Santuit Pond Aeration Systems

Ashley Fisher – Mashpee Director of Natural Resources

Santuit Pond

- 176 acre shallow kettle hole pond (Maximum depth of 11 feet)
- Outlets to the Santuit River on the Southern end of the pond, which ultimately feeds into Popponesset Bay
- Groundwater fed pond with an average flushing rate of approximately 3 times per year or a residence time of 0.33 years or 120 days.
- Public boat launch provides boating access to fisherman or recreational canoeing, kayaking, or paddle boarding.
- Substantial residential development around the western and eastern shores. Each single family home is currently entirely reliant on standard title 5 septic systems.
- Past agricultural uses abutting the pond on the northern and southern shores (Cranberry Bogs, Broom Factory).
- Santuit Pond Preserve – Conservation lands on the eastern shores offers walking trails, scenic vistas, and interactive educational kiosks.
- Traditional winter camp utilized by the Mashpee Wampanoag for hunting and fishing etc.

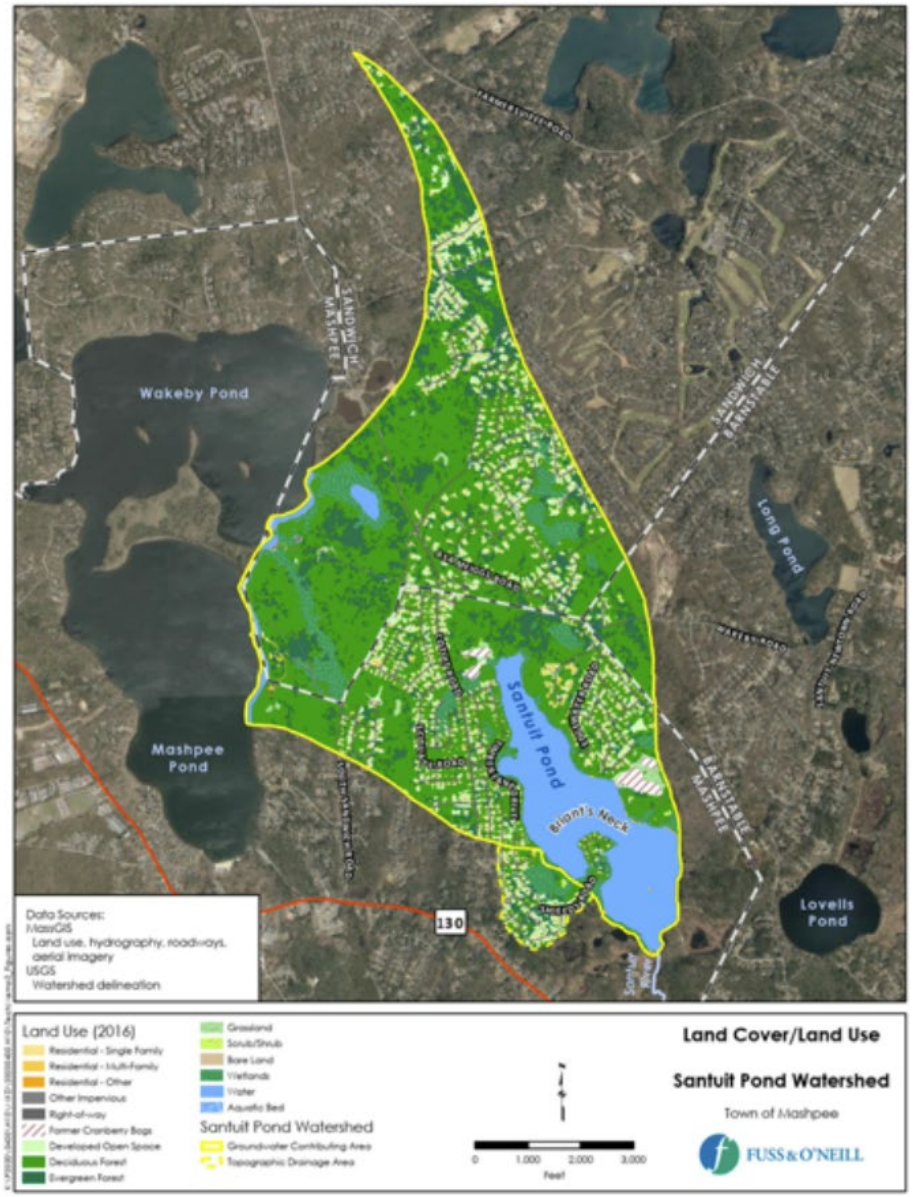


Figure A-3: Watershed Land Use Map (Town of Mashpee (2022), MassGIS 2016).

