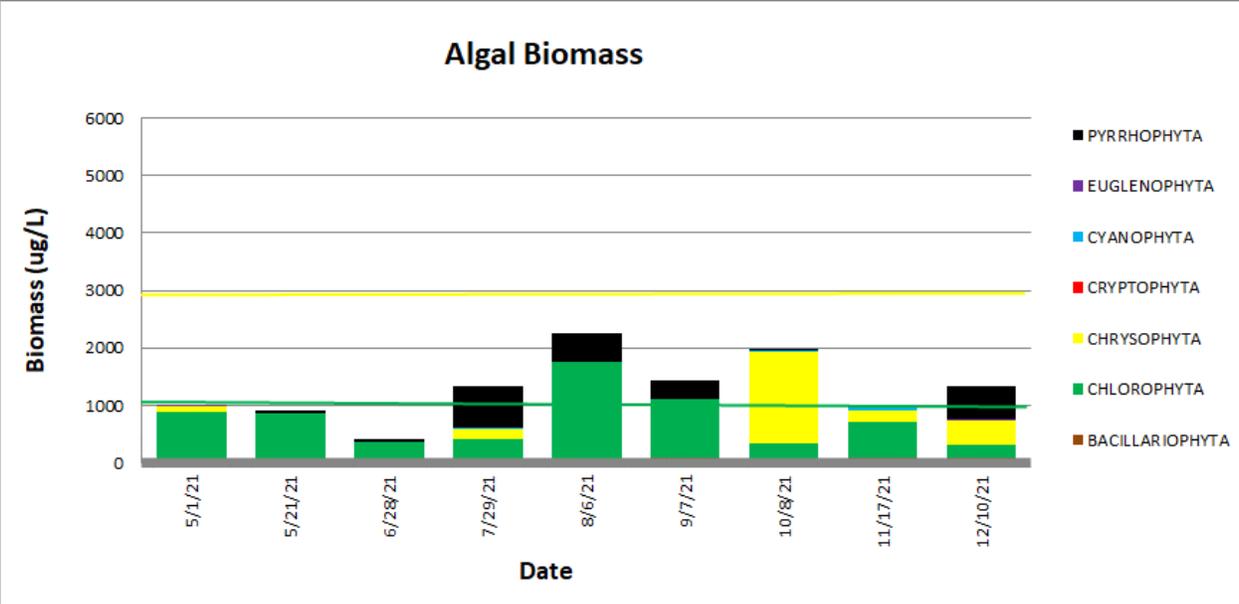
TAXON	PHYTOPLANKTON DENSITY (CELLS/ML)									
	Fresh P Buoy 05/01/21	Fresh P Buoy 05/21/21	Fresh P Buoy 06/28/21	Fresh P Buoy 07/29/21	Fresh P Buoy 08/06/21	Fresh P Buoy 09/07/21	Fresh P Buoy 10/08/21	Fresh P Buoy 11/17/21	Fresh P Buoy 12/10/21	
BACILLARIOPHYTA										
Centric Diatoms										
Araphid Pennate Diatoms										
<i>Synedra</i>	0	0	78	0	0	0	0	0	0	
<i>Tabellaria</i>	14	77	0	0	68	109	54	118	124	
Monoraphid Pennate Diatoms										
Biraphid Pennate Diatoms										
CHLOROPHYTA										
Flagellated Chlorophytes										
<i>Chlamydomonas</i>	0	0	0	0	0	0	0	0	12	
Coccolid/Colonial Chlorophytes										
<i>Ankistrodesmus</i>	21	38	78	41	14	16	54	59	37	
<i>Chlorella</i>	0	2688	0	0	14484	9048	1179	0	0	
<i>Coelastrum</i>	0	0	0	544	326	0	0	0	0	
<i>Crucigenia</i>	168	1133	0	1414	870	936	214	237	99	
<i>Dictyosphaerium</i>	476	115	388	0	0	0	0	178	0	
<i>Elakatothrix</i>	0	19	543	109	109	31	107	178	50	
<i>Kirchneriella</i>	0	0	0	0	0	0	0	0	50	
<i>Oocystis</i>	0	230	116	27	109	62	54	59	0	
<i>Quadrigula</i>	0	0	0	0	0	0	0	59	50	
<i>Scenedesmus</i>	56	154	78	326	163	62	322	355	99	
<i>Schroederia</i>	14	19	19	0	0	0	13	44	25	
<i>Sphaerocystis</i>	0	922	310	0	0	0	214	0	0	
<i>Tetraedron</i>	0	19	0	27	14	0	0	0	0	
<i>Tetrastrum</i>	0	0	0	0	0	0	0	237	50	
Filamentous Chlorophytes										
<i>Oedogonium</i>	28	0	0	0	0	0	0	0	0	
Desmids										
<i>Closterium</i>	0	0	0	0	0	0	0	0	25	
<i>Desmidium</i>	0	0	0	0	0	0	0	30	0	
<i>Euastrum</i>	0	10	0	41	0	0	13	0	0	
<i>Mougeotia/Debarya</i>	0	0	0	0	0	0	0	15	0	
<i>Spirogyra</i>	35	0	0	0	0	0	0	0	0	
<i>Staurastrum</i>	0	38	0	27	14	0	0	15	0	
<i>Staurodesmus</i>	70	19	58	54	0	0	0	15	0	
CHRYSTOPHYTA										
Flagellated Classic Chrysophytes										
<i>Chromulina</i>	0	0	0	0	0	0	0	0	1116	
<i>Dinobryon</i>	35	0	0	54	0	0	523	59	112	
<i>Mallomonas</i>	0	0	0	27	14	0	0	30	50	
Non-Motile Classic Chrysophytes										
Haptophytes										
Tribophytes/Eustigmatophytes										
<i>Pseudostaurastrum</i>	0	0	0	0	0	0	13	0	0	
Raphidophytes										
CRYPTOPHYTA										
<i>Cryptomonas</i>	0	0	19	0	0	0	13	0	0	
CYANOPHYTA										
Unicellular and Colonial Forms										
<i>Aphanocapsa</i>	0	0	776	0	0	0	0	0	0	
<i>Microcystis</i>	0	0	0	0	0	0	2680	5920	0	
Filamentous Nitrogen Fixers										
Filamentous Non-Nitrogen Fixers										
<i>Planktothrix</i>	0	0	0	544	0	0	0	0	620	
EUGLENOPHYTA										
<i>Trachelomonas</i>	14	0	0	14	0	0	0	15	25	
PYRRHOPHYTA										
<i>Ceratium</i>	0	0	0	41	27	16	0	0	0	
<i>Peridinium</i>	0	19	19	0	14	16	13	0	12	

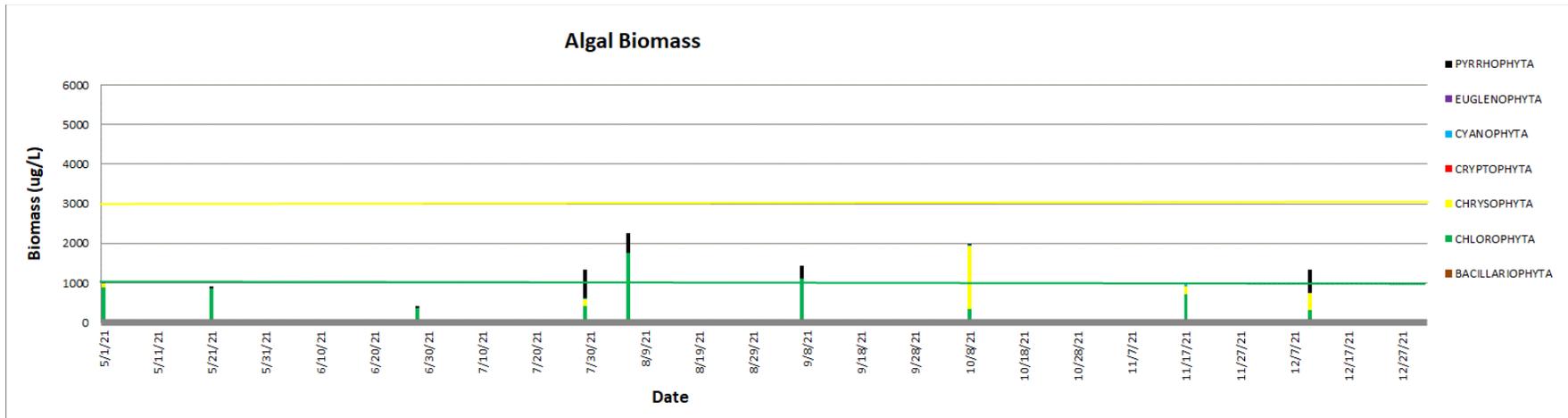
DENSITY (CELLS/ML) SUMMARY									
BACILLARIOPHYTA	14	76.8	77.6	0	68	109.2	53.6	118.4	124
Centric Diatoms	0	0	0	0	0	0	0	0	0
Araphid Pennate Diatoms	14	76.8	77.6	0	68	109.2	53.6	118.4	124
Monoraphid Pennate Diatoms	0	0	0	0	0	0	0	0	0
Biraphid Pennate Diatoms	0	0	0	0	0	0	0	0	0
CHLOROPHYTA	868	5404.8	1590.8	2611.2	16102.4	10155.6	2170.8	1480	496
Flagellated Chlorophytes	0	0	0	0	0	0	0	0	12.4
Coccolid/Colonial Chlorophytes	735	5337.6	1532.6	2488.8	16088.8	10155.6	2157.4	1406	458.8
Filamentous Chlorophytes	28	0	0	0	0	0	0	0	0
Desmids	105	67.2	58.2	122.4	13.6	0	13.4	74	24.8
CHRYSOPHYTA	35	0	0	81.6	13.6	0	536	88.8	1277.2
Flagellated Classic Chrysophytes	35	0	0	81.6	13.6	0	522.6	88.8	1277.2
Non-Motile Classic Chrysophytes	0	0	0	0	0	0	0	0	0
Haptophytes	0	0	0	0	0	0	0	0	0
Tribophytes/Eustigmatophytes	0	0	0	0	0	0	13.4	0	0
Raphidophytes	0	0	0	0	0	0	0	0	0
CRYPTOPHYTA	0	0	19.4	0	0	0	13.4	0	0
CYANOPHYTA	0	0	776	544	0	0	2680	5920	620
Unicellular and Colonial Forms	0	0	776	0	0	0	2680	5920	0
Filamentous Nitrogen Fixers	0	0	0	0	0	0	0	0	0
Filamentous Non-Nitrogen Fixers	0	0	0	544	0	0	0	0	620
EUGLENOPHYTA	14	0	0	13.6	0	0	0	14.8	24.8
PYRRHOPHYTA	0	19.2	19.4	40.8	40.8	31.2	13.4	0	12.4
TOTAL	931	5500.8	2483.2	3291.2	16224.8	10296	5467.2	7622	2554.4
CELL DIVERSITY	0.71	0.66	0.83	0.77	0.22	0.21	0.70	0.46	0.81
CELL EVENNESS	0.69	0.56	0.77	0.66	0.20	0.22	0.60	0.37	0.66
NUMBER OF TAXA									
BACILLARIOPHYTA	1	1	1	0	1	1	1	1	1
Centric Diatoms	0	0	0	0	0	0	0	0	0
Araphid Pennate Diatoms	1	1	1	0	1	1	1	1	1
Monoraphid Pennate Diatoms	0	0	0	0	0	0	0	0	0
Biraphid Pennate Diatoms	0	0	0	0	0	0	0	0	0
CHLOROPHYTA	8	13	8	10	9	6	9	13	10
Flagellated Chlorophytes	0	0	0	0	0	0	0	0	1
Coccolid/Colonial Chlorophytes	5	10	7	7	8	6	8	9	8
Filamentous Chlorophytes	1	0	0	0	0	0	0	0	0
Desmids	2	3	1	3	1	0	1	4	1
CHRYSOPHYTA	1	0	0	2	1	0	2	2	3
Flagellated Classic Chrysophytes	1	0	0	2	1	0	1	2	3
Non-Motile Classic Chrysophytes	0	0	0	0	0	0	0	0	0
Haptophytes	0	0	0	0	0	0	0	0	0
Tribophytes/Eustigmatophytes	0	0	0	0	0	0	1	0	0
Raphidophytes	0	0	0	0	0	0	0	0	0
CRYPTOPHYTA	0	0	1	0	0	0	1	0	0
CYANOPHYTA	0	0	1	1	0	0	1	1	1
Unicellular and Colonial Forms	0	0	1	0	0	0	1	1	0
Filamentous Nitrogen Fixers	0	0	0	0	0	0	0	0	0
Filamentous Non-Nitrogen Fixers	0	0	0	1	0	0	0	0	1
EUGLENOPHYTA	1	0	0	1	0	0	0	1	1
PYRRHOPHYTA	0	1	1	1	2	2	1	0	1
TOTAL	11	15	12	15	13	9	15	18	17

TAXON	PHYTOPLANKTON BIOMASS (UG/L)									
	Fresh P Buoy 05/01/21	Fresh P Buoy 05/21/21	Fresh P Buoy 06/28/21	Fresh P Buoy 07/29/21	Fresh P Buoy 08/06/21	Fresh P Buoy 09/07/21	Fresh P Buoy 10/08/21	Fresh P Buoy 11/17/21	Fresh P Buoy 12/10/21	
BACILLARIOPHYTA										
Centric Diatoms										
Araphid Pennate Diatoms										
<i>Synedra</i>	0.0	0.0	62.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Tabellaria</i>	11.2	61.4	0.0	0.0	54.4	87.4	42.9	94.7	99.2	
Monoraphid Pennate Diatoms										
Biraphid Pennate Diatoms										
CHLOROPHYTA										
Flagellated Chlorophytes										
<i>Chlamydomonas</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0
Coccolid/Colonial Chlorophytes										
<i>Ankistrodesmus</i>	2.1	3.8	7.8	4.1	1.4	1.6	5.4	5.9	3.7	
<i>Chlorella</i>	0.0	268.8	0.0	0.0	1448.4	904.8	117.9	0.0	0.0	
<i>Coelastrum</i>	0.0	0.0	0.0	108.8	65.3	0.0	0.0	0.0	0.0	
<i>Crucigenia</i>	16.8	113.3	0.0	141.4	87.0	93.6	21.4	23.7	9.9	
<i>Dictyosphaerium</i>	47.6	11.5	38.8	0.0	0.0	0.0	0.0	17.8	0.0	
<i>Elakatothrix</i>	0.0	1.9	54.3	10.9	10.9	3.1	10.7	17.8	5.0	
<i>Kirchneriella</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	
<i>Oocystis</i>	0.0	92.2	46.6	10.9	43.5	25.0	21.4	23.7	0.0	
<i>Quadrigula</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.8	9.9	
<i>Scenedesmus</i>	5.6	15.4	7.8	32.6	16.3	6.2	32.2	35.5	9.9	
<i>Schroederia</i>	35.0	48.0	48.5	0.0	0.0	0.0	33.5	111.0	62.0	
<i>Sphaerocystis</i>	0.0	184.3	62.1	0.0	0.0	0.0	42.9	0.0	0.0	
<i>Tetraedron</i>	0.0	11.5	0.0	16.3	8.2	0.0	0.0	0.0	0.0	
<i>Tetrastrum</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.4	9.9	
Filamentous Chlorophytes										
<i>Oedogonium</i>	28.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Desmids										
<i>Closterium</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	99.2	
<i>Desmidium</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	281.2	0.0	
<i>Euastrum</i>	0.0	9.6	0.0	40.8	0.0	0.0	13.4	0.0	0.0	
<i>Mougeotia/Debarya</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.8	0.0	
<i>Spirogyra</i>	700.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
<i>Staurastrum</i>	0.0	30.7	0.0	21.8	10.9	0.0	0.0	11.8	0.0	
<i>Staurodesmus</i>	42.0	11.5	34.9	32.6	0.0	0.0	0.0	8.9	0.0	
CHRYSTOPHYTA										
Flagellated Classic Chrysophytes										
<i>Chromulina</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	55.8	
<i>Dinobryon</i>	105.0	0.0	0.0	163.2	0.0	0.0	1567.8	177.6	334.8	
<i>Mallomonas</i>	0.0	0.0	0.0	13.6	6.8	0.0	0.0	14.8	24.8	
Non-Motile Classic Chrysophytes										
Haptophytes										
Tribophytes/Eustigmatophytes										
<i>Pseudostaurastrum</i>	0.0	0.0	0.0	0.0	0.0	0.0	10.7	0.0	0.0	
Raphidophytes										
CRYPTOPHYTA										
<i>Cryptomonas</i>	0.0	0.0	3.9	0.0	0.0	0.0	2.7	0.0	0.0	
CYANOPHYTA										
Unicellular and Colonial Forms										
<i>Aphanocapsa</i>	0.0	0.0	7.8	0.0	0.0	0.0	0.0	0.0	0.0	
<i>Microcystis</i>	0.0	0.0	0.0	0.0	0.0	0.0	26.8	59.2	0.0	
Filamentous Nitrogen Fixers										
Filamentous Non-Nitrogen Fixers										
<i>Planktothrix</i>	0.0	0.0	0.0	5.4	0.0	0.0	0.0	0.0	6.2	
EUGLENOPHYTA										
<i>Trachelomonas</i>	14.0	0.0	0.0	13.6	0.0	0.0	0.0	14.8	24.8	
PYRRHOPHYTA										
<i>Ceratium</i>	0.0	0.0	0.0	709.9	473.3	271.4	0.0	0.0	0.0	
<i>Peridinium</i>	0.0	40.3	40.7	0.0	28.6	32.8	28.1	0.0	558.0	

DENSITY (UG/ML) SUMMARY									
BACILLARIOPHYTA	11.2	61.4	62.1	0.0	54.4	87.4	42.9	94.7	99.2
Centric Diatoms	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Araphid Pennate Diatoms	11.2	61.4	62.1	0.0	54.4	87.4	42.9	94.7	99.2
Monoraphid Pennate Diatoms	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Biraphid Pennate Diatoms	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CHLOROPHYTA	877.1	802.6	300.7	420.2	1691.8	1034.3	298.8	611.2	219.5
Flagellated Chlorophytes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0
Cocoid/Colonial Chlorophytes	107.1	750.7	265.8	325.0	1681.0	1034.3	285.4	294.5	115.3
Filamentous Chlorophytes	28.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Desmids	742.0	51.8	34.9	95.2	10.9	0.0	13.4	316.7	99.2
CHRYSOPHYTA	105.0	0.0	0.0	176.8	6.8	0.0	1578.5	192.4	415.4
Flagellated Classic Chrysophytes	105.0	0.0	0.0	176.8	6.8	0.0	1567.8	192.4	415.4
Non-Motile Classic Chrysophytes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Haptophytes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tribophytes/Eustigmatophytes	0.0	0.0	0.0	0.0	0.0	0.0	10.7	0.0	0.0
Raphidophytes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRYPTOPHYTA	0.0	0.0	3.9	0.0	0.0	0.0	2.7	0.0	0.0
CYANOPHYTA	0.0	0.0	7.8	5.4	0.0	0.0	26.8	59.2	6.2
Unicellular and Colonial Forms	0.0	0.0	7.8	0.0	0.0	0.0	26.8	59.2	0.0
Filamentous Nitrogen Fixers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Filamentous Non-Nitrogen Fixers	0.0	0.0	0.0	5.4	0.0	0.0	0.0	0.0	6.2
EUGLENOPHYTA	14.0	0.0	0.0	13.6	0.0	0.0	0.0	14.8	24.8
PYRRHOPHYTA	0.0	40.3	40.7	709.9	501.8	304.2	28.1	0.0	558.0
TOTAL	1007.3	904.3	415.2	1326.0	2254.9	1425.8	1977.8	972.4	1323.1
BIOMASS DIVERSITY	0.52	0.91	0.98	0.72	0.52	0.50	0.43	0.99	0.77
BIOMASS EVENNESS	0.50	0.77	0.91	0.61	0.46	0.53	0.36	0.79	0.63
	5/1/21	5/21/21	6/28/21	7/29/21	8/6/21	9/7/21	10/8/21	11/17/21	12/10/21
DENSITY (UG/ML) SUMMARY									
BACILLARIOPHYTA	11	61	62	0	54	87	43	95	99
CHLOROPHYTA	877	803	301	420	1692	1034	299	611	219
CHRYSOPHYTA	105	0	0	177	7	0	1579	192	415
CRYPTOPHYTA	0	0	4	0	0	0	3	0	0
CYANOPHYTA	0	0	8	5	0	0	27	59	6
EUGLENOPHYTA	14	0	0	14	0	0	0	15	25
PYRRHOPHYTA	0	40	41	710	502	304	28	0	558

DENSITY (UG/L) SUMMARY									
	5/1/21	5/21/21	6/28/21	7/29/21	8/6/21	9/7/21	10/8/21	11/17/21	12/10/21
BACILLARIOPHYTA	11	61	62	0	54	87	43	95	99
CHLOROPHYTA	877	803	301	420	1692	1034	299	611	219
CHRYSOPHYTA	105	0	0	177	7	0	1579	192	415
CRYPTOPHYTA	0	0	4	0	0	0	3	0	0
CYANOPHYTA	0	0	8	5	0	0	27	59	6
EUGLENOPHYTA	14	0	0	14	0	0	0	15	25
PYRRHOPHYTA	0	40	41	710	502	304	28	0	558





APPENDIX F REFERENCES

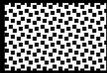
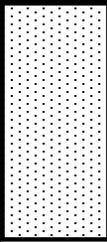
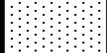
1. Lombardo P., W. Robertson, A. Mehrotra, C. Ptacek and D. Blowes. 2005. Phosphorus Geochemistry in Septic Tanks, Soil Absorption Systems, and Groundwater. Project No. WU-HT-03-21. Prepared for the National Decentralized Water Resources Capacity Development Project, Washington University, St. Louis, MO, by Lombardo Associates, Inc., Newton, MA.
2. Misut, P.E., Casamassina, N.A., and Walter, D.A., 2021, Delineation of areas contributing groundwater and travel times to receiving waters in Kings, Queens, Nassau, and Suffolk Counties, New York: U.S. Geological Survey Scientific Investigations Report 2021–5047, 61 p., <https://doi.org/10.3133/sir20215047>.
3. Nelson, Pope & Voorhis (NPV), 2014, Town of Shelter Island Watershed Management Plan.
4. Robertson, W.D. 2008. Irreversible Phosphorus Sorption in Septic System Plumes? Ground Water. 46(1): 51-60.
5. Suffolk County Department of Health Services (SCDHS), 2020, Subwatersheds Wastewater Plan
6. Wagner, K., 2015. Oxygenation and Circulation to Aid Water Supply Reservoir Management, Water Research Foundation, Denver, CO.
7. “Walter, D.A., Masterson, J.P., Finkelstein, J.S., Monti, J., Jr., Misut, P.E., and Fienen, M.N., 2020, Simulation of groundwater flow in the regional aquifer system on Long Island, New York, for pumping and recharge conditions in 2005–15: U.S. Geological Survey Scientific Investigations Report 2020–5091, 75 p., <https://doi.org/10.3133/sir20205091>
8. Water Resource Services (WRS), Data Review for Sarah’s Pond, Orleans, MA, December 2021.

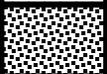
Pond Water Quality Models

- a. Carlson, R. 1977. A Trophic State Index for Lakes. *Limnol. and Oceanogr.* 22:261-369 Mifflin Co., NY.
- b. Dillon, P.J. and F.H. Rigler. 1974. The Phosphorus-Chlorophyll Relationship in Lakes. *Limnol. Oceanogr.* 19:767-773.
- c. Jones, J. and R. Bachmann. 1976. Prediction of Phosphorus and Chlorophyll Levels in Lakes. *JWPCF* 48:2176-2184.
- d. Jones, R.A., W. Rast and G.F. Lee. 1979. Relationship between summer mean and summer maximum chlorophyll a concentrations in lakes. *Env. Sci. & Technol.* 13:869-870.
- e. Kirchner, W. and P. Dillon. 1975. An Empirical Method of Estimating the Retention of Phosphorus in Lakes. *Water Resour. Res.* 11:182-183.
- f. Larsen, D. and H. Mercier. 1976. Phosphorus Retention Capacity of Lakes. *J. Fish. Res. Bd. Can.* 33:1742-1750.
- g. Oglesby, R.T. and W.R. Schaffner. 1978. Phosphorus Loadings to Lakes and some of their responses. Part 2. Regression Models of Summer Phytoplankton Standing Crops, Winter Total P, and Transparency of New York Lakes with Phosphorus Loadings. *Limnol. Oceanogr.* 23:135-145.
- h. Reckhow, K. 1977. Phosphorus Models for Lake Management. Ph.D. Dissertation, Harvard University, Cambridge, MA.

- i. Vollenweider, R.A. 1975. Input-output models with special references to the phosphorus loading concept in limnology. *Schweiz. Z. Hydrol.* 37:53-62.
- j. Vollenweider, R. 1982. *Eutrophication of Waters: Monitoring, Assessment and Control.* OECD, Paris.
- k. Walker. W.W. 1984. Statistical bases for mean chlorophyll-a criteria. Pages 57-62 in *Lake and Reservoir Management – Practical Applications.* Proceedings of the 4th annual NALMS symposium. USEPA, Washington, DC

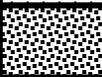
APPENDIX G 65 SOUTH MIDWAY ROAD SITE TEST PITS & BORING

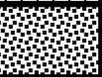
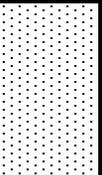
Project: Fresh Pond HLW Dispersal Site		Project # 6700	Client: Town of Shelter Island	Test Pit # TP-1
Location: 41° 3'19.58"N, 72°20'12.13"W				
Groundwater Depth: Not Encountered		Elevation:	Total Depth of Test Pit: 5-ft	
Depth (feet)	Sample Number	Graphic Log	Lithology	
			Soil Group Name: modifier, color, moisture, density/consistency, grain size, other descriptors Rock Description: modifier color, hardness/degree of concentration, bedding and joint characteristics, solutions, void conditions.	
1			0-4" - organic matter	
2			4" - 2' - Light brown fine sand w/cobbles. Some silt / clay	
3			Beige fine sand w/cobbles, no groundwater	
4				
5				

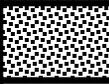
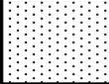
Project: Fresh Pond HLW Dispersal Site		Project # 6700	Client: Town of Shelter Island	Test Pit # TP-2
Location: 41° 3'21.07"N, 72°20'13.15"W				
Groundwater Depth: None Encountered		Elevation:	Total Depth of Test Pit: 5-ft	
Depth (feet)	Sample Number	Graphic Log	Lithology	
			Soil Group Name: modifier, color, moisture, density/consistency, grain size, other descriptors Rock Description: modifier color, hardness/degree of concentration, bedding and joint characteristics, solutions, void conditions.	
1			0-4" - organic matter	
2			4" - 2' - Dark brown fine sand w/cobbles. Some silt / clay	
3			Light brown fine sand w/cobbles	
4				
5				

Project: Fresh Pond HLW Dispersal Site		Project # 6700	Client: Town of Shelter Island	Test Pit # TP-3
Location: 41° 3'20.74"N 72°20'12.40"W				
Groundwater Depth: None Encountered		Elevation:	Total Depth of Test Pit: 5-ft	
Depth (feet)	Sample Number	Graphic Log	Lithology	
			Soil Group Name: modifier, color, moisture, density/consistency, grain size, other descriptors	
			Rock Description: modifier color, hardness/degree of concentration, bedding and joint characteristics, solutions, void conditions.	
			1	0-4" - organic matter
			2	4" - 2' - Light brown fine sand w/cobbles. Some silt / clay
3		Light brown coarse sand w/cobbles, no groundwater		
4				
5				

Project: Fresh Pond HLW Dispersal Site		Project # 6700	Client: Town of Shelter Island	Test Pit # TP-4
Location: 41° 3'19.65"N, 72°20'11.08"W				
Groundwater Depth: None Encountered		Elevation:	Total Depth of Test Pit: 5-ft	
Depth (feet)	Sample Number	Graphic Log	Lithology	
			Soil Group Name: modifier, color, moisture, density/consistency, grain size, other descriptors	
			Rock Description: modifier color, hardness/degree of concentration, bedding and joint characteristics, solutions, void conditions.	
			1	0-4" - organic matter
			2	4" - 2' - Brown fine sand / clay mix w/cobbles
3		Brown coarse sand, some clay/silt, w/cobbles		
4		Light brown coarse sand w/cobbles, no groundwater		
5				

Project:		Project #	Client:	Test Pit #
Fresh Pond HLW Dispersal Site		6700	Town of Shelter Island	TP-5
Location:				
41° 3'20.06"N, 72°20'13.06"W				
Groundwater Depth		Elevation:	Total Depth of Test Pit:	
None Encountered			5-ft	
Depth (feet)	Sample Number	Graphic Log	Lithology	
			Soil Group Name: modifier, color, moisture, density/consistency, grain size, other descriptors Rock Description: modifier color, hardness/degree of concentration, bedding and joint characteristics, solutions, void conditions.	
1			0-4" - organic matter	
2			4" - 2' - Dark brown clayey fine sand w/cobbles	
3			Light brown fine sand, some silt/clay w/cobbles	
4			Beige coarse sand w/cobbles, no groundwater	
5				

Project:		Project #	Client:	Test Pit #
Fresh Pond HLW Dispersal Site		6700	Town of Shelter Island	TP-6
Location:				
41° 3'20.78"N, 72°20'14.58"W				
Groundwater Depth		Elevation:	Total Depth of Test Pit:	
None Encountered			5-ft	
Depth (feet)	Sample Number	Graphic Log	Lithology	
			Soil Group Name: modifier, color, moisture, density/consistency, grain size, other descriptors Rock Description: modifier color, hardness/degree of concentration, bedding and joint characteristics, solutions, void conditions.	
1			0-4" - organic matter	
2			4" - 2' - Light brown fine sand w/cobbles. Some silt / clay	
3			Beige coarse sand w/cobbles, no groundwater	
4				
5				

Project:		Project #	Client:	Test Pit #
Fresh Pond HLW Dispersal Site		6700	Town of Shelter Island	TP-7
Location:				
41° 3'21.65"N, 72°20'14.09"W				
Groundwater Depth		Elevation:	Total Depth of Test Pit:	
None encountered			3-ft	
Depth (feet)	Sample Number	Graphic Log	Lithology	
			Soil Group Name: modifier, color, moisture, density/consistency, grain size, other descriptors	
			Rock Description: modifier color, hardness/degree of concentration, bedding and joint characteristics, solutions, void conditions.	
1			0-4" - organic matter	
2			4" - 2' - Light brown fine sand w/cobbles. Some silt / clay	
3			Beige coarse sand w/cobbles, no groundwater	

Shawn M. Barron M.S.
124 Pleasure Drive, Riverhead, NY 11901
631.786.6672
shawn@barronenvironmental.com

December 22, 2021

Pio Lombardo, P.E.
Lombardo Associates, Inc.
53 Hill Street | Southampton, NY

Re: Test Hole Boring
Situate: Turkems Rest Preserve
65 Midway Road, Shelter Island, NY
SCTM#: 700-23-1-29

Test Hole Log

Date of test hole boring: December 22, 2021

Time: 11:53 A.M.

Depth Below Grade

0.0' – 2.1'	Sandy silt with gravel (ML)
2.1' – 4.2'	Loamy sand with gravel (SM)
4.2' – 7.0'	Coarse sand with gravel (SP)
7.0' – 9.0'	Mixed sand with gravel (SP)

No groundwater encountered to 9-feet below grade.

Test Hole Location: Adjacent to TP-5.

APPENDIX H NEWS ARTICLES ON FRESH POND

07.17.2018 FEATURED STORY

Swimmers warned to steer clear of Fresh Pond — Certain areas dangerous to people, pets

By Ambrose Clancy



Samples taken recently from the pond and sent to the New York State Department of Environmental Conservation (DEC) for analysis have revealed the presence of cyanobacteria, or blue-green algae blooms.

Swimming for people or pets can pose a risk to their health, according to the DEC.

The public has been notified about the risk. At the town landing off Lake Drive, signs from the county in English and Spanish are posted, reading:

"BLUE-GREEN ALGAE BLOOM ADVISORY

Blue-green algae blooms have been spotted in this water body.

- Don't swim or wade near blooms.
- Keep children and pets away from blooms or scum.
- Rinse with clean water if exposed."

According to the National Oceanic and Atmospheric Administration, the presence of "harmful algal blooms" (HABs) can produce "harmful effects on people, fish, shellfish, marine mammals and birds."

The DEC stated last week that the HABs in Fresh Pond are in "small localized" areas, meaning "portions ... may be clear and fully support recreational uses."

Contact with algal blooms, according to the DEC, can produce symptoms including vomiting, nausea, diarrhea, skin, eye or throat irritation, allergic reactions and breathing difficulties.

Water samples were taken at the pond on July 8 by Peter Grand, a member of the town's Water Advisory Committee and the Fresh Pond Neighbors Association, who then delivered them to the DEC. The neighbors association is a member of the New York State Federation of Lake Associations. Mr. Grand and another member, James Eklund, have been trained in sampling and processing of water as part of the Citizens Statewide Lake Assessment Program.

Mr. Grand said this was the third test done this summer of the pond and all three tests, aside from the HABs, "showed the water to be exceptionally clear." He found two locations "where there were growths of algae. That's what we sampled."

In addition to untreated sewage from aged or malfunctioning septic systems, HABs can be the result, according to the DEC, of a combination of factors, including extended periods of still water, sunlight and high temperatures.

DEC: Fresh Pond 'Not Swimmable'

By Jade Eckardt

0 comments

Posted on July 24, 2018



Shelter Island's Fresh Pond has been deemed not swimmable by

the New York State Department of Environmental Conservation. The DEC has confirmed the presence of a new cyanobacteria bloom, more commonly known as blue-green algae, in the pond, which is dotted with upscale homes along its shores.

Because of these findings, health officials have asked residents not to use or swim or wade in these waters and to keep their pets and children away from the area.

Signs have been posted at the pond's access alerting Islanders of the risk.

Though blue-green algae are naturally present in lakes and streams in low numbers, they can become abundant, forming blooms in shades of green, blue-green, yellow, brown, or red. The algae may produce floating scums on the surface of the water or may cause the water to take on paint-like appearance.

beach, contact the Division of Water at New York State DEC at 518-402-8179 between 8 AM and 4 PM or anytime via email at habsinfo@dec.ny.gov.

The DEC advises that contact with water that appears scummy or discolored should be avoided. If contact does occur, rinse off with clean water immediately. Seek medical attention if any of the following symptoms occur after contact: nausea, vomiting or diarrhea; skin, eye or throat irritation; or allergic reactions or breathing difficulties.

To report a suspected blue-green algae bloom at a body of water that contains a Suffolk County-permitted bathing beach, contact the Suffolk County Department of Health Services' Office of Ecology at 631-852-5760 between 8:30 AM and 4:30 PM or by email at any time at scdhsweb@suffolkcountyny.gov.

To report a suspected blue-green algae bloom that is in a body of water that does not contain a Suffolk County permitted bathing

07.18.2017 FEATURED STORY

Fresh Pond's history of water quality

By Charity Robey



CHARITY ROBEY PHOTO Green scum on the shores of Fresh Pond on Monday.

Before the Shelter Island landfill opened in 1950s, Fresh Pond was the most popular dump site on the Island with everything from refrigerators to car batteries tossed into the drink.

But according to Tom Junod, who has been swimming in Fresh Pond for 17 years, water quality reached a new low last Sunday.

"It was the first time I looked and said, there is no way I'm going in that—milky-green water with scum piled up on the shore," Mr. Junod said.

It's been a tough year for Fresh Pond, Shelter Island's only deep freshwater lake, with the town putting up signs late last week cautioning against swimming.

Fed by the local aquifer, the pond is what geologists call a kettlehole, dug out by the receding glacier of the last Ice Age.

Putting refuse into Fresh Pond may be an Island tradition that goes back thousands of years, but it's taken an especially toxic and widespread sort of pollution — nitrates from untreated sewage — to fuel the algae bloom that colored the water green in recent weeks and led to Monday's posted warnings against any exposure of humans or animals to the potentially poisonous conditions in the water.

Town Engineer John Cronin, in a presentation to the Hay Beach Association two years ago noted that, "Nitrate pollution of the aquifer has been a known issue on the Island at least as far back as the 1980s."

In addition to untreated sewage, harmful algae blooms (HABs) can be the result, according to the Department of Environmental Conservation's website, of a combination of factors, including extended periods of still water, sunlight and high temperatures.

Monday afternoon the surface of the water was glass, reflecting sky and trees. A woman who said she was a visitor emerged from a minivan full of bathing-suited would-be swimmers, but decided against letting the kids out when she saw the warnings.

EXHIBIT 1 POND WATER QUALITY CHEMISTRY DATA LAB REPORTS

EXHIBIT 2 QUALITY ASSURANCE PROJECT PLAN (QAPP)



Microbac Laboratories, Inc., Lee

CERTIFICATE OF ANALYSIS

L1E0117

Water Resource Services, Inc.

Project Name: Fresh Pond -Shelter Island

Ken Wagner
144 Crane Hill Rd.
Wilbraham, MA 01095

Project / PO Number: N/A
Received: 05/06/2021
Reported: 05/12/2021

Analytical Testing Parameters

Table with 4 columns: Client Sample ID, Sample Matrix, Lab Sample ID, Collected By, Collection Date. Values include FP-1s, Aqueous, L1E0117-01, Ken Wagner, 05/01/2021 14:10.

Analyses Performed by: Microbac Laboratories, Inc. - Dayville

Table with 10 columns: Inorganics Total, Result, RL, Units, DF, Note, Prepared, Analyzed, Analyst. Rows include EPA 351.1 (TKN), EPA 365.1 (Phosphorus), and SM 4500-NO3- (Nitrate-Nitrite).

Table with 4 columns: Client Sample ID, Sample Matrix, Lab Sample ID, Collected By, Collection Date. Values include FP-1m, Aqueous, L1E0117-02, Ken Wagner, 05/01/2021 14:05.

Analyses Performed by: Microbac Laboratories, Inc. - Dayville

Table with 10 columns: Inorganics Total, Result, RL, Units, DF, Note, Prepared, Analyzed, Analyst. Rows include EPA 351.1 (TKN), EPA 365.1 (Phosphorus), and SM 4500-NO3- (Nitrate-Nitrite).

Table with 4 columns: Client Sample ID, Sample Matrix, Lab Sample ID, Collected By, Collection Date. Values include FP-1b, Aqueous, L1E0117-03, Ken Wagner, 05/01/2021 14:00.

Analyses Performed by: Microbac Laboratories, Inc. - Dayville

Table with 10 columns: Inorganics Total, Result, RL, Units, DF, Note, Prepared, Analyzed, Analyst. Rows include EPA 351.1 (TKN), EPA 365.1 (Phosphorus), and SM 4500-NO3- (Nitrate-Nitrite).

Microbac Laboratories, Inc.

80 Run Way | Lee, MA 01238 | 413-776-5025 p | www.microbac.com



Microbac Laboratories, Inc., Lee

CERTIFICATE OF ANALYSIS

L1E0117

Client Sample ID:	FP -2	Collected By:	Ken Wagner
Sample Matrix:	Aqueous	Collection Date:	05/01/2021 14:15
Lab Sample ID:	L1E0117-04		

Analyses Performed by: Microbac Laboratories, Inc. - Dayville

Inorganics Total	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 351.1								
Total Kjeldahl Nitrogen (TKN)	0.678	0.200	mg/L	1		05/11/21 0918	05/11/21 1642	CLW
EPA 365.1, Rv. 2 (1993)								
Phosphorus - Total as P	0.0276	0.0106	mg/L	1		05/07/21 1517	05/10/21 1148	CLW
SM 4500-NO3⁻ F-2011								
Nitrate-Nitrite as N	0.159	0.0500	mg/L	1	A5,Y1		05/06/21 1922	DJM

Definitions

- A5: Sample was filtered (0.45 um) before analysis.
- mg/L: Milligrams per Liter
- RL: Reporting Limit
- Y1: Accreditation is not offered by the accrediting body for this analyte.

Project Requested Certification(s)

Microbac Laboratories, Inc. - Dayville
M-CT008

Massachusetts Department of Environmental Protection

Report Comments

Samples were received in proper condition and the reported results conform to applicable accreditation standard unless otherwise noted.

The data and information on this, and other accompanying documents, represents only the sample(s) analyzed. This report is incomplete unless all pages indicated in the footnote are present and an authorized signature is included. The services were provided under and subject to Microbac's standard terms and conditions which can be located and reviewed at <https://www.microbac.com/standard-terms-conditions>.

Reviewed and Approved By:

Christine F. Reynolds
Service Center Manager
Reported: 05/12/2021 12:12

Microbac Laboratories, Inc.

80 Run Way | Lee, MA 01238 | 413-776-5025 p | www.microbac.com



Chain of Custody

WWW.MICROBAC.COM



L 1 E 0 1 1 7

Water Resource Services Inc.

80 Run Way
Lee, MA 01238 (413) 776-5025 fax 413-776-5029

Copy of Report To

CUSTOMER: **Water Resource Services**
ADDRESS: 144 Crane Hill Road
Wilbraham, MA 01095
ATTENTION: Ken Wagner
E-MAIL: kiwagner@charter.net
PHONE: 413-219-8071 Fax:

Billing Information

BILL TO: Same
ADDRESS:
ATTENTION: Ken Wagner
TELEPHONE:
PURCHASE ORDER #: **verbal**

Project Information

Project: Fresh Pond
Project Location: Shelter Island NY
Project Manager: Ken Wagner
EMAIL: kiwagner@charter.net
TELEPHONE: 413-219-0871
Fax:

Sample Identification	Date Collected	Time Collected	Sample Type		Sample Matrix	Analysis						Preservatives							
			COMPOSITE	GRAB		Dissolved Phos	Total Phos	NO2/NO3-N	NH4-N	TKN	Non-pres	HCL	HNO3	NH4Cl	Sulfuric	Na2S2O3			
FP-1 S	5/1/21	14:10		X	Water		X	X		X								X	
FP-1 M	↓	14:05		X	↓		X	X		X								X	
FP-1 b	↓	14:00		X	↓		X	X		X								X	
FP-2	↓	14:15		X	↓		X	X		X								X	

CUSTODY TRANSFER	DATE	TIME
SAMPLER: <u>Walt J. Wagner</u>	5/6/21	8:30
RECEIVED: <u>[Signature]</u>	5-6-21	8:30
RELINQUISHED:		
RECEIVED:		
RELINQUISHED:		
RECEIVED:		

TURNAROUND (INDICATE IN CALENDAR DAYS):
 STD _____ HARD COPY or E-MAIL _____
 EXPEDITED SERVICE MAY BE SUBJECT TO SURCHARGE
 COMMENTS: _____ PRESERVATIVE VERIFIED Initials [Signature]
 CONDITIONS UPON RECEIPT: (CHECK ONE)
 _____ AMBIENT 2.8 °C Upon Receipt at LAB



ANALYTICAL REPORT

Lab Number:	L2134259
Client:	Lombardo Associates, Inc. 188 Church Street Newton, MA 02458
ATTN:	Pio Lombardo
Phone:	(617) 964-2924
Project Name:	FRESH POND
Project Number:	Not Specified
Report Date:	07/13/21

The original project report/data package is held by Alpha Analytical. This report/data package is paginated and should be reproduced only in its entirety. Alpha Analytical holds no responsibility for results and/or data that are not consistent with the original.

Certifications & Approvals: MA (M-MA086), NH NELAP (2064), CT (PH-0574), IL (200077), ME (MA00086), MD (348), NJ (MA935), NY (11148), NC (25700/666), PA (68-03671), RI (LAO00065), TX (T104704476), VT (VT-0935), VA (460195), USDA (Permit #P330-17-00196).