Santuit Pond Impairment

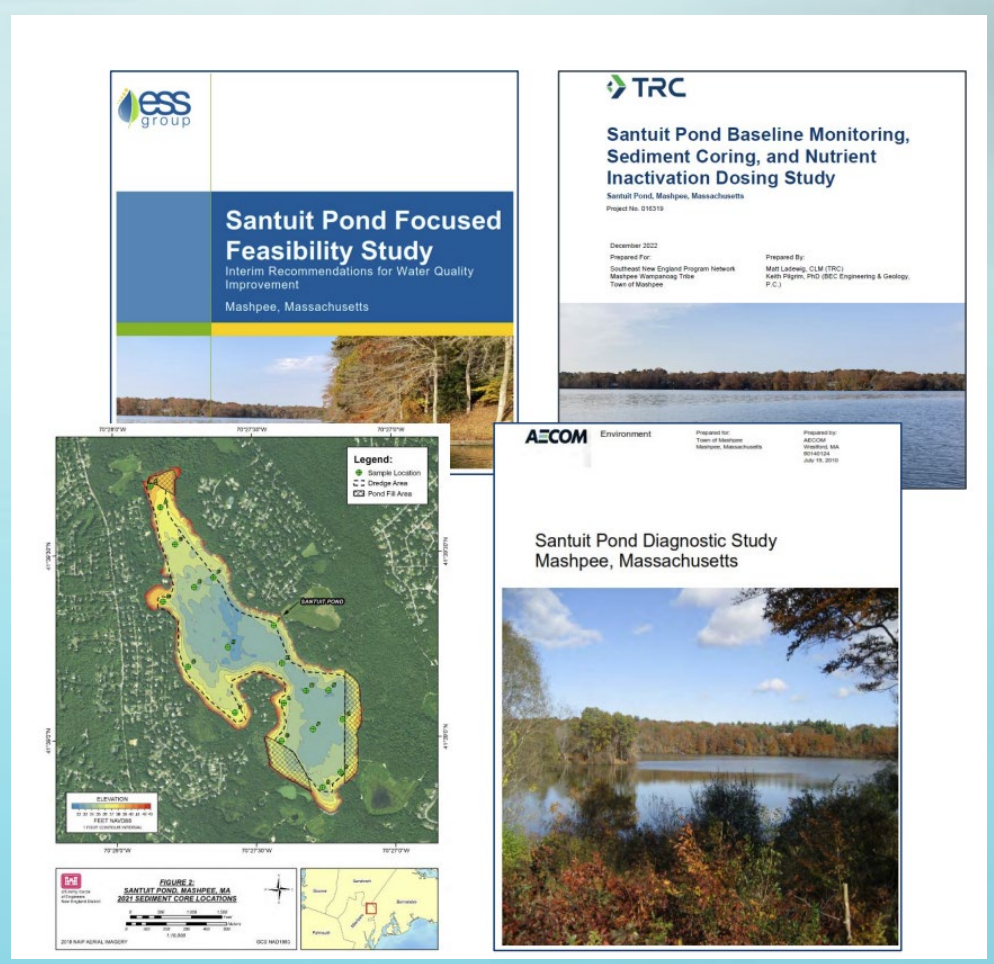
- Listed on the “Massachusetts List of Impaired water bodies” for nutrients and noxious aquatic plants (Cat.5).
- Low water transparency (high Turbidity), frequent and dense cyanobacteria or blue green algal blooms, periodic anoxic or loss of oxygen events resulting in fish kills, high pH, high total phosphorous, high chlorophyll a concentrations, dense emergent pond weeds, and invasive species (variable leaf milfoil and fanwort).
- Mashpee BOH cyanobacteria advisories posted in 2006, 2008, 2010, 2012, 2014, 2016, 2017,2018, 2019, 2020, 2021, 2022, and 2023.
- Cyanobacteria cell counts exceeding 450,000 cells/ ml in some years post Solar Bee deployment.