Eight Walkup Drive, Westborough, MA 01581-1019
508-898-9220 (Fax) 508-898-9193 800-624-9220 - www.alphalab.com



Project Name: FRESH POND
Project Number: Not Specified

Lab Number: L2134259
Report Date: 07/13/21

Alpha Sample ID	Client ID	Matrix	Sample Location	Collection Date/Time	Receive Date
L2134259-01	5 FT DEPTH	WATER	SHELTER ISLAND	06/23/21 16:15	06/24/21
L2134259-02	15 FT DEPTH	WATER	SHELTER ISLAND	06/23/21 16:10	06/24/21
L2134259-03	25 FT DEPTH	WATER	SHELTER ISLAND	06/23/21 16:05	06/24/21
L2134259-04	35 FT DEPTH	WATER	SHELTER ISLAND	06/23/21 15:55	06/24/21
L2134259-05	40 FT DEPTH	WATER	SHELTER ISLAND	06/23/21 15:45	06/24/21

Project Name: FRESH POND
Project Number: Not Specified

Lab Number: L2134259
Report Date: 07/13/21

Case Narrative

The samples were received in accordance with the Chain of Custody and no significant deviations were encountered during the preparation or analysis unless otherwise noted. Sample Receipt, Container Information, and the Chain of Custody are located at the back of the report.

Results contained within this report relate only to the samples submitted under this Alpha Lab Number and meet NELAP requirements for all NELAP accredited parameters unless otherwise noted in the following narrative. The data presented in this report is organized by parameter (i.e. VOC, SVOC, etc.). Sample specific Quality Control data (i.e. Surrogate Spike Recovery) is reported at the end of the target analyte list for each individual sample, followed by the Laboratory Batch Quality Control at the end of each parameter. Tentatively Identified Compounds (TICs), if requested, are reported for compounds identified to be present and are not part of the method/program Target Compound List, even if only a subset of the TCL are being reported. If a sample was re-analyzed or re-extracted due to a required quality control corrective action and if both sets of data are reported, the Laboratory ID of the re-analysis or re-extraction is designated with an "R" or "RE", respectively.

When multiple Batch Quality Control elements are reported (e.g. more than one LCS), the associated samples for each element are noted in the grey shaded header line of each data table. Any Laboratory Batch, Sample Specific % recovery or RPD value that is outside the listed Acceptance Criteria is bolded in the report. In reference to questions H (CAM) or 4 (RCP) when "NO" is checked, the performance criteria for CAM and RCP methods allow for some quality control failures to occur and still be within method compliance. In these instances, the specific failure is not narrated but noted in the associated QC Outlier Summary Report, located directly after the Case Narrative. QC information is also incorporated in the Data Usability Assessment table (Format 11) of our Data Merger tool, where it can be reviewed in conjunction with the sample result, associated regulatory criteria and any associated data usability implications.

Soil/sediments, solids and tissues are reported on a dry weight basis unless otherwise noted. Definitions of all data qualifiers and acronyms used in this report are provided in the Glossary located at the back of the report.

HOLD POLICY - For samples submitted on hold, Alpha's policy is to hold samples (with the exception of Air canisters) free of charge for 21 calendar days from the date the project is completed. After 21 calendar days, we will dispose of all samples submitted including those put on hold unless you have contacted your Alpha Project Manager and made arrangements for Alpha to continue to hold the samples. Air canisters will be disposed after 3 business days from the date the project is completed.

Please contact Project Management at 800-624-9220 with any questions.

Project Name: FRESH POND
Project Number: Not Specified

Lab Number: L2134259
Report Date: 07/13/21

Case Narrative (continued)

Sample Receipt

The analyses performed were specified by the client.

I, the undersigned, attest under the pains and penalties of perjury that, to the best of my knowledge and belief and based upon my personal inquiry of those responsible for providing the information contained in this analytical report, such information is accurate and complete. This certificate of analysis is not complete unless this page accompanies any and all pages of this report.

Authorized Signature:



Sebastian Corbin

Title: Technical Director/Representative

Date: 07/13/21

INORGANICS & MISCELLANEOUS

Project Name: FRESH POND

Lab Number: L2134259

Project Number: Not Specified

Report Date: 07/13/21

SAMPLE RESULTS

Lab ID: L2134259-01

Date Collected: 06/23/21 16:15

Client ID: 5 FT DEPTH

Date Received: 06/24/21

Sample Location: SHELTER ISLAND

Field Prep: Not Specified

Sample Depth:

Matrix: Water

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Phosphorus, Total	0.022		mg/l	0.010	--	1	07/01/21 11:20	07/02/21 09:48	121,4500P-E	SD



Project Name: FRESH POND

Lab Number: L2134259

Project Number: Not Specified

Report Date: 07/13/21

SAMPLE RESULTS

Lab ID: L2134259-02

Date Collected: 06/23/21 16:10

Client ID: 15 FT DEPTH

Date Received: 06/24/21

Sample Location: SHELTER ISLAND

Field Prep: Not Specified

Sample Depth:

Matrix: Water

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Phosphorus, Total	0.107		mg/l	0.010	--	1	07/01/21 11:20	07/02/21 10:12	121,4500P-E	SD



Project Name: FRESH POND

Lab Number: L2134259

Project Number: Not Specified

Report Date: 07/13/21

SAMPLE RESULTS

Lab ID: L2134259-03

Date Collected: 06/23/21 16:05

Client ID: 25 FT DEPTH

Date Received: 06/24/21

Sample Location: SHELTER ISLAND

Field Prep: Not Specified

Sample Depth:

Matrix: Water

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Phosphorus, Total	0.174		mg/l	0.010	--	1	07/01/21 11:20	07/02/21 10:13	121,4500P-E	SD



Project Name: FRESH POND

Lab Number: L2134259

Project Number: Not Specified

Report Date: 07/13/21

SAMPLE RESULTS

Lab ID: L2134259-04

Date Collected: 06/23/21 15:55

Client ID: 35 FT DEPTH

Date Received: 06/24/21

Sample Location: SHELTER ISLAND

Field Prep: Not Specified

Sample Depth:

Matrix: Water

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Phosphorus, Total	0.157		mg/l	0.010	--	1	07/01/21 11:20	07/02/21 10:14	121,4500P-E	SD



Project Name: FRESH POND

Lab Number: L2134259

Project Number: Not Specified

Report Date: 07/13/21

SAMPLE RESULTS

Lab ID: L2134259-05

Date Collected: 06/23/21 15:45

Client ID: 40 FT DEPTH

Date Received: 06/24/21

Sample Location: SHELTER ISLAND

Field Prep: Not Specified

Sample Depth:

Matrix: Water

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Phosphorus, Total	0.241		mg/l	0.010	--	1	07/01/21 11:20	07/02/21 10:15	121,4500P-E	SD



Project Name: FRESH POND
Project Number: Not Specified

Lab Number: L2134259
Report Date: 07/13/21

Method Blank Analysis
Batch Quality Control

Parameter	Result Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab for sample(s): 01-05 Batch: WG1519360-1									
Phosphorus, Total	ND	mg/l	0.010	--	1	07/01/21 11:20	07/02/21 09:46	121,4500P-E	SD

Lab Control Sample Analysis Batch Quality Control

Project Name: FRESH POND
Project Number: Not Specified

Lab Number: L2134259
Report Date: 07/13/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
General Chemistry - Westborough Lab Associated sample(s): 01-05 Batch: WG1519360-2								
Phosphorus, Total	109		-		80-120	-		

Matrix Spike Analysis Batch Quality Control

Project Name: FRESH POND

Lab Number: L2134259

Project Number: Not Specified

Report Date: 07/13/21

Parameter	Native Sample	MS Added	MS Found	MS %Recovery	MSD Qual	MSD Found	MSD %Recovery	MSD Qual	Recovery Limits	RPD	RPD Qual	RPD Limits
General Chemistry - Westborough Lab Associated sample(s): 01-05 QC Batch ID: WG1519360-4 QC Sample: L2134259-01 Client ID: 5 FT DEPTH												
Phosphorus, Total	0.022	0.5	0.557	107	-	-	-	-	75-125	-	-	20

Lab Duplicate Analysis

Batch Quality Control

Project Name: FRESH POND

Project Number: Not Specified

Lab Number: L2134259

Report Date: 07/13/21

Parameter	Native Sample	Duplicate Sample	Units	RPD	Qual	RPD Limits
General Chemistry - Westborough Lab Associated sample(s): 01-05 QC Batch ID: WG1519360-3 QC Sample: L2134259-01 Client ID: 5 FT DEPTH						
Phosphorus, Total	0.022	0.021	mg/l	5		20

Project Name: FRESH POND**Lab Number:** L2134259**Project Number:** Not Specified**Report Date:** 07/13/21**Sample Receipt and Container Information**

Were project specific reporting limits specified?

YES

Cooler Information

Cooler	Custody Seal
A	Absent

Container Information

Container ID	Container Type	Cooler	Initial pH	Final pH	Temp deg C	Pres	Seal	Frozen Date/Time	Analysis(*)
L2134259-01A	Plastic 500ml H2SO4 preserved	A	<2	<2	2.3	Y	Absent		TKN-4500(28),TPHOS-4500(28),NO3/NO2-4500(28),TNITROGEN(28)
L2134259-02A	Plastic 500ml H2SO4 preserved	A	<2	<2	2.3	Y	Absent		TKN-4500(28),TPHOS-4500(28),NO3/NO2-4500(28),TNITROGEN(28)
L2134259-03A	Plastic 500ml H2SO4 preserved	A	<2	<2	2.3	Y	Absent		TKN-4500(28),TPHOS-4500(28),NO3/NO2-4500(28),TNITROGEN(28)
L2134259-04A	Plastic 500ml H2SO4 preserved	A	<2	<2	2.3	Y	Absent		TKN-4500(28),TPHOS-4500(28),NO3/NO2-4500(28),TNITROGEN(28)
L2134259-05A	Plastic 500ml H2SO4 preserved	A	<2	<2	2.3	Y	Absent		TKN-4500(28),TPHOS-4500(28),NO3/NO2-4500(28),TNITROGEN(28)

Project Name: FRESH POND
Project Number: Not Specified

Lab Number: L2134259
Report Date: 07/13/21

GLOSSARY

Acronyms

DL	- Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the limit of quantitation (LOQ). The DL includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)
EDL	- Estimated Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The EDL includes any adjustments from dilutions, concentrations or moisture content, where applicable. The use of EDLs is specific to the analysis of PAHs using Solid-Phase Microextraction (SPME).
EMPC	- Estimated Maximum Possible Concentration: The concentration that results from the signal present at the retention time of an analyte when the ions meet all of the identification criteria except the ion abundance ratio criteria. An EMPC is a worst-case estimate of the concentration.
EPA	- Environmental Protection Agency.
LCS	- Laboratory Control Sample: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.
LCSD	- Laboratory Control Sample Duplicate: Refer to LCS.
LFB	- Laboratory Fortified Blank: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.
LOD	- Limit of Detection: This value represents the level to which a target analyte can reliably be detected for a specific analyte in a specific matrix by a specific method. The LOD includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)
LOQ	- Limit of Quantitation: The value at which an instrument can accurately measure an analyte at a specific concentration. The LOQ includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.) Limit of Quantitation: The value at which an instrument can accurately measure an analyte at a specific concentration. The LOQ includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)
MDL	- Method Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The MDL includes any adjustments from dilutions, concentrations or moisture content, where applicable.
MS	- Matrix Spike Sample: A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. For Method 332.0, the spike recovery is calculated using the native concentration, including estimated values.
MSD	- Matrix Spike Sample Duplicate: Refer to MS.
NA	- Not Applicable.
NC	- Not Calculated: Term is utilized when one or more of the results utilized in the calculation are non-detect at the parameter's reporting unit.
NDPA/DPA	- N-Nitrosodiphenylamine/Diphenylamine.
NI	- Not Ignitable.
NP	- Non-Plastic: Term is utilized for the analysis of Atterberg Limits in soil.
NR	- No Results: Term is utilized when 'No Target Compounds Requested' is reported for the analysis of Volatile or Semivolatile Organic TIC only requests.
RL	- Reporting Limit: The value at which an instrument can accurately measure an analyte at a specific concentration. The RL includes any adjustments from dilutions, concentrations or moisture content, where applicable.
RPD	- Relative Percent Difference: The results from matrix and/or matrix spike duplicates are primarily designed to assess the precision of analytical results in a given matrix and are expressed as relative percent difference (RPD). Values which are less than five times the reporting limit for any individual parameter are evaluated by utilizing the absolute difference between the values; although the RPD value will be provided in the report.
SRM	- Standard Reference Material: A reference sample of a known or certified value that is of the same or similar matrix as the associated field samples.
STLP	- Semi-dynamic Tank Leaching Procedure per EPA Method 1315.
TEF	- Toxic Equivalency Factors: The values assigned to each dioxin and furan to evaluate their toxicity relative to 2,3,7,8-TCDD.
TEQ	- Toxic Equivalent: The measure of a sample's toxicity derived by multiplying each dioxin and furan by its corresponding TEF and then summing the resulting values.
TIC	- Tentatively Identified Compound: A compound that has been identified to be present and is not part of the target compound list (TCL) for the method and/or program. All TICs are qualitatively identified and reported as estimated concentrations.

Report Format: Data Usability Report



Project Name: FRESH POND
Project Number: Not Specified

Lab Number: L2134259
Report Date: 07/13/21

Footnotes

- 1 - The reference for this analyte should be considered modified since this analyte is absent from the target analyte list of the original method.

Terms

Analytical Method: Both the document from which the method originates and the analytical reference method. (Example: EPA 8260B is shown as 1,8260B.) The codes for the reference method documents are provided in the References section of the Addendum.

Difference: With respect to Total Oxidizable Precursor (TOP) Assay analysis, the difference is defined as the Post-Treatment value minus the Pre-Treatment value.

Final pH: As it pertains to Sample Receipt & Container Information section of the report, Final pH reflects pH of container determined after adjustment at the laboratory, if applicable. If no adjustment required, value reflects Initial pH.

Frozen Date/Time: With respect to Volatile Organics in soil, Frozen Date/Time reflects the date/time at which associated Reagent Water-preserved vials were initially frozen. Note: If frozen date/time is beyond 48 hours from sample collection, value will be reflected in 'bold'.

Initial pH: As it pertains to Sample Receipt & Container Information section of the report, Initial pH reflects pH of container determined upon receipt, if applicable.

PAH Total: With respect to Alkylated PAH analyses, the 'PAHs, Total' result is defined as the summation of results for all or a subset of the following compounds: Naphthalene, C1-C4 Naphthalenes, 2-Methylnaphthalene, 1-Methylnaphthalene, Biphenyl, Acenaphthylene, Acenaphthene, Fluorene, C1-C3 Fluorenes, Phenanthrene, C1-C4 Phenanthrenes/Anthracenes, Anthracene, Fluoranthene, Pyrene, C1-C4 Fluoranthenes/Pyrenes, Benz(a)anthracene, Chrysene, C1-C4 Chrysenes, Benzo(b)fluoranthene, Benzo(j)+(k)fluoranthene, Benzo(e)pyrene, Benzo(a)pyrene, Perylene, Indeno(1,2,3-cd)pyrene, Dibenz(ah)+(ac)anthracene, Benzo(g,h,i)perylene. If a 'Total' result is requested, the results of its individual components will also be reported.

PFAS Total: With respect to PFAS analyses, the 'PFAS, Total (5)' result is defined as the summation of results for: PFHpA, PFHxS, PFOA, PFNA and PFOS. In addition, the 'PFAS, Total (6)' result is defined as the summation of results for: PFHpA, PFHxS, PFOA, PFNA, PFDA and PFOS. For MassDEP DW compliance analysis only, the 'PFAS, Total (6)' result is defined as the summation of results at or above the RL. Note: If a 'Total' result is requested, the results of its individual components will also be reported.

The target compound Chlordane (CAS No. 57-74-9) is reported for GC ECD analyses. Per EPA, this compound "refers to a mixture of chlordane isomers, other chlorinated hydrocarbons and numerous other components." (Reference: USEPA Toxicological Review of Chlordane, In Support of Summary Information on the Integrated Risk Information System (IRIS), December 1997.)

Total: With respect to Organic analyses, a 'Total' result is defined as the summation of results for individual isomers or Aroclors. If a 'Total' result is requested, the results of its individual components will also be reported. This is applicable to 'Total' results for methods 8260, 8081 and 8082.

Data Qualifiers

- A** - Spectra identified as "Aldol Condensates" are byproducts of the extraction/concentration procedures when acetone is introduced in the process.
- B** - The analyte was detected above the reporting limit in the associated method blank. Flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For MCP-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For DOD-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank AND the analyte was detected above one-half the reporting limit (or above the reporting limit for common lab contaminants) in the associated method blank. For NJ-Air-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte above the reporting limit. For NJ-related projects (excluding Air), flag only applies to associated field samples that have detectable concentrations of the analyte, which was detected above the reporting limit in the associated method blank or above five times the reporting limit for common lab contaminants (Phthalates, Acetone, Methylene Chloride, 2-Butanone).
- C** - Co-elution: The target analyte co-elutes with a known lab standard (i.e. surrogate, internal standards, etc.) for co-extracted analyses.
- D** - Concentration of analyte was quantified from diluted analysis. Flag only applies to field samples that have detectable concentrations of the analyte.
- E** - Concentration of analyte exceeds the range of the calibration curve and/or linear range of the instrument.
- F** - The ratio of quantifier ion response to qualifier ion response falls outside of the laboratory criteria. Results are considered to be an estimated maximum concentration.
- G** - The concentration may be biased high due to matrix interferences (i.e. co-elution) with non-target compound(s). The result should be considered estimated.
- H** - The analysis of pH was performed beyond the regulatory-required holding time of 15 minutes from the time of sample collection.
- I** - The lower value for the two columns has been reported due to obvious interference.
- J** - Estimated value. This represents an estimated concentration for Tentatively Identified Compounds (TICs).
- M** - Reporting Limit (RL) exceeds the MCP CAM Reporting Limit for this analyte.
- ND** - Not detected at the reporting limit (RL) for the sample.
- NJ** - Presumptive evidence of compound. This represents an estimated concentration for Tentatively Identified Compounds (TICs), where

Report Format: Data Usability Report



Project Name: FRESH POND
Project Number: Not Specified

Lab Number: L2134259
Report Date: 07/13/21

Data Qualifiers

the identification is based on a mass spectral library search.

- P** - The RPD between the results for the two columns exceeds the method-specified criteria.
- Q** - The quality control sample exceeds the associated acceptance criteria. For DOD-related projects, LCS and/or Continuing Calibration Standard exceedences are also qualified on all associated sample results. Note: This flag is not applicable for matrix spike recoveries when the sample concentration is greater than 4x the spike added or for batch duplicate RPD when the sample concentrations are less than 5x the RL. (Metals only.)
- R** - Analytical results are from sample re-analysis.
- RE** - Analytical results are from sample re-extraction.
- S** - Analytical results are from modified screening analysis.

Project Name: FRESH POND
Project Number: Not Specified

Lab Number: L2134259
Report Date: 07/13/21

REFERENCES

- 121 Standard Methods for the Examination of Water and Wastewater. APHA-AWWA-WEF. Standard Methods Online.

LIMITATION OF LIABILITIES

Alpha Analytical performs services with reasonable care and diligence normal to the analytical testing laboratory industry. In the event of an error, the sole and exclusive responsibility of Alpha Analytical shall be to re-perform the work at it's own expense. In no event shall Alpha Analytical be held liable for any incidental, consequential or special damages, including but not limited to, damages in any way connected with the use of, interpretation of, information or analysis provided by Alpha Analytical.

We strongly urge our clients to comply with EPA protocol regarding sample volume, preservation, cooling, containers, sampling procedures, holding time and splitting of samples in the field.



Certification Information

The following analytes are not included in our Primary NELAP Scope of Accreditation:

Westborough Facility

EPA 624/624.1: m/p-xylene, o-xylene, Naphthalene

EPA 625/625.1: alpha-Terpineol

EPA 8260C/8260D: NPW: 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene, Azobenzene; SCM: Iodomethane (methyl iodide), 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene.

EPA 8270D/8270E: NPW: Dimethylnaphthalene, 1,4-Diphenylhydrazine, alpha-Terpineol; SCM: Dimethylnaphthalene, 1,4-Diphenylhydrazine.

SM4500: NPW: Amenable Cyanide; SCM: Total Phosphorus, TKN, NO₂, NO₃.

Mansfield Facility

SM 2540D: TSS

EPA 8082A: NPW: PCB: 1, 5, 31, 87, 101, 110, 141, 151, 153, 180, 183, 187.

EPA TO-15: Halothane, 2,4,4-Trimethyl-2-pentene, 2,4,4-Trimethyl-1-pentene, Thiophene, 2-Methylthiophene,

3-Methylthiophene, 2-Ethylthiophene, 1,2,3-Trimethylbenzene, Indan, Indene, 1,2,4,5-Tetramethylbenzene, Benzothiophene, 1-Methylnaphthalene.

Biological Tissue Matrix: EPA 3050B

The following analytes are included in our Massachusetts DEP Scope of Accreditation

Westborough Facility:

Drinking Water

EPA 300.0: Chloride, Nitrate-N, Fluoride, Sulfate; **EPA 353.2:** Nitrate-N, Nitrite-N; **SM4500NO3-F:** Nitrate-N, Nitrite-N; **SM4500F-C, SM4500CN-CE,**

EPA 180.1, SM2130B, SM4500CI-D, SM2320B, SM2540C, SM4500H-B, SM4500NO2-B

EPA 332: Perchlorate; **EPA 524.2:** THMs and VOCs; **EPA 504.1:** EDB, DBCP.

Microbiology: **SM9215B; SM9223-P/A, SM9223B-Colilert-QT, SM9222D.**

Non-Potable Water

SM4500H,B, EPA 120.1, SM2510B, SM2540C, SM2320B, SM4500CL-E, SM4500F-BC, SM4500NH3-BH: Ammonia-N and Kjeldahl-N, **EPA 350.1:**

Ammonia-N, **LCHAT 10-107-06-1-B:** Ammonia-N, **EPA 351.1, SM4500NO3-F, EPA 353.2:** Nitrate-N, **SM4500P-E, SM4500P-B, E, SM4500SO4-E,**

SM5220D, EPA 410.4, SM5210B, SM5310C, SM4500CL-D, EPA 1664, EPA 420.1, SM4500-CN-CE, SM2540D, EPA 300: Chloride, Sulfate, Nitrate.

EPA 624.1: Volatile Halocarbons & Aromatics,

EPA 608.3: Chlordane, Toxaphene, Aldrin, alpha-BHC, beta-BHC, gamma-BHC, delta-BHC, Dieldrin, DDD, DDE, DDT, Endosulfan I, Endosulfan II,

Endosulfan sulfate, Endrin, Endrin Aldehyde, Heptachlor, Heptachlor Epoxide, PCBs

EPA 625.1: SVOC (Acid/Base/Neutral Extractables), **EPA 600/4-81-045:** PCB-Oil.

Microbiology: **SM9223B-Colilert-QT; Enterolert-QT, SM9221E, EPA 1600, EPA 1603, SM9222D.**

Mansfield Facility:

Drinking Water

EPA 200.7: Al, Ba, Cd, Cr, Cu, Fe, Mn, Ni, Na, Ag, Ca, Zn. **EPA 200.8:** Al, Sb, As, Ba, Be, Cd, Cr, Cu, Pb, Mn, Ni, Se, Ag, TL, Zn. **EPA 245.1 Hg.**

EPA 522, EPA 537.1.

Non-Potable Water

EPA 200.7: Al, Sb, As, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Ag, Na, Sr, TL, Ti, V, Zn.

EPA 200.8: Al, Sb, As, Be, Cd, Cr, Cu, Fe, Pb, Mn, Ni, K, Se, Ag, Na, TL, Zn.

EPA 245.1 Hg.

SM2340B

For a complete listing of analytes and methods, please contact your Alpha Project Manager.



CHAIN OF CUSTODY

PAGE _____ OF _____

8 Walkup Drive
Westboro, MA 01581
Tel: 508-898-9220

320 Forbes Blvd
Mansfield, MA 02048
Tel: 508-822-9300

Date Rec'd in Lab: 6/24/21

ALPHA Job #: L2134259

Project Information

Project Name: FRESH POND
Project Location: SHELTER ISLAND
Project #: 6700
Project Manager:
ALPHA Quote #:

Report Information - Data Deliverables

ADEx EMAIL

Billing Information

Same as Client info PO #:

Client Information

Client: LOMBARDO ASSOCIATES
Address: 188 CHURCH ST
NEWTON, MA 02458
Phone: 617-964-2924
Email: P10@LOMBARDOASSOCIATES.COM

Turn-Around Time

Standard RUSH (only confirmed if pre-approved!)
Date Due:

Regulatory Requirements & Project Information Requirements

Yes No MA MCP Analytical Methods Yes No CT RCP Analytical Methods
 Yes No Matrix Spike Required on this SDG? (Required for MCP Inorganics)
 Yes No GW1 Standards (Info Required for Metals & EPH with Targets)
 Yes No NPDES RGP
 Other State /Fed Program _____ Criteria _____

Additional Project Information:

ANALYSIS		SAMPLE INFO Filtration <input type="checkbox"/> Field <input checked="" type="checkbox"/> Lab to do Preservation <input checked="" type="checkbox"/> Lab to do	TOTAL # BOTTLES
VOC: <input type="checkbox"/> 8260 <input type="checkbox"/> 624 <input type="checkbox"/> 524.2			
SVOC: <input type="checkbox"/> ABN <input type="checkbox"/> PAH			
METALS: <input type="checkbox"/> MCP 13 <input type="checkbox"/> MCP 14 <input type="checkbox"/> RCP 15			
METALS: <input type="checkbox"/> RCRA5 <input type="checkbox"/> RCRA8			
EPH: <input type="checkbox"/> Ranges & Targets <input type="checkbox"/> Ranges Only			
VPH: <input type="checkbox"/> Ranges & Targets <input type="checkbox"/> Ranges Only			
PCB <input type="checkbox"/> PEST			
TPH: <input type="checkbox"/> Quant Only <input type="checkbox"/> Fingerprint			
<u>TOTAL NITROGEN / SERIUM</u> <u>TOTAL PHOSPHORUS</u>			
Sample Comments			

ALPHA Lab ID (Lab Use Only)	Sample ID	Collection		Sample Matrix	Sampler Initials	ANALYSIS	SVOC	METALS	METALS	EPH	VPH	PCB	TPH	SAMPLE INFO	TOTAL # BOTTLES
		Date	Time												
34259 01	5 FT DEPTH	6-23-21	4:15	POND	PL									<input checked="" type="checkbox"/> Lab to do	
02	15 FT DEPTH		4:10	WATER	PL									<input checked="" type="checkbox"/> Lab to do	
03	25 FT DEPTH		4:05		PL									<input checked="" type="checkbox"/> Lab to do	
04	35 FT DEPTH		3:55		PL									<input checked="" type="checkbox"/> Lab to do	
05	40 FT DEPTH	6-23-21	3:45		PL									<input checked="" type="checkbox"/> Lab to do	

Container Type P= Plastic A= Amber glass V= Vial G= Glass B= Bacteria cup C= Cube O= Other E= Encore D= BOD Bottle	Preservative A= None B= HCl C= HNO ₃ D= H ₂ SO ₄ E= NaOH F= MeOH G= NaHSO ₄ H= Na ₂ S ₂ O ₈ I= Ascorbic Acid J= NH ₄ Cl K= Zn Acetate O= Other	Container Type _____ Preservative _____	Relinquished By: <u>[Signature]</u> Date/Time: <u>6-24-21 9:00 AM</u>	Received By: <u>[Signature]</u> Date/Time: <u>6/24/21 13:20</u>	Date/Time: <u>6/24/21 11:03</u> <u>6/24/21 11:22</u>	All samples submitted are subject to Alpha's Terms and Conditions. See reverse side. FORM NO: 01-01 (rev. 12-Mar-2012)
--	---	--	--	--	---	---



IEH ANALYTICAL LABORATORIES
LABORATORY & CONSULTING SERVICES
 3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
 PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	1723292A	PAGE	1
REPORT DATE:	07/14/21		
DATE SAMPLED:	05/01/21	DATE RECEIVED:	05/05/21
FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON SEDIMENT SAMPLES FROM WATER RESOURCE SERVICES			

CASE NARRATIVE

Six sediment samples were received by the laboratory in good condition and analyzed according to the chain of custody. Phosphorus fractions were determined according to the method of Rydin and Welch. Successive extractions with NH₄Cl, Bicarbonate/Dithionate, NaOH, and HCl were performed and analyzed for phosphorus. One part of Organic P was determined by digesting the residue after the inorganic fractions were extracted. Organic P includes the P after the inorganic fractions plus Biogenic P. Total P is the sum of all fractions minus Biogenic P, which is part of the Organic P fraction. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows, while OA/QC data is contained on subsequent pages.

SAMPLE DATA - SEDIMENTS (DRY WT. BASIS)

SAMPLE ID	% SOLIDS	% WATER	TOTAL P	LOOSELY BOUND P	FE BOUND P	AL BOUND P	BIOGENIC P	CA BOUND P	ORGANIC P
			(mg/kg)	(NH ₄ Cl) (mg/kg)	(DITHIONATE) (mg/kg)	(NaOH) (mg/kg)	(mg/kg)	(HCl) (mg/kg)	(mg/kg)
FP-1A	7.12%	92.9%	2582	<2.00	623	1027	676	63.8	868
FP-1B	7.17%	92.8%	2683	<2.00	649	1014	767	57.3	962
FP-2	7.87%	92.1%	2235	<2.00	526	874	622	55.2	780
FP-3	8.47%	91.5%	2003	<2.00	443	832	526	47.5	681
FP-4	42.3%	57.7%	307	<2.00	43.5	118	102	9.59	136
FP-5	14.4%	85.6%	1082	<2.00	269	407	261	35.2	371



IEH ANALYTICAL LABORATORIES
LABORATORY & CONSULTING SERVICES
 3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
 PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	1723292A	PAGE	2
REPORT DATE:	07/14/21		
DATE SAMPLED:	05/01/21	DATE RECEIVED:	05/05/21
FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON SEDIMENT SAMPLES FROM WATER RESOURCE SERVICES			

QA/QC DATA - SEDIMENTS

QC PARAMETER	% SOLIDS	TOTAL-P (mg/kg)	LOOSELY BOUND P (NH ₄ CL) (mg/kg)	FE BOUND P (DITHIONATE) (mg/kg)	AL BOUND P (NAOH) (mg/kg)	BIOGENIC P (mg/kg)	CA BOUND P (HCL) (mg/kg)	ORGANIC P (mg/kg)
METHOD	SM18 2540B	CALCULATED	SM18 4500PF	SM18 4500PF	SM18 4500PF	EPA 365.1	SM18 4500PF	EPA 365.1
DATE PREPARED	05/25/21	06/01/21	05/26/21	05/26/21	05/28/21	06/01/21	05/28/21	06/01/21
DATE ANALYZED	1.00%	5.00	2.00	2.00	2.00	2.00	2.00	2.00
DETECTION LIMIT								
DUPLICATE								
	FP-5	FP-5	FP-5	FP-5	FP-5	FP-5	FP-5	FP-5
SAMPLE ID	14.4%	1082	<2.00	269	407	261	35.2	371
ORIGINAL	14.5%	1038	<2.00	255	383	255	34.6	365
DUPLICATE	0.95%	4.23%	NC	5.02%	6.31%	2.39%	1.92%	1.66%
RPD								
SPIKE SAMPLE								
SAMPLE ID								
ORIGINAL								
SPIKED SAMPLE								
SPIKE ADDED	NA	NA	NA	NA	NA	NA	NA	NA
% RECOVERY								
QC CHECK (mg/l)								
FOUND			0.039	0.039	0.040	0.094	0.040	0.094
TRUE			0.039	0.039	0.039	0.094	0.039	0.094
% RECOVERY	NA	NA	100.00%	100.00%	102.56%	100.00%	102.56%	100.00%
BLANK	NA	NA	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00

RPD = RELATIVE PERCENT DIFFERENCE.
 NA = NOT APPLICABLE OR NOT AVAILABLE.
 NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
 OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:

Damien Gadomski

Damien Gadomski
 Project Manager



IEH ANALYTICAL LABORATORIES
LABORATORY & CONSULTING SERVICES
3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	1723292B	PAGE	1
REPORT DATE:	07/14/21		
DATE SAMPLED:	05/01/21	DATE RECEIVED:	05/05/21
FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON SEDIMENT SAMPLES FROM WATER RESOURCE SERVICES			

CASE NARRATIVE

Six sediment samples were received by the laboratory and analyzed according to the chain of custody. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows, while QA/QC data is contained on subsequent pages.

SAMPLE DATA - SEDIMENTS (DRY WT. BASIS)

SAMPLE ID	% SOLIDS	% WATER	ALUMINUM (mg/kg)	IRON (mg/kg)	CALCIUM (mg/kg)
FP-1A	7.12%	92.9%	12277	18045	3310
FP-1B	7.17%	92.8%	13796	20290	3473
FP-2	7.87%	92.1%	13364	17964	3402
FP-3	8.47%	91.5%	12704	15453	3077
FP-4	42.3%	57.7%	1559	1965	488
FP-5	14.4%	85.6%	5388	8876	3368



IEH ANALYTICAL LABORATORIES
LABORATORY & CONSULTING SERVICES
 3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
 PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	1723292B	PAGE	2
REPORT DATE:	07/14/21		
DATE SAMPLED:	05/01/21	DATE RECEIVED:	05/05/21
FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON SEDIMENT SAMPLES FROM WATER RESOURCE SERVICES			

QA/QC DATA- SEDIMENTS

QC PARAMETER	% SOLIDS	ALUMINUM (mg/kg)	IRON (mg/kg)	CALCIUM (mg/kg)
METHOD	SM18 2540B	EPA 6020A	EPA 6020A	EPA 6020A
DATE ANALYZED	05/26/21	05/12/21	05/12/21	05/12/21
DETECTION LIMIT	1.00%	2.00	2.00	2.00
DUPLICATE				
SAMPLE ID	FP-5	BATCH	BATCH	BATCH
ORIGINAL	14.4%	<2.00	<2.00	<2.00
DUPLICATE	14.5%	<2.00	<2.00	<2.00
RPD	0.95%	NC	NC	NC
SPIKE SAMPLE				
SAMPLE ID				
ORIGINAL				
SPIKED SAMPLE				
SPIKE ADDED				
% RECOVERY	NA	NA	NA	NA
QC CHECK (mg/L)				
FOUND		0.549	0.496	9.29
TRUE		0.500	0.500	10.0
% RECOVERY	NA	109.80%	99.20%	92.90%
BLANK	NA	<2.00	<2.00	<2.00

RPD = RELATIVE PERCENT DIFFERENCE.
 NA = NOT APPLICABLE OR NOT AVAILABLE.
 NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
 OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:

Damien Gadomski
 Project Manager



ANALYTICAL REPORT

Lab Number:	L2166493
Client:	Lombardo Associates, Inc. 188 Church Street Newton, MA 02458
ATTN:	Pio Lombardo
Phone:	(617) 964-2924
Project Name:	FRESH POND
Project Number:	6700
Report Date:	12/20/21

The original project report/data package is held by Alpha Analytical. This report/data package is paginated and should be reproduced only in its entirety. Alpha Analytical holds no responsibility for results and/or data that are not consistent with the original.

Certifications & Approvals: MA (M-MA086), NH NELAP (2064), CT (PH-0574), IL (200077), ME (MA00086), MD (348), NJ (MA935), NY (11148), NC (25700/666), PA (68-03671), RI (LAO00065), TX (T104704476), VT (VT-0935), VA (460195), USDA (Permit #P330-17-00196).

Eight Walkup Drive, Westborough, MA 01581-1019
508-898-9220 (Fax) 508-898-9193 800-624-9220 - www.alphalab.com



Project Name: FRESH POND
Project Number: 6700

Lab Number: L2166493
Report Date: 12/20/21

Alpha Sample ID	Client ID	Matrix	Sample Location	Collection Date/Time	Receive Date
L2166493-01	5 FOOT DEPTH	WATER	SHELTER ISLAND, NY	12/01/21 14:15	12/03/21
L2166493-02	10 FOOT DEPTH	WATER	SHELTER ISLAND, NY	12/01/21 14:15	12/03/21
L2166493-03	15 FOOT DEPTH	WATER	SHELTER ISLAND, NY	12/01/21 14:30	12/03/21
L2166493-04	20 FOOT DEPTH	WATER	SHELTER ISLAND, NY	12/01/21 14:15	12/03/21
L2166493-05	25 FOOT DEPTH	WATER	SHELTER ISLAND, NY	12/01/21 14:00	12/03/21
L2166493-06	30 FOOT DEPTH	WATER	SHELTER ISLAND, NY	12/01/21 13:45	12/03/21
L2166493-07	35 FOOT DEPTH	WATER	SHELTER ISLAND, NY	12/01/21 13:15	12/03/21
L2166493-08	40 FOOT DEPTH	WATER	SHELTER ISLAND, NY	12/01/21 13:30	12/03/21
L2166493-09	45 FOOT DEPTH	WATER	SHELTER ISLAND, NY	12/01/21 13:30	12/03/21

Project Name: FRESH POND
Project Number: 6700

Lab Number: L2166493
Report Date: 12/20/21

Case Narrative

The samples were received in accordance with the Chain of Custody and no significant deviations were encountered during the preparation or analysis unless otherwise noted. Sample Receipt, Container Information, and the Chain of Custody are located at the back of the report.

Results contained within this report relate only to the samples submitted under this Alpha Lab Number and meet NELAP requirements for all NELAP accredited parameters unless otherwise noted in the following narrative. The data presented in this report is organized by parameter (i.e. VOC, SVOC, etc.). Sample specific Quality Control data (i.e. Surrogate Spike Recovery) is reported at the end of the target analyte list for each individual sample, followed by the Laboratory Batch Quality Control at the end of each parameter. Tentatively Identified Compounds (TICs), if requested, are reported for compounds identified to be present and are not part of the method/program Target Compound List, even if only a subset of the TCL are being reported. If a sample was re-analyzed or re-extracted due to a required quality control corrective action and if both sets of data are reported, the Laboratory ID of the re-analysis or re-extraction is designated with an "R" or "RE", respectively.

When multiple Batch Quality Control elements are reported (e.g. more than one LCS), the associated samples for each element are noted in the grey shaded header line of each data table. Any Laboratory Batch, Sample Specific % recovery or RPD value that is outside the listed Acceptance Criteria is bolded in the report. In reference to questions H (CAM) or 4 (RCP) when "NO" is checked, the performance criteria for CAM and RCP methods allow for some quality control failures to occur and still be within method compliance. In these instances, the specific failure is not narrated but noted in the associated QC Outlier Summary Report, located directly after the Case Narrative. QC information is also incorporated in the Data Usability Assessment table (Format 11) of our Data Merger tool, where it can be reviewed in conjunction with the sample result, associated regulatory criteria and any associated data usability implications.

Soil/sediments, solids and tissues are reported on a dry weight basis unless otherwise noted. Definitions of all data qualifiers and acronyms used in this report are provided in the Glossary located at the back of the report.

HOLD POLICY - For samples submitted on hold, Alpha's policy is to hold samples (with the exception of Air canisters) free of charge for 21 calendar days from the date the project is completed. After 21 calendar days, we will dispose of all samples submitted including those put on hold unless you have contacted your Alpha Project Manager and made arrangements for Alpha to continue to hold the samples. Air canisters will be disposed after 3 business days from the date the project is completed.

Please contact Project Management at 800-624-9220 with any questions.

Project Name: FRESH POND
Project Number: 6700

Lab Number: L2166493
Report Date: 12/20/21

Case Narrative (continued)

Report Submission

All non-detect (ND) or estimated concentrations (J-qualified) have been quantitated to the limit noted in the MDL column.

Sample Receipt

L2166493-01: The collection date and time on the chain of custody was 03-DEC-21 14:00; however, the collection date/time on the container label was 01-DEC-21 14:15. At the client's request, the collection date/time is reported as 01-DEC-21 14:15.

L2166493-02: The collection date and time on the chain of custody was 03-DEC-21 13:45; however, the collection date/time on the container label was 01-DEC-21 14:15. At the client's request, the collection date/time is reported as 01-DEC-21 14:15.

L2166493-03: The collection date and time on the chain of custody was 03-DEC-21 13:45; however, the collection date/time on the container label was 01-DEC-21 14:30. At the client's request, the collection date/time is reported as 01-DEC-21 14:30.

L2166493-04: The collection date and time on the chain of custody was 03-DEC-21 13:30; however, the collection date/time on the container label was 01-DEC-21 14:15. At the client's request, the collection date/time is reported as 01-DEC-21 14:15.

L2166493-06: The collection date and time on the chain of custody was 03-DEC-21 13:30; however, the collection date/time on the container label was 01-DEC-21 14:00. At the client's request, the collection date/time is reported as 01-DEC-21 13:45.

L2166493-07: The collection date and time on the chain of custody was 03-DEC-21 13:15; however, the collection date/time on the container label was 01-DEC-21 13.45. At the client's request, the collection date/time is reported as 01-DEC-21 13:15.

L2166493-08: The collection date and time on the chain of custody was 03-DEC-21 13:15; however, the collection date/time on the container label was 01-DEC-21 13.30. At the client's request, the collection date/time is reported as 01-DEC-21 13:30.

L2166493-09: The collection date and time on the chain of custody was 03-DEC-21 13:00; however, the

Project Name: FRESH POND
Project Number: 6700

Lab Number: L2166493
Report Date: 12/20/21

Case Narrative (continued)

collection date/time on the container label was 01-DEC-21 13.30. At the client's request, the collection date/time is reported as 01-DEC-21 13:30.

I, the undersigned, attest under the pains and penalties of perjury that, to the best of my knowledge and belief and based upon my personal inquiry of those responsible for providing the information contained in this analytical report, such information is accurate and complete. This certificate of analysis is not complete unless this page accompanies any and all pages of this report.