Photo taken by Ed Baker in 2010

Photo taken by Ashley Fisher 2017

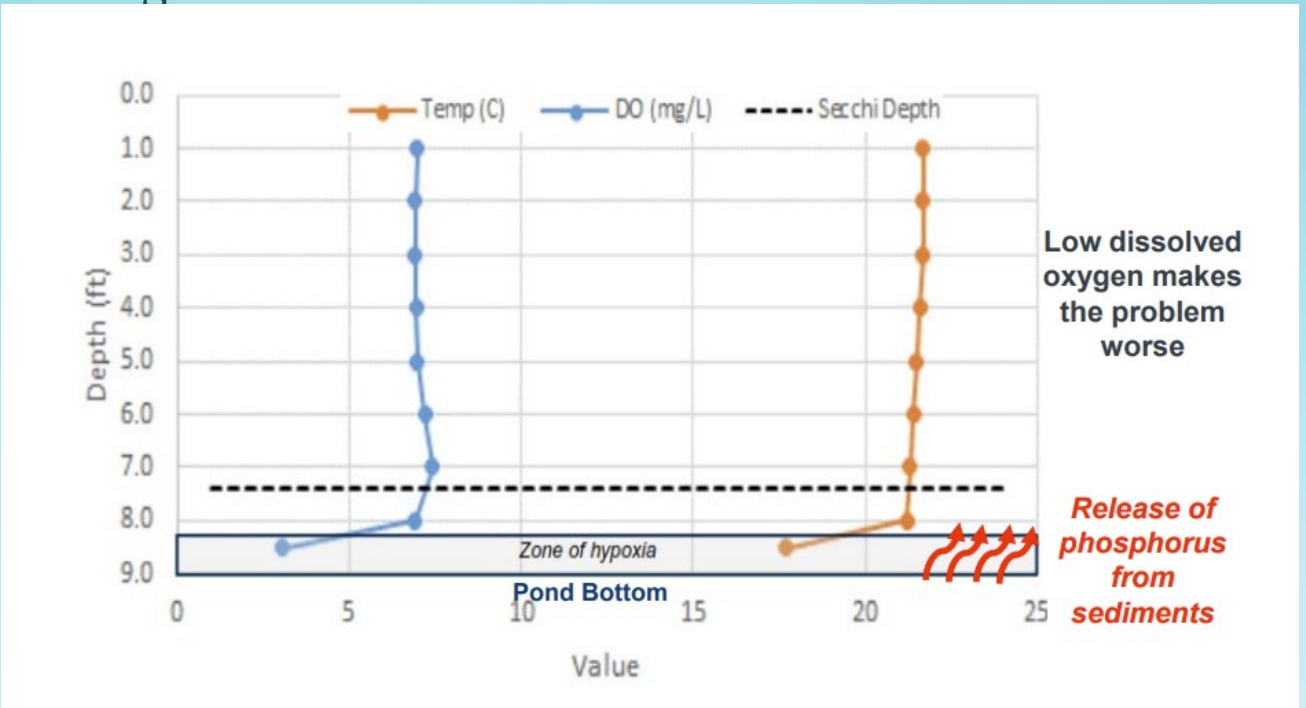
Town Action

- Multiple studies of Santuit Pond to diagnose these issues and assess feasibility of solutions.
  - 2010 AECOM Diagnostic Study
  - 2021 USACE Sediment Sampling and Testing (Dredging Feasibility Study)
  - 2022 ESS Focused Feasibility Study
  - 2022 TRC Sediment Coring and Nutrient Inactivation Dosing Study
  - Data collection and sampling by The Town and Tribe's Natural Resources Departments (2001-present)



Key Takeaways From These Studies

- Santuit Pond is highly nutrient- enriched, especially in regards to phosphorous.
- Sediments are phosphorous-rich and responsible for a large portion of the problem via “internal loading” >70%
- Low dissolved oxygen near the bottom of the pond is causing phosphorous release into the water column further exacerbating blue-green algae blooms.



Town Action – 2012 AECOM Diagnostic Study and SolarBee Purchase

Problems found:

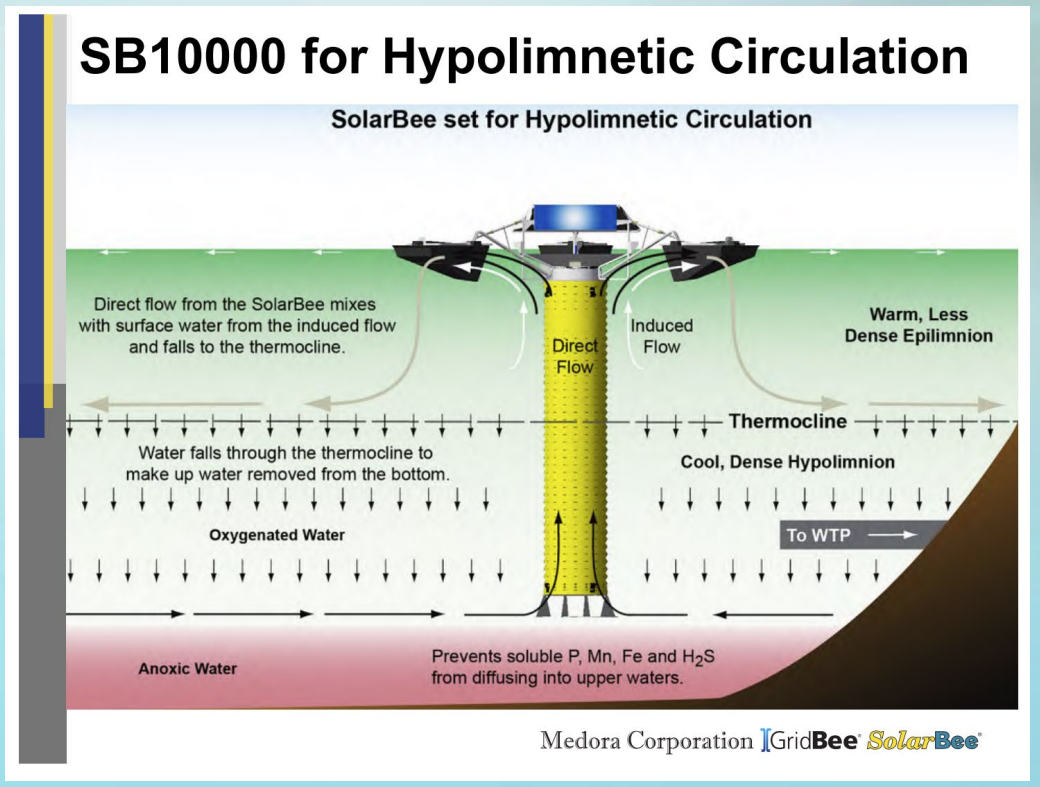
- Total phosphorous concentrations estimated to be 80 µg/L on average
- Some locations (deep spot off Bryant's Neck) ranged from 40 -140 µg/L
- Cape Cod Commission recommends regional phosphorous criterion of 10 µg/L
- Internal TP loading found to be 78% (oxygen depletion in bottom waters allowing phosphorous-rich soft sediments to release available phosphorous)