Authorized Signature:



Sebastian Corbin

Title: Technical Director/Representative

Date: 12/20/21

METALS

Project Name: FRESH POND

Lab Number: L2166493

Project Number: 6700

Report Date: 12/20/21

SAMPLE RESULTS

Lab ID: L2166493-07

Date Collected: 12/01/21 13:15

Client ID: 35 FOOT DEPTH

Date Received: 12/03/21

Sample Location: SHELTER ISLAND, NY

Field Prep: Not Specified

Sample Depth:

Matrix: Water

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
Total Metals - Mansfield Lab											
Iron, Total	0.400		mg/l	0.050	0.009	1	12/14/21 04:30	12/16/21 18:30	EPA 3005A	1,6010D	EW



Project Name: FRESH POND
Project Number: 6700

Lab Number: L2166493
Report Date: 12/20/21

SAMPLE RESULTS

Lab ID: L2166493-09
 Client ID: 45 FOOT DEPTH
 Sample Location: SHELTER ISLAND, NY

Date Collected: 12/01/21 13:30
 Date Received: 12/03/21
 Field Prep: Not Specified

Sample Depth:
 Matrix: Water

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
Total Metals - Mansfield Lab											
Iron, Total	0.296		mg/l	0.050	0.009	1	12/14/21 04:30	12/16/21 18:35	EPA 3005A	1,6010D	EW



Project Name: FRESH POND
Project Number: 6700

Lab Number: L2166493
Report Date: 12/20/21

Method Blank Analysis Batch Quality Control

Parameter	Result Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Metals - Mansfield Lab for sample(s): 07,09 Batch: WG1580551-1									
Iron, Total	ND	mg/l	0.050	0.009	1	12/14/21 04:30	12/16/21 15:56	1,6010D	EW

Prep Information

Digestion Method: EPA 3005A

Lab Control Sample Analysis

Batch Quality Control

Project Name: FRESH POND

Project Number: 6700

Lab Number: L2166493

Report Date: 12/20/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Total Metals - Mansfield Lab Associated sample(s): 07,09 Batch: WG1580551-2								
Iron, Total	102		-		80-120	-		

Matrix Spike Analysis
Batch Quality Control

Project Name: FRESH POND

Lab Number: L2166493

Project Number: 6700

Report Date: 12/20/21

Parameter	Native Sample	MS Added	MS Found	MS %Recovery	Qual	MSD Found	MSD %Recovery	Qual	Recovery Limits	RPD	Qual	RPD Limits
Total Metals - Mansfield Lab Associated sample(s): 07,09 QC Batch ID: WG1580551-3 QC Sample: L2166618-01 Client ID: MS Sample												
Iron, Total	5.19	1	6.05	86		-	-		75-125	-		20

INORGANICS & MISCELLANEOUS

Project Name: FRESH POND

Lab Number: L2166493

Project Number: 6700

Report Date: 12/20/21

SAMPLE RESULTS

Lab ID: L2166493-01

Date Collected: 12/01/21 14:15

Client ID: 5 FOOT DEPTH

Date Received: 12/03/21

Sample Location: SHELTER ISLAND, NY

Field Prep: Not Specified

Sample Depth:

Matrix: Water

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Phosphorus, Total	0.055		mg/l	0.010	0.004	1	12/14/21 09:25	12/14/21 13:31	121,4500P-E	SD



Project Name: FRESH POND
Project Number: 6700

Lab Number: L2166493
Report Date: 12/20/21

SAMPLE RESULTS

Lab ID: L2166493-02
 Client ID: 10 FOOT DEPTH
 Sample Location: SHELTER ISLAND, NY

Date Collected: 12/01/21 14:15
 Date Received: 12/03/21
 Field Prep: Not Specified

Sample Depth:
 Matrix: Water

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Phosphorus, Total	0.058		mg/l	0.010	0.004	1	12/14/21 09:25	12/14/21 13:32	121,4500P-E	SD



Project Name: FRESH POND

Lab Number: L2166493

Project Number: 6700

Report Date: 12/20/21

SAMPLE RESULTS

Lab ID: L2166493-03

Date Collected: 12/01/21 14:30

Client ID: 15 FOOT DEPTH

Date Received: 12/03/21

Sample Location: SHELTER ISLAND, NY

Field Prep: Not Specified

Sample Depth:

Matrix: Water

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Phosphorus, Total	0.051		mg/l	0.010	0.004	1	12/14/21 09:25	12/14/21 13:35	121,4500P-E	SD



Project Name: FRESH POND

Lab Number: L2166493

Project Number: 6700

Report Date: 12/20/21

SAMPLE RESULTS

Lab ID: L2166493-04

Date Collected: 12/01/21 14:15

Client ID: 20 FOOT DEPTH

Date Received: 12/03/21

Sample Location: SHELTER ISLAND, NY

Field Prep: Not Specified

Sample Depth:

Matrix: Water

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Phosphorus, Total	0.046		mg/l	0.010	0.004	1	12/14/21 09:25	12/14/21 13:37	121,4500P-E	SD



Project Name: FRESH POND

Lab Number: L2166493

Project Number: 6700

Report Date: 12/20/21

SAMPLE RESULTS

Lab ID: L2166493-05

Date Collected: 12/01/21 14:00

Client ID: 25 FOOT DEPTH

Date Received: 12/03/21

Sample Location: SHELTER ISLAND, NY

Field Prep: Not Specified

Sample Depth:

Matrix: Water

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Phosphorus, Total	0.047		mg/l	0.010	0.004	1	12/14/21 09:25	12/14/21 13:38	121,4500P-E	SD



Project Name: FRESH POND

Lab Number: L2166493

Project Number: 6700

Report Date: 12/20/21

SAMPLE RESULTS

Lab ID: L2166493-06

Date Collected: 12/01/21 13:45

Client ID: 30 FOOT DEPTH

Date Received: 12/03/21

Sample Location: SHELTER ISLAND, NY

Field Prep: Not Specified

Sample Depth:

Matrix: Water

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Nitrogen, Nitrate/Nitrite	0.026	J	mg/l	0.10	0.023	1	-	12/20/21 10:59	121,4500NO3-F	MR
Nitrogen, Total Kjeldahl	0.853		mg/l	0.300	0.066	1	12/17/21 12:39	12/19/21 09:43	121,4500NH3-H	AT
Phosphorus, Total	0.052		mg/l	0.010	0.004	1	12/14/21 09:25	12/14/21 13:39	121,4500P-E	SD



Project Name: FRESH POND

Lab Number: L2166493

Project Number: 6700

Report Date: 12/20/21

SAMPLE RESULTS

Lab ID: L2166493-07

Date Collected: 12/01/21 13:15

Client ID: 35 FOOT DEPTH

Date Received: 12/03/21

Sample Location: SHELTER ISLAND, NY

Field Prep: Not Specified

Sample Depth:

Matrix: Water

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Phosphorus, Total	0.040		mg/l	0.010	0.004	1	12/14/21 09:25	12/14/21 13:40	121,4500P-E	SD



Project Name: FRESH POND

Lab Number: L2166493

Project Number: 6700

Report Date: 12/20/21

SAMPLE RESULTS

Lab ID: L2166493-08

Date Collected: 12/01/21 13:30

Client ID: 40 FOOT DEPTH

Date Received: 12/03/21

Sample Location: SHELTER ISLAND, NY

Field Prep: Not Specified

Sample Depth:

Matrix: Water

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Nitrogen, Nitrate/Nitrite	0.027	J	mg/l	0.10	0.023	1	-	12/20/21 11:01	121,4500NO3-F	MR
Nitrogen, Total Kjeldahl	0.825		mg/l	0.300	0.066	1	12/16/21 17:35	12/19/21 07:57	121,4500NH3-H	AT
Phosphorus, Total	0.049		mg/l	0.010	0.004	1	12/14/21 09:25	12/14/21 13:41	121,4500P-E	SD



Project Name: FRESH POND

Lab Number: L2166493

Project Number: 6700

Report Date: 12/20/21

Method Blank Analysis
Batch Quality Control

Parameter	Result Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab for sample(s): 01-08 Batch: WG1582952-1									
Phosphorus, Total	ND	mg/l	0.010	0.004	1	12/14/21 09:25	12/14/21 13:23	121,4500P-E	SD
General Chemistry - Westborough Lab for sample(s): 08 Batch: WG1584310-1									
Nitrogen, Total Kjeldahl	ND	mg/l	0.300	0.022	1	12/16/21 17:35	12/19/21 07:52	121,4500NH3-H	AT
General Chemistry - Westborough Lab for sample(s): 06 Batch: WG1584568-1									
Nitrogen, Total Kjeldahl	ND	mg/l	0.300	0.022	1	12/17/21 12:39	12/19/21 09:30	121,4500NH3-H	AT
General Chemistry - Westborough Lab for sample(s): 06,08 Batch: WG1585326-1									
Nitrogen, Nitrate/Nitrite	ND	mg/l	0.10	0.023	1	-	12/20/21 10:26	121,4500NO3-F	MR

Lab Control Sample Analysis

Batch Quality Control

Project Name: FRESH POND

Project Number: 6700

Lab Number: L2166493

Report Date: 12/20/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
General Chemistry - Westborough Lab Associated sample(s): 01-08 Batch: WG1582952-2								
Phosphorus, Total	110		-		80-120	-		
General Chemistry - Westborough Lab Associated sample(s): 08 Batch: WG1584310-2								
Nitrogen, Total Kjeldahl	102		-		78-122	-		
General Chemistry - Westborough Lab Associated sample(s): 06 Batch: WG1584568-2								
Nitrogen, Total Kjeldahl	101		-		78-122	-		
General Chemistry - Westborough Lab Associated sample(s): 06,08 Batch: WG1585326-2								
Nitrogen, Nitrate/Nitrite	94		-		90-110	-		20

Matrix Spike Analysis Batch Quality Control

Project Name: FRESH POND
Project Number: 6700

Lab Number: L2166493
Report Date: 12/20/21

Parameter	Native Sample	MS Added	MS Found	MS %Recovery	MSD Qual	MSD Found	MSD %Recovery	MSD Qual	Recovery Limits	RPD	RPD Qual	RPD Limits
General Chemistry - Westborough Lab Associated sample(s): 01-08 QC Batch ID: WG1582952-3 QC Sample: L2166374-02 Client ID: MS Sample												
Phosphorus, Total	0.027	0.5	0.558	106	-	-	-	-	75-125	-	-	20
General Chemistry - Westborough Lab Associated sample(s): 08 QC Batch ID: WG1584310-4 QC Sample: L2166608-06 Client ID: MS Sample												
Nitrogen, Total Kjeldahl	0.428	8	7.18	84	-	-	-	-	77-111	-	-	24
General Chemistry - Westborough Lab Associated sample(s): 06 QC Batch ID: WG1584568-4 QC Sample: L2166783-01 Client ID: MS Sample												
Nitrogen, Total Kjeldahl	0.161J	8	6.92	86	-	-	-	-	77-111	-	-	24
General Chemistry - Westborough Lab Associated sample(s): 06,08 QC Batch ID: WG1585326-4 QC Sample: L2166636-01 Client ID: MS Sample												
Nitrogen, Nitrate/Nitrite	1.2	4	4.9	92	-	-	-	-	80-120	-	-	20

Lab Duplicate Analysis

Batch Quality Control

Project Name: FRESH POND

Project Number: 6700

Lab Number: L2166493

Report Date: 12/20/21

Parameter	Native Sample	Duplicate Sample	Units	RPD	Qual	RPD Limits
General Chemistry - Westborough Lab Associated sample(s): 01-08 QC Batch ID: WG1582952-4 QC Sample: L2166374-02 Client ID: DUP Sample						
Phosphorus, Total	0.027	0.026	mg/l	4		20
General Chemistry - Westborough Lab Associated sample(s): 08 QC Batch ID: WG1584310-3 QC Sample: L2166608-06 Client ID: DUP Sample						
Nitrogen, Total Kjeldahl	0.428	0.564	mg/l	27	Q	24
General Chemistry - Westborough Lab Associated sample(s): 06 QC Batch ID: WG1584568-3 QC Sample: L2166783-01 Client ID: DUP Sample						
Nitrogen, Total Kjeldahl	0.161J	0.298J	mg/l	NC		24
General Chemistry - Westborough Lab Associated sample(s): 06,08 QC Batch ID: WG1585326-3 QC Sample: L2166636-01 Client ID: DUP Sample						
Nitrogen, Nitrate/Nitrite	1.2	1.2	mg/l	0		20

Project Name: FRESH POND**Lab Number:** L2166493**Project Number:** 6700**Report Date:** 12/20/21**Sample Receipt and Container Information**

Were project specific reporting limits specified?

YES

Cooler Information

Cooler	Custody Seal
A	Absent

Container Information

Container ID	Container Type	Cooler	Initial pH	Final pH	Temp deg C	Pres	Seal	Frozen Date/Time	Analysis(*)
L2166493-01A	Plastic 250ml H2SO4 preserved	A	<2	<2	5.5	Y	Absent		TPHOS-4500(28)
L2166493-02A	Plastic 250ml H2SO4 preserved	A	<2	<2	5.5	Y	Absent		TPHOS-4500(28)
L2166493-03A	Plastic 250ml H2SO4 preserved	A	<2	<2	5.5	Y	Absent		TPHOS-4500(28)
L2166493-04A	Plastic 250ml H2SO4 preserved	A	<2	<2	5.5	Y	Absent		TPHOS-4500(28)
L2166493-05A	Plastic 250ml H2SO4 preserved	A	<2	<2	5.5	Y	Absent		TPHOS-4500(28)
L2166493-06A	Plastic 250ml H2SO4 preserved	A	<2	<2	5.5	Y	Absent		TKN-4500(28),TPHOS-4500(28),NO3/NO2-4500(28)
L2166493-06B	Plastic 250ml H2SO4 preserved	A	<2	<2	5.5	Y	Absent		TKN-4500(28),TPHOS-4500(28),NO3/NO2-4500(28)
L2166493-07A	Plastic 250ml HNO3 preserved	A	<2	<2	5.5	Y	Absent		FE-TI(180)
L2166493-07B	Plastic 250ml H2SO4 preserved	A	<2	<2	5.5	Y	Absent		TPHOS-4500(28)
L2166493-08A	Plastic 250ml H2SO4 preserved	A	<2	<2	5.5	Y	Absent		TKN-4500(28),TPHOS-4500(28),NO3/NO2-4500(28)
L2166493-08B	Plastic 250ml H2SO4 preserved	A	<2	<2	5.5	Y	Absent		TKN-4500(28),TPHOS-4500(28),NO3/NO2-4500(28)
L2166493-09A	Plastic 250ml HNO3 preserved	A	<2	<2	5.5	Y	Absent		FE-TI(180)

Project Name: FRESH POND
Project Number: 6700

Lab Number: L2166493
Report Date: 12/20/21

GLOSSARY

Acronyms

DL	- Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the limit of quantitation (LOQ). The DL includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)
EDL	- Estimated Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The EDL includes any adjustments from dilutions, concentrations or moisture content, where applicable. The use of EDLs is specific to the analysis of PAHs using Solid-Phase Microextraction (SPME).
EMPC	- Estimated Maximum Possible Concentration: The concentration that results from the signal present at the retention time of an analyte when the ions meet all of the identification criteria except the ion abundance ratio criteria. An EMPC is a worst-case estimate of the concentration.
EPA	- Environmental Protection Agency.
LCS	- Laboratory Control Sample: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.
LCSD	- Laboratory Control Sample Duplicate: Refer to LCS.
LFB	- Laboratory Fortified Blank: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.
LOD	- Limit of Detection: This value represents the level to which a target analyte can reliably be detected for a specific analyte in a specific matrix by a specific method. The LOD includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)
LOQ	- Limit of Quantitation: The value at which an instrument can accurately measure an analyte at a specific concentration. The LOQ includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.) Limit of Quantitation: The value at which an instrument can accurately measure an analyte at a specific concentration. The LOQ includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)
MDL	- Method Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The MDL includes any adjustments from dilutions, concentrations or moisture content, where applicable.
MS	- Matrix Spike Sample: A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. For Method 332.0, the spike recovery is calculated using the native concentration, including estimated values.
MSD	- Matrix Spike Sample Duplicate: Refer to MS.
NA	- Not Applicable.
NC	- Not Calculated: Term is utilized when one or more of the results utilized in the calculation are non-detect at the parameter's reporting unit.
NDPA/DPA	- N-Nitrosodiphenylamine/Diphenylamine.
NI	- Not Ignitable.
NP	- Non-Plastic: Term is utilized for the analysis of Atterberg Limits in soil.
NR	- No Results: Term is utilized when 'No Target Compounds Requested' is reported for the analysis of Volatile or Semivolatile Organic TIC only requests.
RL	- Reporting Limit: The value at which an instrument can accurately measure an analyte at a specific concentration. The RL includes any adjustments from dilutions, concentrations or moisture content, where applicable.
RPD	- Relative Percent Difference: The results from matrix and/or matrix spike duplicates are primarily designed to assess the precision of analytical results in a given matrix and are expressed as relative percent difference (RPD). Values which are less than five times the reporting limit for any individual parameter are evaluated by utilizing the absolute difference between the values; although the RPD value will be provided in the report.
SRM	- Standard Reference Material: A reference sample of a known or certified value that is of the same or similar matrix as the associated field samples.
STLP	- Semi-dynamic Tank Leaching Procedure per EPA Method 1315.
TEF	- Toxic Equivalency Factors: The values assigned to each dioxin and furan to evaluate their toxicity relative to 2,3,7,8-TCDD.
TEQ	- Toxic Equivalent: The measure of a sample's toxicity derived by multiplying each dioxin and furan by its corresponding TEF and then summing the resulting values.
TIC	- Tentatively Identified Compound: A compound that has been identified to be present and is not part of the target compound list (TCL) for the method and/or program. All TICs are qualitatively identified and reported as estimated concentrations.

Report Format: DU Report with 'J' Qualifiers



Project Name: FRESH POND
Project Number: 6700

Lab Number: L2166493
Report Date: 12/20/21

Footnotes

- 1 - The reference for this analyte should be considered modified since this analyte is absent from the target analyte list of the original method.

Terms

Analytical Method: Both the document from which the method originates and the analytical reference method. (Example: EPA 8260B is shown as 1,8260B.) The codes for the reference method documents are provided in the References section of the Addendum.

Difference: With respect to Total Oxidizable Precursor (TOP) Assay analysis, the difference is defined as the Post-Treatment value minus the Pre-Treatment value.

Final pH: As it pertains to Sample Receipt & Container Information section of the report, Final pH reflects pH of container determined after adjustment at the laboratory, if applicable. If no adjustment required, value reflects Initial pH.

Frozen Date/Time: With respect to Volatile Organics in soil, Frozen Date/Time reflects the date/time at which associated Reagent Water-preserved vials were initially frozen. Note: If frozen date/time is beyond 48 hours from sample collection, value will be reflected in 'bold'.

Initial pH: As it pertains to Sample Receipt & Container Information section of the report, Initial pH reflects pH of container determined upon receipt, if applicable.

PAH Total: With respect to Alkylated PAH analyses, the 'PAHs, Total' result is defined as the summation of results for all or a subset of the following compounds: Naphthalene, C1-C4 Naphthalenes, 2-Methylnaphthalene, 1-Methylnaphthalene, Biphenyl, Acenaphthylene, Acenaphthene, Fluorene, C1-C3 Fluorenes, Phenanthrene, C1-C4 Phenanthrenes/Anthracenes, Anthracene, Fluoranthene, Pyrene, C1-C4 Fluoranthenes/Pyrenes, Benz(a)anthracene, Chrysene, C1-C4 Chrysenes, Benzo(b)fluoranthene, Benzo(j)+(k)fluoranthene, Benzo(e)pyrene, Benzo(a)pyrene, Perylene, Indeno(1,2,3-cd)pyrene, Dibenz(ah)+(ac)anthracene, Benzo(g,h,i)perylene. If a 'Total' result is requested, the results of its individual components will also be reported.

PFAS Total: With respect to PFAS analyses, the 'PFAS, Total (5)' result is defined as the summation of results for: PFHpA, PFHxS, PFOA, PFNA and PFOS. In addition, the 'PFAS, Total (6)' result is defined as the summation of results for: PFHpA, PFHxS, PFOA, PFNA, PFDA and PFOS. For MassDEP DW compliance analysis only, the 'PFAS, Total (6)' result is defined as the summation of results at or above the RL. Note: If a 'Total' result is requested, the results of its individual components will also be reported.

The target compound Chlordane (CAS No. 57-74-9) is reported for GC ECD analyses. Per EPA, this compound "refers to a mixture of chlordane isomers, other chlorinated hydrocarbons and numerous other components." (Reference: USEPA Toxicological Review of Chlordane, In Support of Summary Information on the Integrated Risk Information System (IRIS), December 1997.)

Total: With respect to Organic analyses, a 'Total' result is defined as the summation of results for individual isomers or Aroclors. If a 'Total' result is requested, the results of its individual components will also be reported. This is applicable to 'Total' results for methods 8260, 8081 and 8082.

Data Qualifiers

- A** - Spectra identified as "Aldol Condensates" are byproducts of the extraction/concentration procedures when acetone is introduced in the process.
- B** - The analyte was detected above the reporting limit in the associated method blank. Flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For MCP-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For DOD-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank AND the analyte was detected above one-half the reporting limit (or above the reporting limit for common lab contaminants) in the associated method blank. For NJ-Air-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte above the reporting limit. For NJ-related projects (excluding Air), flag only applies to associated field samples that have detectable concentrations of the analyte, which was detected above the reporting limit in the associated method blank or above five times the reporting limit for common lab contaminants (Phthalates, Acetone, Methylene Chloride, 2-Butanone).
- C** - Co-elution: The target analyte co-elutes with a known lab standard (i.e. surrogate, internal standards, etc.) for co-extracted analyses.
- D** - Concentration of analyte was quantified from diluted analysis. Flag only applies to field samples that have detectable concentrations of the analyte.
- E** - Concentration of analyte exceeds the range of the calibration curve and/or linear range of the instrument.
- F** - The ratio of quantifier ion response to qualifier ion response falls outside of the laboratory criteria. Results are considered to be an estimated maximum concentration.
- G** - The concentration may be biased high due to matrix interferences (i.e. co-elution) with non-target compound(s). The result should be considered estimated.
- H** - The analysis of pH was performed beyond the regulatory-required holding time of 15 minutes from the time of sample collection.
- I** - The lower value for the two columns has been reported due to obvious interference.
- J** - Estimated value. The Target analyte concentration is below the quantitation limit (RL), but above the Method Detection Limit (MDL) or Estimated Detection Limit (EDL) for SPME-related analyses. This represents an estimated concentration for Tentatively Identified Compounds (TICs).
- M** - Reporting Limit (RL) exceeds the MCP CAM Reporting Limit for this analyte.
- ND** - Not detected at the method detection limit (MDL) for the sample, or estimated detection limit (EDL) for SPME-related analyses.

Report Format: DU Report with 'J' Qualifiers



Project Name: FRESH POND
Project Number: 6700

Lab Number: L2166493
Report Date: 12/20/21

Data Qualifiers

- NJ** - Presumptive evidence of compound. This represents an estimated concentration for Tentatively Identified Compounds (TICs), where the identification is based on a mass spectral library search.
- P** - The RPD between the results for the two columns exceeds the method-specified criteria.
- Q** - The quality control sample exceeds the associated acceptance criteria. For DOD-related projects, LCS and/or Continuing Calibration Standard exceedences are also qualified on all associated sample results. Note: This flag is not applicable for matrix spike recoveries when the sample concentration is greater than 4x the spike added or for batch duplicate RPD when the sample concentrations are less than 5x the RL. (Metals only.)
- R** - Analytical results are from sample re-analysis.
- RE** - Analytical results are from sample re-extraction.
- S** - Analytical results are from modified screening analysis.
- V** - The surrogate associated with this target analyte has a recovery outside the QC acceptance limits. (Applicable to MassDEP DW Compliance samples only.)
- Z** - The batch matrix spike and/or duplicate associated with this target analyte has a recovery/RPD outside the QC acceptance limits. (Applicable to MassDEP DW Compliance samples only.)

Project Name: FRESH POND
Project Number: 6700

Lab Number: L2166493
Report Date: 12/20/21

REFERENCES

- 1 Test Methods for Evaluating Solid Waste: Physical/Chemical Methods. EPA SW-846. Third Edition. Updates I - VI, 2018.
- 121 Standard Methods for the Examination of Water and Wastewater. APHA-AWWA-WEF. Standard Methods Online.

LIMITATION OF LIABILITIES

Alpha Analytical performs services with reasonable care and diligence normal to the analytical testing laboratory industry. In the event of an error, the sole and exclusive responsibility of Alpha Analytical shall be to re-perform the work at it's own expense. In no event shall Alpha Analytical be held liable for any incidental, consequential or special damages, including but not limited to, damages in any way connected with the use of, interpretation of, information or analysis provided by Alpha Analytical.

We strongly urge our clients to comply with EPA protocol regarding sample volume, preservation, cooling, containers, sampling procedures, holding time and splitting of samples in the field.



Certification Information

The following analytes are not included in our Primary NELAP Scope of Accreditation:

Westborough Facility

EPA 624/624.1: m/p-xylene, o-xylene, Naphthalene

EPA 625/625.1: alpha-Terpineol

EPA 8260C/8260D: NPW: 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene, Azobenzene; SCM: Iodomethane (methyl iodide), 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene.

EPA 8270D/8270E: NPW: Dimethylnaphthalene, 1,4-Diphenylhydrazine, alpha-Terpineol; SCM: Dimethylnaphthalene, 1,4-Diphenylhydrazine.

SM4500: NPW: Amenable Cyanide; SCM: Total Phosphorus, TKN, NO₂, NO₃.

Mansfield Facility

SM 2540D: TSS

EPA 8082A: NPW: PCB: 1, 5, 31, 87,101, 110, 141, 151, 153, 180, 183, 187.

EPA TO-15: Halothane, 2,4,4-Trimethyl-2-pentene, 2,4,4-Trimethyl-1-pentene, Thiophene, 2-Methylthiophene,

3-Methylthiophene, 2-Ethylthiophene, 1,2,3-Trimethylbenzene, Indan, Indene, 1,2,4,5-Tetramethylbenzene, Benzothiophene, 1-Methylnaphthalene.

Biological Tissue Matrix: EPA 3050B

The following analytes are included in our Massachusetts DEP Scope of Accreditation

Westborough Facility:

Drinking Water

EPA 300.0: Chloride, Nitrate-N, Fluoride, Sulfate; **EPA 353.2:** Nitrate-N, Nitrite-N; **SM4500NO3-F:** Nitrate-N, Nitrite-N; **SM4500F-C, SM4500CN-CE,**

EPA 180.1, SM2130B, SM4500CI-D, SM2320B, SM2540C, SM4500H-B, SM4500NO2-B

EPA 332: Perchlorate; **EPA 524.2:** THMs and VOCs; **EPA 504.1:** EDB, DBCP.

Microbiology: **SM9215B; SM9223-P/A, SM9223B-Colilert-QT, SM9222D.**

Non-Potable Water

SM4500H,B, EPA 120.1, SM2510B, SM2540C, SM2320B, SM4500CL-E, SM4500F-BC, SM4500NH3-BH: Ammonia-N and Kjeldahl-N, **EPA 350.1:**

Ammonia-N, **LCHAT 10-107-06-1-B:** Ammonia-N, **EPA 351.1, SM4500NO3-F, EPA 353.2:** Nitrate-N, **SM4500P-E, SM4500P-B, E, SM4500SO4-E,**

SM5220D, EPA 410.4, SM5210B, SM5310C, SM4500CL-D, EPA 1664, EPA 420.1, SM4500-CN-CE, SM2540D, EPA 300: Chloride, Sulfate, Nitrate.

EPA 624.1: Volatile Halocarbons & Aromatics,

EPA 608.3: Chlordane, Toxaphene, Aldrin, alpha-BHC, beta-BHC, gamma-BHC, delta-BHC, Dieldrin, DDD, DDE, DDT, Endosulfan I, Endosulfan II,

Endosulfan sulfate, Endrin, Endrin Aldehyde, Heptachlor, Heptachlor Epoxide, PCBs

EPA 625.1: SVOC (Acid/Base/Neutral Extractables), **EPA 600/4-81-045:** PCB-Oil.

Microbiology: **SM9223B-Colilert-QT; Enterolert-QT, SM9221E, EPA 1600, EPA 1603, SM9222D.**

Mansfield Facility:

Drinking Water

EPA 200.7: Al, Ba, Cd, Cr, Cu, Fe, Mn, Ni, Na, Ag, Ca, Zn. **EPA 200.8:** Al, Sb, As, Ba, Be, Cd, Cr, Cu, Pb, Mn, Ni, Se, Ag, TL, Zn. **EPA 245.1 Hg.**

EPA 522, EPA 537.1.

Non-Potable Water

EPA 200.7: Al, Sb, As, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Ag, Na, Sr, TL, Ti, V, Zn.

EPA 200.8: Al, Sb, As, Be, Cd, Cr, Cu, Fe, Pb, Mn, Ni, K, Se, Ag, Na, TL, Zn.

EPA 245.1 Hg.

SM2340B

For a complete listing of analytes and methods, please contact your Alpha Project Manager.

**QUALITY ASSURANCE PROJECT PLAN
FOR THE
INTERNAL PHOSPHORUS LOADING
ASSESSMENT FOR FRESH POND, SHELTER
ISLAND, NY**

**Associated with the In-Waterbody Control for Nutrients Project for the Town of Shelter
Island in part funded by the New York State Department of Environmental Conservation
Grant DEC01-T00944GG-3350000**



Prepared by Water Resource Services, Inc.



For Lombardo Associates, Inc.

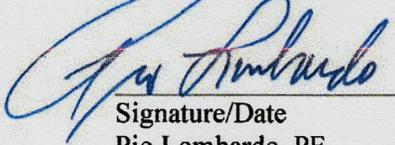
March 22, 2021

A Project Management Elements

A.1. Title and Approval Sheet

Study of Internal Phosphorus Loading for Fresh Pond
Quality Assurance Project Plan
March 2021

Project Manager

 3-23-21

Signature/Date

Pio Lombardo, PE

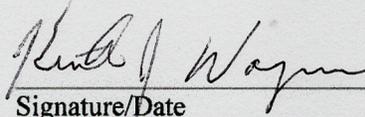
Lombardo Associates, Inc.

188 Church Street, Newton, MA 02458

617-964-2924

pio@lombardoAssociates.com

Project Quality Assurance Officer

 3/23/21

Signature/Date

Kenneth J. Wagner, Ph.D., CLM

Water Resource Services, Inc.

144 Crane Hill Road, Wilbraham, MA 01095

413-219-8071

kjwagner@charter.net

A.2. Table of Contents

A Project Management Elements	1
A.1. Title and Approval Sheet	1
A.2. Table of Contents	1
A.3. Distribution List	3
A.4. List of Acronyms	4
A.5. Project / Task Organization	5
A.6. Problem Definition / Background	5
A.7. Project / Task Description	8
A.7. Necessary Equipment	12
A.8. Quality Objectives and Criteria for Data Measurement	13
A.8.1. Accuracy	13
A.8.2. Precision	13
A.8.3. Detection Limit	15
A.8.4. Resolution	15
A.8.5. Bias	15
A.8.6. Completeness	15
A.8.7. Representativeness	15
A.8.8. Comparability	16
A.9. Special Training Requirements / Certification	16
A.10. Documentation Records	16
B. Measurement / Data Acquisition	17
B.1. Sampling Process Design and Intent	17
B.1.1. Specific Field and Laboratory Tasks	17
B.1.2. Data Use	18
B.2. Sampling Method Requirements	18
B.2.1. Procedures for making in-situ water quality measurements	18
B.2.2. Procedures for collecting surficial sediment samples	18
B.2.3. Procedures for collecting in-lake water samples	19
B.2.6. Procedures for collecting plankton samples	20
B.2.7. Corrective Actions for Failures/Deviations in Sampling Methods	20
B.3. Sample Handling and Custody Requirements	20
B.3.1. Field record management	20
B.3.2. Sample transport and delivery	21
B.3.3. Laboratory Custody Procedures	21
B.3.4. Corrective Action for Failures in Sample Handling and Chain-of-Custody	21
B.4. Analytical Methods Requirements	22
B.5. Quality Control Requirements	22
B.6. Instrument / Equipment Testing, Inspection and Maintenance Requirements	22
B.7. Instrument Calibration and Frequency	22
B.8. Inspection / Acceptance Requirements for Supplies and Consumables	23

B.9. Data Acquisition Requirements (Non – Direct Measurements)	23
B.10. Data Management	23
C. Assessment / Oversight	24
C.1. Assessment and Response Actions	24
C.1.1. Data Quality Assessment	24
C.1.2. Accuracy Assessment	24
C.1.3. Precision Assessment	24
C.1.4. Completeness Assessment	24
C.1.5. Corrective Action	25
C.2. Reports to Management	25
D. Data Validation and Usability	25
D.1 Data Review, Validation and Verification Requirements	25
D.2 Validation and Verification Methods	26
D.3. Reconciliation with User Requirements	27

A.3. Distribution List

Pio Lombardo, PE
Lombardo Associates, Inc.
188 Church Street, Newton, MA 02458
617-964-2924
pio@lombardoAssociates.com

Kenneth J. Wagner, Ph.D., CLM
Water Resource Services
144 Crane Hill Road
Wilbraham, MA 01095
413-219-8071
kjwagner@charter.net

Wendy Gendron
Aquatic Restoration Consulting
18 Sunset Drive,
Ashburnham, MA 01430
508-397-0033
wgendron@gmail.com

Christine Furcinite-Reynolds
Microbac Laboratories Inc.
80 Run Way
Lee, MA 01238
413-776-5025
christiner@premierlaboratory.com

Damien Gadomski
IEH Analytical Laboratories
3927 Aurora Ave North
Seattle, WA 98103
206-632-2715
damieng@iehinc.com

A.4. List of Acronyms

ARC	Aquatic Restoration Consulting
BMP	Best Management Practices
COC	Chain-of-Custody
DO	Dissolved Oxygen
DQA	Data Quality Assessment
DQO	Data Quality Objective
GC/MS	Gas Chromatography/ Mass Spectrometry
GIS	Geographic Information System
LAI	Lombardo Associates, Inc.
LCS	Laboratory Control Samples
LLRM	Lake Loading Response Model
MS	Matrix Spike
MSD	Matrix Spike Duplicate
P	Phosphorus
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
QC	Quality Control
QMP	Quality Management Plan
RPD	Relative Percent Difference
SOP	Standard Operating Procedure
T	Temperature (Centigrade scale unless otherwise specified)
TMDLs	Total Maximum Daily Loads
TP	Total Phosphorus
WRS	Water Resource Services

A.5. Project / Task Organization

The Town of Shelter Island is investigating the causes of eutrophication and cyanobacteria blooms in Fresh Pond. Actual work on the project will be carried out by Lombardo Associates, Inc. (LAI) with subcontractors Water Resource Services Inc. (WRS) and Aquatic Restoration Consulting (ARC). The specific project tasks that fall under this QAPP are incorporated into a field program to acquire sediment quality data from Fresh Pond, quantify in-lake phosphorus (P) and dissolved oxygen (DO) profiles that include the deepest water at a time of expected worst conditions, assess plankton in the pond, and evaluate internal phosphorus loading from sediment in the context of an overall phosphorus loading framework. Assuming internal P loading to be a significant factor in eutrophication of the pond, possible remedial measures will be evaluated, but this QAPP focuses on the acquisition of key data for that evaluation.

Mr. Pio Lombardo of LAI will act as Project Manager and will be responsible for the overall conduct of the investigative monitoring program. Dr. Ken Wagner of WRS will act as Quality Assurance Officer. Dr. Wagner and Ms. Gendron will be responsible for collecting water and sediment quality data. The laboratories that will conduct analysis testing are Microbac Laboratories of Lee, MA (water) and IEH Analytical Laboratories of Seattle, WA (sediment). Laboratory Standard Operating Procedure (SOP) as relates to water quality and sediment variables to be assessed in the lab can be made available upon request but we have worked with each of these lab for years and are comfortable with their procedures and QA/QC programs.

A.6. Problem Definition / Background

Fresh Pond is a 14-acre lake in the Town of Shelter Island (Figure 1). It is relatively deep for its area with a maximum depth of 45 feet (Figure 2). It has no permanent tributaries and is fed mainly by precipitation and groundwater. Fresh Pond is a public recreational resource on Shelter Island but has suffered from cyanobacteria and other algae blooms. Elevated phosphorus (P) is most often the cause of such blooms and can come from multiple sources, but kettlehole ponds such as Fresh Pond are often subject to excessive internal loading, the recycling of much longer term P inputs from runoff, groundwater, and atmospheric deposition. If elevated P is a function of current watershed inputs, the level of reduction necessary to achieve a desirable P concentration ($<20 \mu\text{g/L}$ nearly all the time, preferably close to $10 \mu\text{g/L}$ as an average) can be estimated and the types of watershed management methods and the extent of application needed to achieve those reductions can be evaluated within the context of a simple watershed model. If elevated P is a function of wastewater disposal via on-site systems, modeling supported by field data can determine the magnitude and likely input rate. If elevated P is a function of internal loading from sediment exposed to anoxia, the reduction achievable from oxygenation or P inactivation (the two logical methods for addressing this problem in a stratified lake) can be estimated and compared to the target load necessary to meet water quality goals. Some combination of watershed and in-lake methods may indeed be necessary to meet goals over an extended time period.

Low oxygen is a natural condition in deep water in many lakes, but one that is often exacerbated by human actions. Knowledge of the actual oxygen demand allows consideration of whether reduced internal production (based mainly on P control) can counter the demand or if other measures (most often oxygenation) will be needed to meet the oxygen standard in deep water. This project seeks to quantify inputs from those sources and put them into a management context.

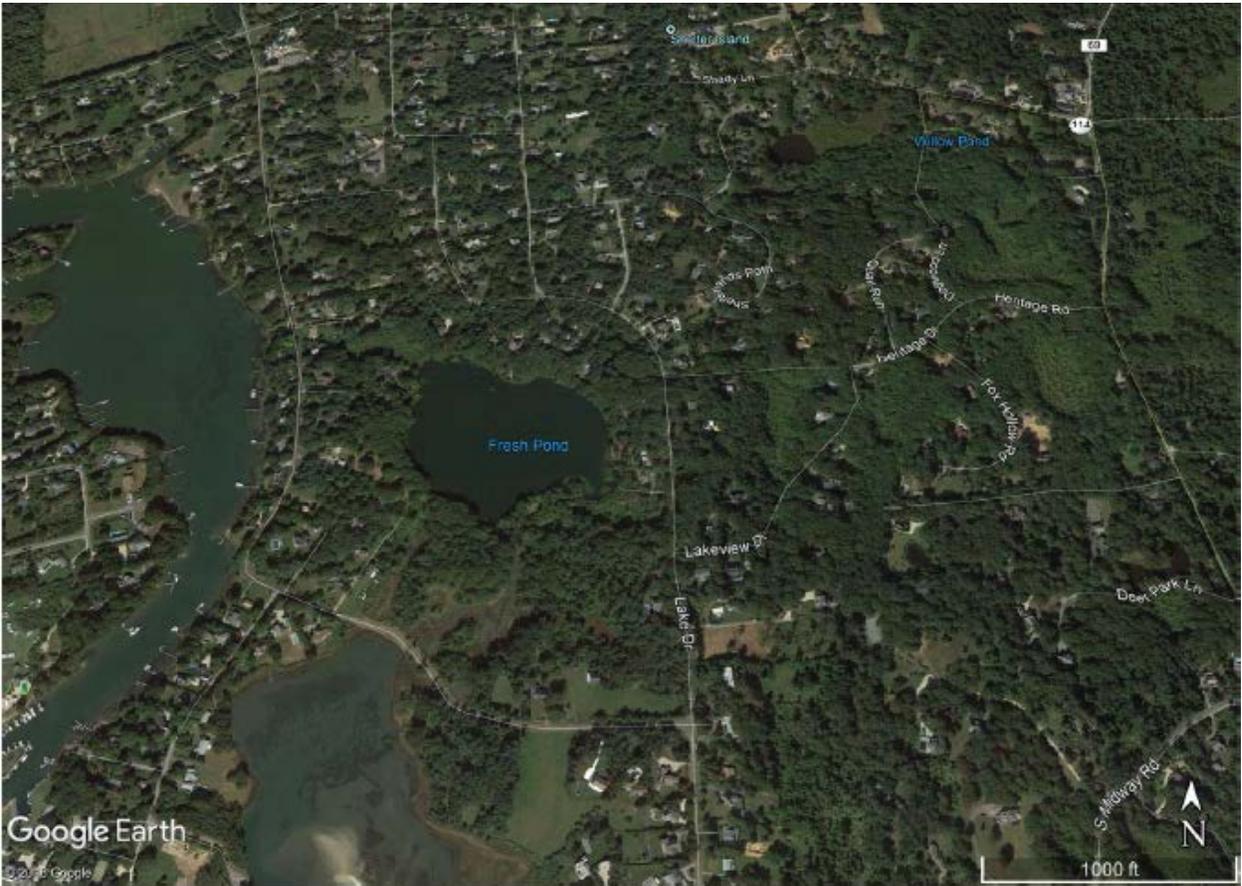
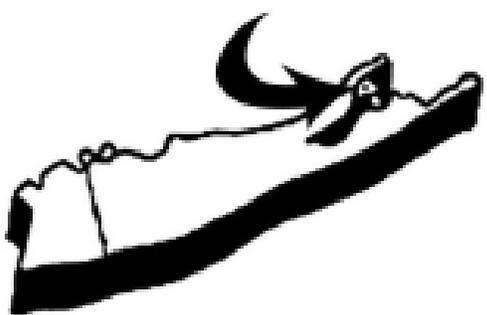


Figure A6-1. Fresh Pond location on Shelter Island.



Region 1

**Fresh Pond,
Shelter Island**



Not For Use in Navigation

Fresh Pond	
County: Suffolk	Town: Shelter Island
Surface Area: 14 Acres	Mean Depth: 19ft
Fish Species Present: Smallmouth Bass, Bluegill, Common Carp, Largemouth Bass	
Scale:	0  200 ft



Figure A6-2. Fresh Pond bathymetry.

A.7. Project / Task Description

The goal of this study is to assess P loading, evaluate lake remediation options and make recommendations to improve the water quality in Fresh Pond. Available data are expected to be adequate to evaluate most external inputs, but field work is needed to assess internal loading and is the focus of this QAPP.

Anoxia is expected to occur at water depths of >20 feet during summer, but this requires verification and the amount of lake area affected will be assessed. P bound to iron could be released into the water column, and limited data for deep water P concentrations indicates this to be the case. However we do not have data for Fe-P content of the surficial sediments in deep areas. The amount of available P and its release into the water need to be quantified for a complete picture of P loading to the lake. This is a relatively straightforward matter of collecting sediment and water and having the appropriate lab tests performed.

Oxygen demand must be quantified and can be done in a lab as an oxygen consumption test using sediment cores but can be accomplished with temperature/dissolved oxygen (T/DO) profiles collected while oxygen concentrations are >2 mg/L at all depths. It is harder for decay processes to remove oxygen as it approaches 0 mg/L, leading to less oxygen loss over the measurement period and underestimation of actual oxygen demand. Reasonably accurate estimates of oxygen demand can be obtained from spring profiles when stratification is developing but oxygen depletion has not yet occurred. This is in essence a field version of the Standard Methods lab test. A reduction in P should lead to a reduction in algae production and deposition of oxygen demanding substances, but decaying rooted plants and leaf additions from the proximal watershed also add to the oxygen demand. The level of oxygen demand reduction achievable by available P reduction can be estimated and compared to the measured demand to determine if the oxygen standard can be met by P control alone, or if supplemental action (e.g., oxygenation, sediment oxidization) is needed.

The needs expressed above lead to formulation of a 4-task program of investigation. Specific tasks to be accomplished include the development of the QAPP itself as Task 1 and the following tasks to be completed in accordance with the QAPP:

1. Obtaining in-lake oxygen and temperature profiles in the deepest part of the lake during spring through summer
2. Assessment of available P in surficial sediment in areas subject to anoxia (choice of sampling locations is a matter of representing all areas with a combination of presence of organic sediment and oxygen <2 mg/L)
3. Measuring in-lake phosphorus concentrations in the epilimnion and hypolimnion during peak stratification (usually late August or September)
4. Sampling phytoplankton and zooplankton at key times to aid interpretation of oxygen and P results within the context of lake ecology and cyanobacteria problems

TASK #1: Oxygen Profiles

BACKGROUND:

Oxygen has been measured infrequently in Fresh Pond. The pond has a maximum depth of 45 feet, with about half of the lake deeper than 20 feet, so a substantial area could be subject to low oxygen exposure. Gaining an understanding for the timeframe of loss of oxygen in deeper water is important to understanding possible internal P loading and the actual oxygen demand is important to estimating whether P control can ameliorate that demand or additional actions will be needed to meet the state standard.

APPROACH:

Oxygen status will be assessed with a field instrument that measures oxygen and temperature at 1 m intervals from surface to bottom, with the deepest measurements collected near the sediment-water interface. Assessment will occur in April and May when oxygen decline is most pronounced and again in August or September, allowing both calculation of oxygen demand (which properly must occur in the spring before deep water values drop below 2 mg/L and the kinetics of oxygen uptake are altered – see Standard Methods, 22nd edition, page 2-88) and estimation of the bottom area exposed to anoxia during the period of stratification. The areal and temporal extent of low oxygen will factor into the calculation of P loading from surficial sediment.

DELIVERABLES:

Tabular and graphic summaries of T/DO profile data will be provided, along with areal and temporal estimation of encountered anoxia and calculation of oxygen demand.

TASK #2: Phosphorus in Surficial Sediment

BACKGROUND:

Under anoxic conditions, P is released from Fe-P compounds and enters the water column above. This is the primary means of P release from sediment, although not the only mechanism. We will be measuring the actual accumulation rate of P in the hypolimnion, but if inactivation is needed, we have to know the amount of Fe-P in the sediment to calculate an appropriate dose of inactivator, usually aluminum. Further, the amount of Fe-P in the surficial sediments (upper 10 cm) can be used to provide an independent estimate of P release. In geographic areas where calcium is abundant, it is also possible that Fe-P is low, in which case accumulation may be a function of other processes, such as settling of particles from above or decomposition. Knowledge of Fe-P in surficial sediments is important to a more complete understanding of loading.

APPROACH:

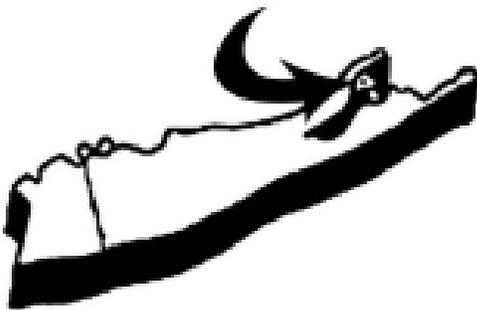
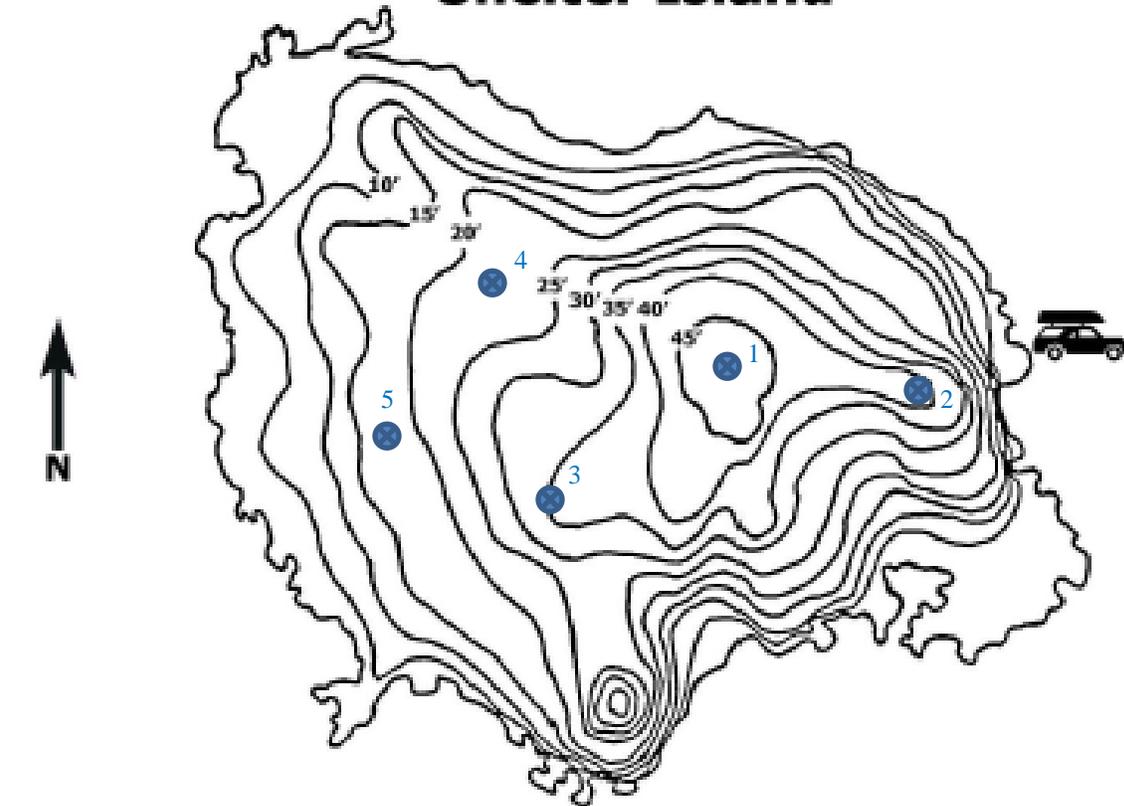
Surficial sediment will be sampled at 5 locations in Fresh Pond, covering the area known to be exposed to anoxia. Only one sampling is needed to characterize the sediment, and sampling can occur any time of year. Samples will be tested for TP, Fe-P, biogenic P, Fe, Al, Ca, % solids and % organic matter, allowing calculation of available Fe-P and its relation to TP and other key sediment features. Samples will be collected with a universal gravity corer or an Ekman dredge and only the upper 10 cm of sediment will be sampled. The corer and Ekman dredge have been used successfully in other projects with acceptable results. The range of plausible mass release from sediment will be calculated based on the range of percent release known from other lakes and daily release rates expected as a function of measured Fe-P and area of sediment exposed to anoxia.

In order to determine where to collect sediment samples, the extent of bottom coverage by organic substrate or silt is needed. Open sandy areas are generally not major sources of available sediment P. Using an underwater video system, the “muck line” will be delineated prior to sampling and sampling points tentatively chosen in Figure A6-3 will be adjusted. The intent is to have one sample in the deepest area, one in an area at or just outside the muck line, and 3 other samples at varied water depths.



Region 1

Fresh Pond, Shelter Island



Not For Use in Navigation

Fresh Pond

County: Suffolk

Town: Shelter Island

Surface Area: 14 Acres

Mean Depth: 19ft

Fish Species Present: Smallmouth Bass, Bluegill, Common Carp, Largemouth Bass

Scale: 0 200 ft



Figure A6-3. Fresh Pond sampling locations.

DELIVERABLES:

Tabular summaries of all data will be provided, along with maps of organic sediment distribution and final sampling points. Estimates of internal P load by multiple methods and a discussion of surficial sediment as a P source to support algae blooms will be provided.

TASK #3: In-Pond Phosphorus Levels

BACKGROUND:

Phosphorus has been measured in Fresh Pond on individual dates sporadically by the New York State Citizens Statewide Lake Assessment Program (CSLAP) program. Values have ranged from near the detection limit (and desirable value) of 10 µg/L to >500 µg/L (near the bottom in the deepest area). These data may be adequate to estimate accumulation of P in deep water from sediment release, but a more focused assessment is desired.

APPROACH:

Water samples will be collected at the deepest point in the pond (station 1 in Figure A6-3) from the upper 5 m, just below the thermocline when the lake is stratified (6-7 m), and close to the bottom (about 13 m) in spring and August or September to observe the change in P levels and any build-up in the bottom waters. Testing will include total P. This will facilitate two methods of internal loading calculation (hypolimnetic accumulation and hypolimnetic vs. epilimnetic concentration), as well as corroborating estimated release rates for P from sediment and allowing comparison of epilimnetic P mass with watershed inputs.

DELIVERABLES:

Tabular summary of P data.

TASK #4: Plankton Assessment

BACKGROUND:

The presence of excessive algae has been documented in recent years and blooms of cyanobacteria have been identified, sometimes to the genus level, with *Microcystis* most common among cyanobacteria. Microcystin, an associated toxin, have also been detected and represent a threat to human health. Verifying what algae are present at what concentrations is desirable during this study.

APPROACH:

Phytoplankton samples can be collected from the surface, especially in peripheral areas as observed, or as a composite of the epilimnetic water. Surface samples can be simple grab samples while epilimnetic composites can be collected by an alpha bottle or equivalent used to collect water at multiple depths for mixing and sampling. Samples are preserved with glutaraldehyde at about a 0.5% solution, settled, concentrated, and viewed under a microscope on a counting slide to determine what types of algae are present at what concentrations. Samples will be collected at station 1 in April or May and again in August or September by the project team. The Town will be provided with sampling kits to allow representatives of the local community to collect samples periodically if blooms develop any time in between our sampling.

Zooplankton are collected by towing a net through the epilimnion multiple times until >300 liters of water have been filtered. Samples are preserved with glutaraldehyde at about a 1% solution.

Samples will be collected at station 1 in April or May and again in August or September by the project team. One spring and one summer sample will be adequate to evaluate relevant aspects of the zooplankton community.

DELIVERABLES:

Tabular summary of phytoplankton and zooplankton composition and abundance, with narrative interpretation of results.

A.7. Necessary Equipment

Essential equipment is listed in Table A7-1.

Table A7-1. Field equipment required.

Instrument	Parameter / Use
Boat	Transport to sampling stations
Boat engine/gas or battery as warranted	Transport to sampling stations
Oars/paddles as appropriate	Back up for engine if needed
Depth sounder	Determining depth at sampling sites
Anchor with 100 feet of line, second anchor if appropriate	Maintain position on station
Wearable Personal Floatation Devices (Type III)	Required for Safety
Handheld GPS device	Locate field stations
Camera	Photographic documentation
Water proof field logbook with pencil	Recording data
Water proof indelible marker (with back up)	Marking water sample containers
Maps of pond with sampling stations and other key features	Orientation and field reference
Chain of Custody forms	Proper sample documentation for lab
Field WQ sonde with spare batteries and charger	Temperature/Dissolved Oxygen
Underwater video camera with cable and battery	Visual survey of sediment surface
Pail or other clean container of at least 2 gal volume	Mixing composite samples
Plankton net with at least 30 ft of line	Zooplankton sampling
Alpha bottle with at least 50 ft of line	Water sampling at depth
Required number and type of sample bottles, plus several spares, including modified caps and spare parts (for water and sediment), plus any associated preservatives	Water/sediment samples for lab analysis
Cooler with ice packs	Sample storage until lab delivery
Ekman dredge	Surficial sediment sampling
Deep plastic pan and plastic spoon	Sediment sample processing
Waterproof gloves and waders	Field protection/contamination control
Towel	Cleaning equipment and bottles

Personnel and equipment required for the laboratory analyses are not listed here but can be made available as needed. The sampling timeline is expected to proceed as follows:

TASK	MONTH						
	1	2	3	4	5	6	7
Task #1 Oxygen Profiles	X	X			X	X	
Task #2 Sediment Phosphorus	X	X	X				
Task 3. Water Column Phosphorus		X			X	X	
Task #4 Plankton	X	X	X	X	X	X	

The above schedule assumes an April 1 start date. Field work will occur April-September, 2021.

A.8. Quality Objectives and Criteria for Data Measurement

The measurement performance criteria to support the project objectives are described below and summarized in Table A8-1.

A.8.1. Accuracy

Accuracy is the degree of agreement between the observed value and an accepted reference or true value. Accuracy in the field is assessed through the adherence to all instrument calibration, sample handling, preservation, and holding time requirements. Additionally, accuracy can be assessed in the field through side by side measurements with properly calibrated instruments or comparison of field measures with available laboratory tests for the same variables (e.g., pH or turbidity). Laboratory accuracy is assessed through the analysis of matrix spikes and matrix spike duplicates (MS/MSDs) and laboratory control samples (LCSs), and the determination of percent recoveries. The goal for accuracy is for values to deviate from the true value by amounts that do not affect the conclusions drawn from the data; this will vary by analyte.

Accuracy may vary with the concentration of the analyte being measured, decreasing as the concentration rises. Accuracy may therefore be expressed as a percentage of the value or a range of percentages, with the percentage rising with analyte concentration. Except where values are less than five times the detection limit, the accuracy goal will be considered achieved when measured values are within 15% of the true value. For low values (within five times the detection limit) an error level of 25% will be acceptable. These levels of error for accuracy will not impact data interpretation as relates to management options.

A.8.2 Precision

Precision is a measure of the degree to which two or more measurements are in agreement, independent of how accurate the measurements are. Precision will be assessed through the measurement of duplicate samples (for example, laboratory duplicates and matrix spike/matrix spike duplicate [MS/MSD] samples) and will be measured through the calculation of relative percent difference (RPD). Precision may also vary with the concentration of the analyte, but variation tends to be greater as a RPD at lower values (the opposite of accuracy). The objectives for precision will be consistent with those of the analytical methodologies; higher RPD values may be acceptable for values near the detection limit, but RPD should not be so high as to impact the conclusions drawn from the data. Except where values are less than five times the detection limit, precision will be considered acceptable when values are within 25% of each other. For low values (within five times the detection limit) a difference of 35% will be acceptable. These levels of error for precision should not impact data interpretation as relates to management options.

Table A8-1. Key Limits for Data Collection

Parameter	Instrument or Method	Precision	Accuracy	Minimum Detection Limit	Resolution	Range of Interest	Changes of Interest
<i>Location</i>							
GPS	Garmin 76C/78S	20 seconds	5 meters	5 meters	5 meters	Not applicable	10 meters
Water Depth	Hondex digital depth sounder	0.1 meter	1% of value	0.6 meter	0.05 m	1 to 4 meters	0.3 meter
<i>Water Features</i>							
Oxygen	YSI ProSolo ODO/CT 626650 or Hydrolab	0.1 mg/L	0.1 mg/L	0.1 mg/L	0.01 mg/L	0 to 6 mg/L	1 mg/L
Temperature	YSI ProSolo ODO CT or Hydrolab	0.1 °C	+/- 0.2 °C	0.0 °C	0.1 °C	0 to 30 °C	3 C°
Conductivity	YSI ProSolo ODO CT or Hydrolab	5 uS/cm	5 uS/cm	5 uS/cm	5 uS/cm	50-300 uS/cm	10 uS/cm
Total phosphorus	SM 4500-PE	25%	15% of value	0.010 mg/L	0.002 mg/L	<0.01 to 0.50 mg/L	0.005 mg/L
<i>Surficial Sediment Features</i>							
Total phosphorus	6010C	25%	15% of value	5 mg/kg	2 mg/kg	100 to 1000 mg/kg	100 mg/kg
Fe-bound P	See SOP	25%	15% of value	10-50 mg/kg	5 mg/kg	<50 to 1000 mg/kg	50 mg/kg
Percent solids	SM2540G	25%	No std available	1%	1%	<10 to 50%	5%
Organic content	ASTM D2974	25%	No std available	1%	1%	<10 to 50%	5%

A.8.3. Detection Limit

Detection limit is defined as the lowest value measurable with an acceptable degree of reliability and is a function of instrument or chemical test features and limitations. Some adjustment may be possible to lower detection limits, such as concentration of a sample, but for the most part the detection limit is set by the manufacturer of the equipment being used. Equipment and test methods are therefore chosen to provide an acceptable detection limit.

A.8.4. Resolution

Resolution is the capability of a method or instrument to discriminate between measurement responses representing different levels of a variable of interest. Resolution is determined from the value of the standard deviation at the concentration level of interest. It represents the minimum difference in concentration that can be distinguished between two samples with a high degree of confidence. Resolution varies with instrument, test protocol and medium (water, soil, possible interfering compounds). The goal is to provide data with adequate resolution such that conditions that are acceptable or unacceptable can be readily distinguished with a high degree of reliability and the level of improvement available from any given management method can be clearly stated.

A.8.5. Bias

Bias is the systematic or persistent distortion of a measurement process that causes errors in one direction. Bias assessments for environmental measurements are made using personnel, equipment, and spiking materials or reference materials as independent as possible from those used in the calibration of the measurement system. When possible, bias assessments should be based on analysis of spiked samples rather than reference materials so that the effect of the matrix on recovery is incorporated into the assessment. A documented spiking protocol and consistency in following that protocol are important to obtaining meaningful data quality estimates. Spikes should be added at different concentration levels to cover the range of expected sample concentrations. For some measurement systems (e.g., continuous analyzers used to measure pollutants in ambient air), spiking samples may not be practical, so assessments should be made using appropriate blind reference materials. For certain multi-analyte methods, bias assessments may be complicated by interference among multiple analytes, which prevents all of the analytes from being spiked into a single sample. For such methods, lower spiking frequencies can be employed for analytes that are seldom or never found. The use of spiked surrogate compounds for multi-analyte gas chromatography/ mass spectrometry (GC/MS) procedures, while not ideal, may be the best available procedure for assessment of bias. The bias goal for all instruments and measurements for this project is that the magnitude of the bias be no greater than $\frac{1}{2}$ the magnitude of the accuracy standard for the instrument or measurement.

A.8.6. Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. "Normal conditions" are defined as the conditions expected if the sampling program was implemented as planned. Field completeness is a measure of the quantity of valid measurements obtained from all the measurements taken in the project. The field completeness objective is greater than 90 percent. Laboratory completeness is a measure of the quantity of valid measurements obtained from all the measurements taken in the project. The laboratory completeness objective is greater than 95 percent.

A.8.7. Representativeness

Representativeness expresses the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition within a defined spatial and/or temporal boundary. Representativeness is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the

QAPP is followed and that proper sampling techniques are used. Representativeness in the laboratory will be ensured by using the proper analytical procedures, appropriate methods, and meeting sample holding times as described in other sections of this document.

A.8.8. Comparability

Comparability expresses the confidence with which one data set can be compared to another. Comparability is dependent upon the proper design of the sampling program and will be maximized by ensuring that the QAPP is followed and that proper sampling techniques are used. Analytical data will be comparable when similar sampling and analytical methods are used and documented in the QAPP. Comparability is also dependent on similar QA objectives. It should be noted, however, that the use of existing data from other studies for some aspects of this project may limit comparability in a manner not controllable under data acquisition procedures set for this project.

Limits of measurements are largely governed by the specific equipment involved (Table A8-1). The most important feature is that the equipment provides data that allow differentiation of values of interest for management purposes. If the range of two pieces of equipment vary, or the detection limits are slightly different, or the accuracy is not identical, it only matters if the resulting data may present differences due to error that are larger than the differences considered relevant to management decisions. For example, if two oxygen meters have accuracies of 0.1 and 0.01 mg/L, but the change of interest is >0.1 mg/L, either is acceptable. A method for measuring phosphorus with a detection limit of 0.1 mg/L (typical of labs doing wastewater work) will be unsuitable for a project where differences of 0.01 mg/L are of interest.

A.9. Special Training Requirements / Certification

Sampling and analyses will be conducted in accordance with the QAPP. WRS and ARC staff are trained in the use of all listed equipment.

A.10. Documentation Records

Field measurements will be hand recorded in a waterproof field book. Each individual field operation will be documented with the following hand recorded information:

1. Heading – Fresh Pond, date, initials of all personnel present
2. Sampling event name (storm water quality, T/DO profile, sediment quality)
3. Weather conditions and flow conditions in tributaries
4. Station number
5. Documentation of equipment calibration prior to use.
6. Any quantitative measurements not electronically recorded elsewhere (e.g., T/DO if not stored in instrument's data bank)
7. Time of any sampling that generates samples for lab analysis
8. Identification of duplicate sample(s)
9. Identification of field blank(s)
10. Locations of any photographs
11. Notes on any station or equipment issues (e.g., site accessibility, equipment problems) with documentation of completeness and any appraisal of representativeness of sampling.

The field book pages for any daily activity are scanned upon return to the office and filed separately as an electronic back up to the field book record. If data are entered directly to a computer in the

field (as is the case for T/DO data collected with instruments equipped with handheld devices), resultant files are printed upon return to the office and stored as hard copies in a dedicated file.

WRS will perform an internal review of data for completeness and accuracy before forwarding any information to LAI. Hard copies of field record pages will be retained on file at the WRS office and be provided to LAI. A copy of each COC will be retained by WRS and provided to LAI.

The laboratories will send test results in hard copy or electronically to WRS as soon as tests are complete, QA/QC is completed, and reports are generated. Submittals will include all QA sample results including known standards and laboratory blanks. A cover letter from laboratory will be enclosed with data results if problems, unusual results, or actions were taken to confirm such values. Labs will retain unused samples at 4°C until WRS has approved the test results.

When WRS receives test results they will be reviewed for completeness and outliers. If missing or questionable results are encountered, the lab will be contacted to resolve any issues.

B. Measurement / Data Acquisition

B.1. Sampling Process Design and Intent

B.1.1. Specific Field and Laboratory Tasks

Task 1 Oxygen Profiles

Oxygen status will be assessed at the deepest location with an instrument that measures oxygen and temperature at 1 m intervals from surface to bottom, with the deepest measurements collected near the sediment-water interface. Assessment will occur in April and May, plus August or September, allowing both calculation of oxygen demand (which properly must occur in the spring before deep water values drop below 2 mg/L and the kinetics of oxygen uptake are altered) and estimation of the bottom area exposed to anoxia during the period of stratification. The areal and temporal extent of low oxygen will factor into calculation of P loading from surficial sediment.

Task 2 Surficial Sediment Sampling

Surficial sediment will be sampled at 5 locations in Fresh Pond, covering the area of organic sediment believed to be exposed to anoxia. Only one sampling is needed to characterize the sediment, and sampling can occur any time of year, but will be done in April or May in this case. Samples will be tested for TP, Fe-P, biogenic P, Al, Fe, Ca, % solids and % organic matter, allowing calculation of available Fe-P and its relation to TP and other key sediment features. Samples will be collected with an Ekman dredge or gravity corer and only the upper 10 cm of sediment will be sampled. The range of plausible mass release from sediment will be calculated based on the range of percent release known from other lakes and daily release rates expected as a function of measured Fe-P and area of sediment exposed to anoxia.

Task 3 In-lake Phosphorus Levels

Water samples will be collected at the deepest point in the lake from the upper 5 m, just below the thermocline when the lake is stratified (6-7 m), and close to the bottom (13 m) in April or May and August or September. Testing will include total P. This will facilitate two methods of internal loading calculation (hypolimnetic accumulation and hypolimnetic vs. epilimnetic concentration), as well as corroborating estimated release rates for P from sediment and allowing comparison of epilimnetic P mass with watershed inputs. Samples will be acid preserved in the field and delivered to a certified lab for analysis.

Task 4 Plankton Assessment

Phytoplankton samples will be collected as whole water samples at the deepest point in the lake from the upper 5 m in April or May and August or September. Additional, peripheral samples may be collected at any time through September by local representatives. Water samples will be collected in a 250 mL bottle and preserved with glutaraldehyde to a concentration of about 0.5%.

Zooplankton samples will be collected in April or May and August or September by towing a net through the epilimnion until at least 300 liters have been filtered. Samples will be placed in a 125 mL bottle and preserved with glutaraldehyde to a concentration of about 1.0%.

All samples will be analyzed by WRS in its lab using standard microscopic methods.

B.1.2. Data Use

Data for available P in surficial sediment will be used to estimate potential release from those sediments in conjunction with oxygen data. Where oxygen < 2 mg/L is encountered and iron-bound P is present, release through redox reactions is possible. Estimates can be derived as a range of literature rates for the area exposed to low oxygen for the duration of time that low oxygen is expected. Estimates can also be derived as a percentage of the iron-bound P in the sediment over the area associated with each measurement.

Overall data will be used in the context of nutrient budgets for total P, relating known in-lake concentrations to estimated loads through empirical models. The potential for watershed runoff, groundwater, atmospheric deposition and surficial sediment subject to low oxygen to provide enough P to result in observed concentrations will be examined.

B.2. Sampling Method Requirements

B.2.1. Procedures for making in-situ water quality measurements

1. Measurements will be carried out by LAI, WRS and ARC staff.
2. Start a page in the field book for the day's operation(s). Note date, pond, station, personnel present, weather conditions, and planned activities. Note any conditions that may have bearing on results (e.g., high winds, dense plants).
3. Measure total depth using a depth sounder, record measurement in field book. Be sure instrument is on a direct downward path, perpendicular to the plane of the pond surface.
4. Measure temperature and dissolved oxygen using a calibrated field meter. Check calibration of the instrument using the air calibration method and an expected saturation level of 100%. Adjust the instrument as necessary and record the process in the field book. Lower the probe into the water and record temperature and dissolved oxygen at each 1.0 m depth increment beginning at the surface and ending at the bottom. The two deepest measurements should be within 0.3 m of the bottom and in contact with the bottom sediments, respectively. Clean the probe as needed upon retrieval.

B.2.2. Procedures for collecting surficial sediment samples

1. Sampling will be conducted by ARC staff.
2. Start a page in the field book for the day's operation(s). Note date, pond, station, personnel present, weather conditions, and planned activities. Note any conditions that may have bearing on results (e.g., high winds, dense plants).
3. Label a 250 mL plastic jar with pond, station, date and time. Use waterproof marker on paper labels to mark jars.

4. Check water depth at site with depth sounder. Be sure instrument is on a direct downward path, perpendicular to the plane of the pond surface.
5. Load Ekman dredge spring mechanism; be careful to keep fingers and other body parts away from the jaws in case of premature closure.
6. Lower Ekman dredge gently until dredge encounters sediment, raise slightly (<1 foot), move several feet horizontally, and lower quickly to engage dredge with sediment.
7. Drop messenger to release spring and shut Ekman dredge, retrieve sampler slowly but steadily.
8. Lift the upper hinged lid of the sampler and inspect the contents. In a proper sample, much of the contents of the dredge will be soft sediment with a small amount of overlying water. If the jaws have not shut completely (gravel, mussels or dense plants may prevent complete closure), discard sample and repeat sampling at a location several feet from original site.
9. When a sample with the proper visual appearance has been obtained, pour off excess water slowly to minimize sediment loss while maximizing solids content.
10. Place Ekman dredge in a plastic pan, open top of Ekman dredge and use plastic spoon to collect upper 10 cm of sediment, filling the sample jar.
11. Cap sample, clean exterior, and store in a dark cooler on ice until delivered to the lab.
12. Repeat steps 3-11 at all designated locations.
13. A gravity corer may be used instead of the Ekman dredging, in which case the retrieved core is extruded to a depth of 10 cm, mixed in a shallow pan, and the 250 mL plastic jar is filled from that mixed core section.

B.2.3. Procedures for collecting in-lake water samples

1. Sample collection will be conducted by WRS or ARC staff.
2. Start a page in the field book for the day's operation(s). Note date, pond, station personnel present, weather conditions, and planned activities. Note any conditions that may have bearing on results (e.g., high winds, dense plants).
3. Verify sample location using depth sounder. Record measurement in field book. Be sure instrument is on a direct downward path, perpendicular to the plane of the pond surface.
4. Label all laboratory water sample bottles with appropriate station location, date and time using a waterproof marker.
5. Triple rinse the Van Dorn/Alpha sampler with lake water at the depth at which the sample is to be collected.
6. Collect grab samples over the upper 5 m of the water column and mix in a container.
7. Determine the thermocline depth sampling location by using temperature measurements at the point of greatest temperature difference. This typically occurs at 6 m in Fresh Pond, but check it before any sampling. If the water column is not thermally stratified, a mid-depth sample may be collected if deemed appropriate.
8. Collect the hypolimnion sample just above the sediment water interface (13 m), taking care not to disturb the bottom sediments.
9. When setting the Van Dorn/Alpha spring mechanism, be careful to keep fingers and other body parts away from the tube openings in case of premature closure and to avoid contamination.
10. Lower Van Dorn/Alpha sampler gently using calibrated rope to ensure sample is taken at the correct depth; move sampler from side to side to ensure water exchange.
11. Drop messenger to release spring and shut the sampler, capturing water at the correct water depth, then retrieve sampler slowly but steadily.
12. Holding the sampler, open spouts and pour sample into a correctly labeled bottle or into the mixing container.
13. Cap all samples and store in a cooler on ice until delivered to the lab.
14. Repeat steps 3-13 at all designated locations.

B.2.6. Procedures for collecting plankton samples

1. Phytoplankton from station 1 can come from the epilimnetic sample collected for total P, or from a separate sample collected the same way.
2. Phytoplankton from peripheral areas where there is concern over a possible bloom would be collected in the sample bottles supplied.
3. All 250 mL phytoplankton bottles come with a small vial of preservative that is opened, put back into the bottle once the sample has been collected, and the bottle is capped and shaken. All label information should be filled in.
4. Zooplankton are collected by dropping the zooplankton net to the thermocline (about 6 m down) and towing it to the surface. The contents are emptied into a clean container and the tow is repeated until at least 300 liters have been filtered. For the nets involved, a 30 m tow length = 380 liters, so 5 tows would be made. The total sample is run back through the net at the end to concentrate it and the concentrate is placed in a 125 mL bottle with preservative to a concentration of about 1%.
5. Samples do not require refrigeration. They are to be delivered to WRS at the earliest convenience but require no special shipping or transfer speed.

B.2.7. Corrective Actions for Failures/Deviations in Sampling Methods

Examples of failures in sampling methods and/or deviations from sample design requirements tend to relate to sample container problems, equipment problems, and sample site considerations. It should be recognized that field operations do not always go as planned and all possible situations cannot be anticipated. Resourcefulness and improvisation in the field is acceptable and even desirable in the conduct of sampling operations but cannot be allowed to compromise the generated data. Failures or deviations from the QAPP are documented on the field logbook and reported to the Project Manager. The Project Manager will determine if the deviation from the QAPP compromises the validity of the resulting data. The Project Manager, in consultation with the QA Manager, will decide to accept or reject data associated with the sampling event, based on best professional judgment. Corrective action documentation will be maintained by WRS.

B.3. Sample Handling and Custody Requirements

B.3.1. Field record management

The field logbook will be the primary document for recording the field in-situ data. Field logbooks will provide the means of recording the data collecting activities performed during the investigation. As such, entries will be described in as much detail as possible so that persons going to the site could reconstruct a particular situation without reliance on memory. Field logbooks will be bound field survey books or notebooks.

The title page of each logbook will contain the following:

- The logbook number
- Organization name and address
- Contact telephone numbers and email addresses
- Logbook start date
- Logbook end date (when full)

Entries into the logbook will contain a variety of information. For each field event the following will be recorded:

- Date

- Start time
- The purpose of the field operation
- Names of all sampling team members present
- Initials of the person making the entries
- Weather conditions
- Measurements made: all values must be clearly associated with a station, depth and medium (water or sediment). Time of measurement will be recorded. If data are electronically logged, the field logbook should note this, but values do not have to be transcribed manually. Unusual readings should be noted, however. Calibration of all measurement instruments is to be documented.
- Samples collected: all samples must be clearly associated with a station, depth and medium (water or sediment). Sampling time will be recorded. The equipment used to collect samples will be noted, along with sample volume and number of containers.
- Any other noteworthy observations.

If an incorrect entry is made, the information will be crossed out with a single strike mark, which is initialed and dated by the sampler. Photographs taken of the sampling location or any activity will be noted, using one column for photo # and another for photo content. Documentation that all equipment used to collect samples or other physical data are suitable for that purpose and in good working order will be recorded.

All field information will be scanned and a PDF electronic file and hard copy will be generated of all relevant pages after completion of a field operation. The PDF electronic file and hard copy will be stored at the WRS office.

B.3.2. Sample transport and delivery

The water or sediment samples collected during the field program will be packed in ice and delivered to the appropriate laboratories. Samples are relinquished by signature on a chain of custody (COC) form. Each water or sediment quality sample will be identified by a date, pond and station where the sample was collected. The COC will have the name of the collector and the time the sample was collected. Staff delivering samples will sign off on the COC and retain a copy of the COC once signed by the lab representative.

B.3.3. Laboratory Custody Procedures

On arrival at the laboratory, all samples will be inspected thoroughly to confirm that the integrity of the samples and containers has not been compromised. The individual sample containers will be inspected to verify that each has a sample label. The condition of the samples, including thermal preservation, will be noted on the COC. Sample containers will be checked against the accompanying COC. If discrepancies are noted, they will be communicated to the Project Manager and QA Manager for resolution. Following sample log in, samples will be placed in a secure area until taken for analysis. Following analysis, samples will be retained until released by the Project Manager following data review and acceptance; this is expected to occur within 5 days of data report receipt by the project manager and allows for re-testing of samples if necessary.

B.3.4. Corrective Action for Failures in Sample Handling and Chain-of-Custody

All failures associated with chain-of-custody procedures are immediately reported to the Project Manager. These include delays in transfer that result in holding time violations, violations of sample preservation requirements, incomplete documentation, and broken or spilled samples. The Project Manager, in consultation with the QA Manager, will determine if the procedural violation may have compromised the validity of the resulting data. The Project Manager will decide how the issue will be resolved based on best professional judgment and will inform the staff. Possible courses of action

include document and proceed, redo the entire sampling event, or selectively analyze the samples. Corrective action documentation is maintained by WRS.

B.4. Analytical Methods Requirements

Field water quality measures will be from a field instrument operated by a trained employee of WRS. In-lake water samples will be tested by Microbac Laboratories. Sediment samples will be tested by IEH Laboratories. All other field data analyses will be conducted by LAI, WRS, or ARC personnel. Analyses and related limits and other metrics are given in Table A8-1 and described in the standard operating procedures attached to this QAPP as appendices.

B.5. Quality Control Requirements

Once each sampling event a blind duplicate will be collected at a random chosen but normally sampled location and included with the other samples delivered to the laboratory. The duplicate sample will be identified as with other samples, but not as a duplicate; a dummy station designation can be used. One field blank will also be delivered to the laboratory during each water sampling event, comprised of distilled water placed in the same type of container(s) used for other samples being delivered. For each round of samples, labs will run at least one known sample of EPA or similar professional grade quality control standard, one split sample as a duplicate and one spiked sample. Based on expected sampling schedule, QA/QC samples will represent $\geq 10\%$ of all samples collected. Accuracy and precision can be assessed from any set of properly collected and processed samples.

B.6. Instrument / Equipment Testing, Inspection and Maintenance Requirements

All equipment required for the field sampling program will be inspected and maintained by the field staff prior to each sampling trip. If any of the equipment is found defective, it will be replaced with similar equipment from the inventory or new equipment as warranted. The maintenance of all field sampling equipment will be conducted in accordance with the manufacturer's specifications. Equipment used during each field event will be listed in the field book and any changes made to field equipment will be recorded. Most equipment is used on multiple projects, is regularly maintained, and back up options are available.

B.7. Instrument Calibration and Frequency

Field instrument calibration will be conducted by appointed employees of WRS, with aid from ARC personnel if present, and will be according to manufacture specifications and/or nationally recognized performance standards. Table B7-1 contains a summary of equipment calibration methods and frequency. All calibration data will be recorded in the field book, including who is doing the calibrating, the starting temperature and % saturation for oxygen, the initial conductivity reading, what adjustments are made, and the resulting values.

Table B7-1. Summary of field equipment calibration methods and frequency.

Instrument	Parameter	Calibration Method	Frequency
YSI ProSolo ODO / CT or Hydrolab	Temperature	Manufacture calibration	Biannual
YSI ProSolo ODO / CT oor Hydrolab	Oxygen	Saturated air method	Weekly

Instrumentation will be calibrated prior to each sampling event. Calibration will be done according to instrumentation guidance manual methods.

Laboratory instruments are calibrated and maintained regularly as part of the business operations of each laboratory. See individual SOPs for tests to be run for each lab in Appendices A and B for additional details.

B.8. Inspection / Acceptance Requirements for Supplies and Consumables

All supplies, bottles, and equipment are inspected for suitability for the intended purpose and are not used if unsuitable. Any anomalies will be recorded in the field book.

B.9. Data Acquisition Requirements (Non – Direct Measurements)

We have already acquired most historic data for the pond but will seek out any additional data of which we become aware and subject it to review.

B.10. Data Management

WRS will be responsible for the collection and validation of all field data and related documentation. Pages from the field book will be copied electronically and filed. Data are entered into Excel spreadsheets upon receipt of completed analyses from the laboratories. Laboratories will provide data from the analysis of the water and sediment samples to WRS on standard laboratory report forms. All laboratory data will be entered in Excel spreadsheets by WRS if not provided as spreadsheets by the laboratories, and these data will be integrated with the field data. The appropriate transfer of the data is also checked to verify accuracy by matching data between field and electronic entries. Replicate and blank analyses will be extracted from the data sets and analyzed for patterns or potential problems, which will be followed up on as warranted.

Laboratory data will be assessed within 5 days of receipt for quality and the appropriate laboratory will be contacted with any questions or issues. The laboratories will maintain samples until released by the Project Manager, allowing re-testing as warranted.

The complete electronic data set will be backed up on dedicated external hard drives or flash drives stored on site at the WRS office.

C. Assessment / Oversight

C.1. Assessment and Response Actions

Dr. Ken Wagner of WRS, as project QA Manager, will be responsible for maintaining quality control and appropriate sampling and sample handling techniques for this project. Each laboratory maintains internal quality control. Field personnel are properly trained in advance of any operation and will follow established field protocols unless there is a good reason to deviate.

C.1.1. Data Quality Assessment

The purpose of this section is to indicate the methods by which it will be determined that the data collected for this investigation adhere with the DQOs established for the project. Analytical data quality will be assessed by the QA Manager assisted by the Project Manager. Data will be assessed for conformity with the accuracy, precision and completeness data quality objectives as described below. In addition, the data will be reviewed for indications of interference to results caused by sample matrices, cross contamination during sampling, cross contamination in the laboratory, and sample preservation and storage anomalies (e.g., sample holding time or analytical instrument problems). Successful meter calibration will be taken as an indication that field measures are valid. Other data quality review pertains mainly to laboratory analyses as discussed below.

C.1.2. Accuracy Assessment

Accuracy of laboratory analysis will be assessed for compliance with the criteria established in Table A8-1 using the analytical results of method blanks, MS/MSD samples, and LCSs. The percent recovery (%R) for MS/MSD samples will be determined according to the following equation:

$$\%R = \frac{(\text{Amount in Spiked Sample} - \text{Amount in Sample})}{\text{Known Amount Added}} \times 100$$

%R for LCSs will be determined according to the following equation:

$$\%R = \frac{\text{Experimental Concentration}}{\text{Known Amount Added}} \times 100$$

C.1.3. Precision Assessment

The relative percent difference (RPD) between the matrix spike and matrix spike duplicate, or sample and sample duplicate in the case of metals, and field duplicate pair is calculated to compare to the criteria in Table A7-1 of this QAPP. The RPD will be calculated according to the following formula.

$$RPD = \frac{(\text{Amount in Sample 1} - \text{Amount in Sample 2})}{0.5 (\text{Amount in Sample 1} + \text{Amount in Sample 2})} \times 100$$

C.1.4. Completeness Assessment

Completeness is the ratio of the number of valid sample results to the total number of samples analyzed with a specific matrix and/or analysis. Following completion of the analytical testing, the percent completeness will be calculated by the following equation:

$$\text{Completeness} = \frac{(\text{number of valid measurements})}{(\text{number of measurements planned})} \times 100$$

C.1.5. Corrective Action

Corrective action is the process of identifying, recommending, approving, and implementing measures to counter unacceptable procedures or out-of-limit QC performance that can affect data quality. Corrective action can occur during data collection, data compilation, data review, data validation, and data assessment. Any nonconformance with the established QC procedures in the QAPP will be identified and corrected in accordance with the QAPP. Corrective actions proposed and implemented will be documented in the QA sections of project deliverables. The following procedures should be followed when problems are identified, and corrective actions are taken:

- The person who identifies the problem is responsible for notifying the Project Manager.
- The Project Manager should implement corrective action after evaluation, if warranted.
- For noncompliance problems, a formal corrective action program will be determined and implemented at the time the problem is identified.
- The Project Manager will issue a nonconformance/corrective action memorandum to the file for each nonconforming condition. Quality assurance activities and corrective actions will be summarized in the study report.

C.2. Reports to Management

Laboratory data quality reviews will be performed whenever data is provided to WRS. A summary of the data quality will be distributed among project officers. Problems will be identified, and solutions implemented as needed. Laboratories will retain samples until released by the Project Manager, allowing re-testing if necessary.

D. Data Validation and Usability

D.1 Data Review, Validation and Verification Requirements

This section describes the QA activities that occur after the data collection phase of the project is completed. These activities ensure that the individual data elements conform to the specified criteria, thus enabling reconciliation with the project objectives.

For the purposes of this document, the term verification refers to the processes taken to determine compliance of data with project requirements, including documentation and technical criteria. The term validation refers to those processes taken independently of the data-generation processes to determine the usability of data for intended use(s). Data classes resulting from this review include:

- **Accepted Data:** Data which are accepted for use are those data which on completion of data validation have been developed in a manner consistent with this QAPP.
- **Rejected Data:** Data which are rejected are those data which on completion of data validation, or by reason of other assessment step described herein, are deemed unacceptable for use because of non-conformity with the requirements of this QAPP of a magnitude or severity which renders data of questionable quality.
- **Qualified Data:** Data which are qualified are those data which on completion of data validation or other assessment steps are found to be in non-conformance, but where the magnitude or severity of such non-conformities is limited or, based on best professional judgment, is deemed unlikely to adversely affect data quality. Also included in this category

are data that on initial review or assessment are found to be non-conforming, but for which corrective actions were taken to render data acceptable for use. All qualified data will include an annotation regarding the cause of qualification.

D.2 Validation and Verification Methods

Data verification will be performed for both field and laboratory data (Figure D2.1). Field personnel initiate the verification process at the end of each sampling event, making sure that all QAPP guidance has been followed and that any deviations are both warranted and clearly documented. Verification later consists of determining that all documentation is in order and that the proper steps were indeed taken in data generation, both in the field and at the lab.

The procedures used to evaluate field data will include checking procedures utilized in the field, ensuring that field measurement equipment was properly calibrated, checking for transcription errors, and comparing the data to historic data or verifying its “reasonableness”. The overall completeness

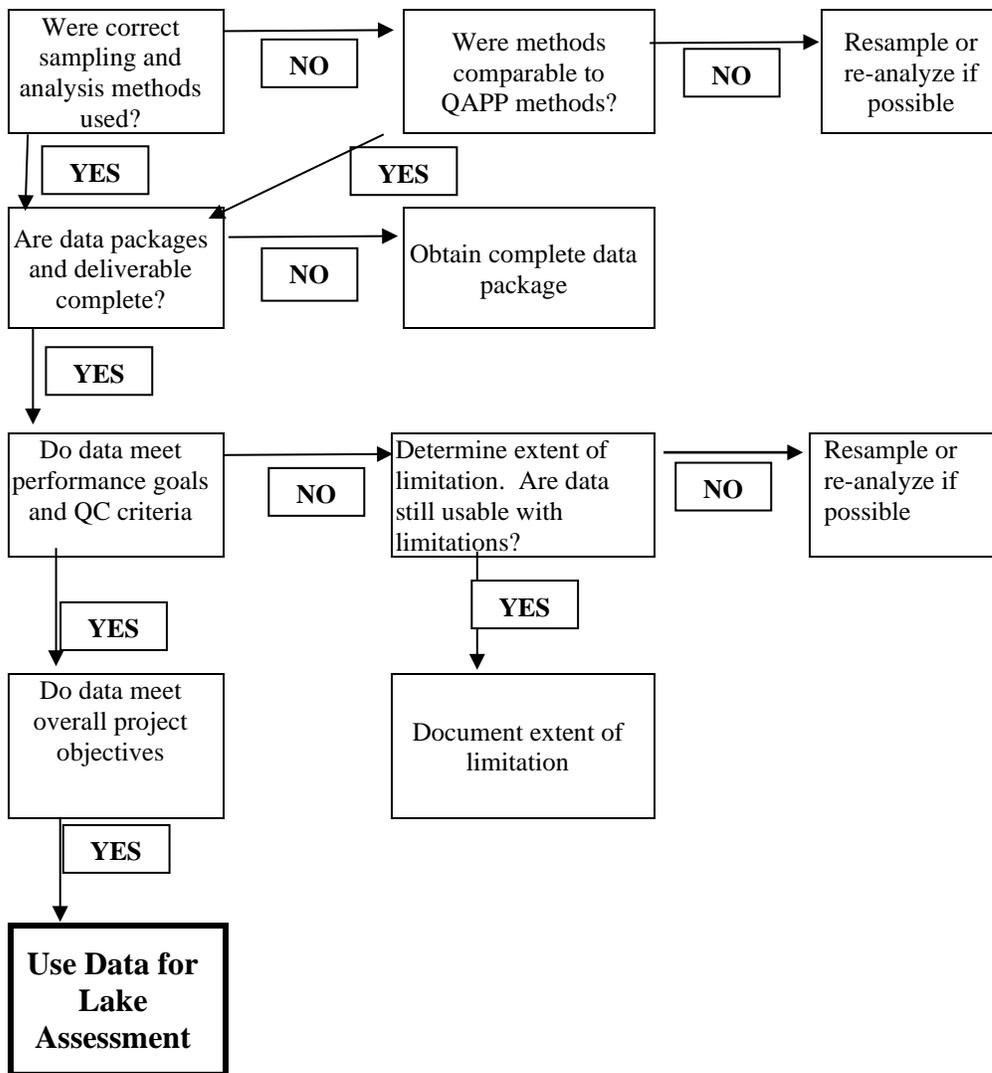


Figure D2-1. Preliminary Decision Tree for Data Review

of the data package will be evaluated. Completeness checks will be administered on all data to determine whether all data necessary to calculations and assessments are present. In addition, holding times and the results of blanks, MS/MSDs, LCSs, and duplicate analyses will be reviewed and evaluated. Evaluation of the field data will be the responsibility of the Project Manager.

The Data Quality Assessment (DQA) process will be used to assess the scientific utility of data collected for a specific purpose, validating the data. In the DQA Process, the data will be analyzed scientifically to inspect for technical anomalies and to judge that the context of the data is correct. The outcome of the DQA process will indicate whether a decision can be made using the existing data, additional data must be collected, or decisions can be made with data limitations noted and accounted for in the decision-making process. The Project Manager will be responsible for data validation as well.

D.3. Reconciliation with User Requirements

Data generated by this project will be used to:

1. Assess the extent and duration of low oxygen conditions in the lake.
2. Evaluate in-lake phosphorus concentrations in the epilimnion, hypolimnion and the thermocline during stratification.
3. Evaluate Pre-, first flush and post-storm water samples for 3 storms in relation to its contribution of total phosphorus (P) from the watershed.
4. Evaluate the quality of surficial pond sediments and their potential to contribute to the phosphorus load in the lake.
5. Determine target P loading to meet water quality objectives.
6. Prepare a comprehensive report of the results and management implications of the above tasks.

The project plan calls for generation of data that can be used for each of these purposes. If data are collected in conformance with this QAPP, each of the above tasks can be accomplished.