Recommended Remedial Management Strategies (External and Internal) :

- Watershed Management- stromwater, fertilizer, and vegetated buffers
- Septic System Maintenance and Upgrades – Town wide sewering
- Cranberry Bog Management
- Waterfowl Control
- Dredging
- Phosphorous Inactivation – Alum Treatment
- Artificial Circulation – Example : SolarBees introducing oxygen into bottom waters to limit phosphorous release.

Artificial Circulation – SolarBees

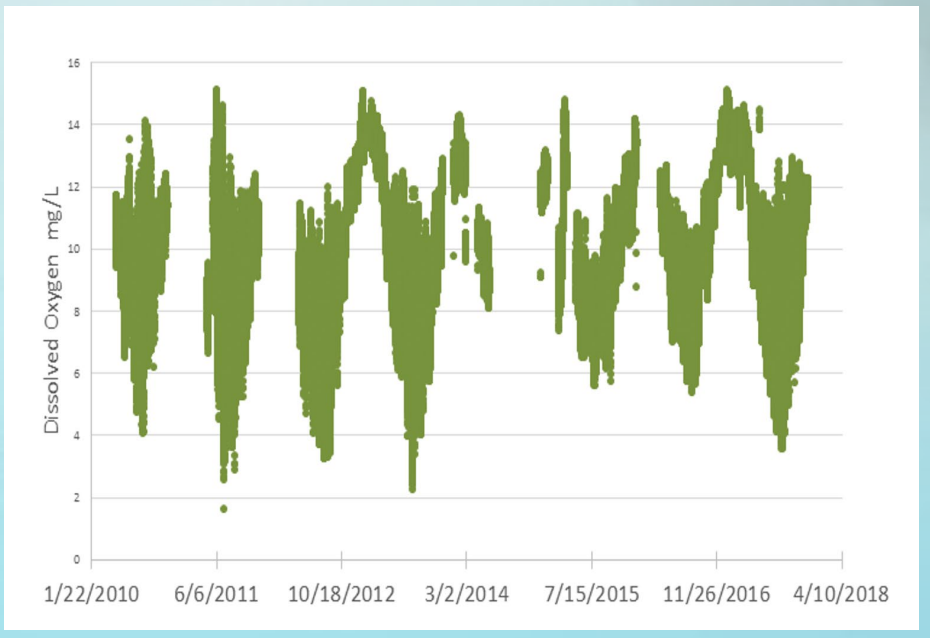
- Received Community Preservation Act (CPA) funding for the purchase of 6 SolarBee artificial circulators in 2011 - $300,000
- Permitted by Mashpee Conservation Commission through a Request for Determination of Applicability
- One Bee can theoretically treat an area up to 30 acres in size.
- Bees are reliant on solar panels and battery banks for power.
- Semiannual maintenance costs by "BeeKeepers" : $19,000 / year



*** Note – Santuit is a shallow pond without any data tracking the presence of a significant thermocline. Temp is consistent throughout 90% of the year.

Artificial Circulators – Results 10 years post deployment

- Some improvements noted, but cannot say that the improvements are related to the SolarBee deployment.
- Even though 2014-2017 showed some initial improvements, 2017- present conditions fell back to pre-deployment levels (cyanobacteria cell counts, low DO, high turbidity etc.)
- In 2017 the company installed a 7th SolarBee on Santuit due to continued cyanobacteria occurrences.
- No improvements were noted post deployment of the 7th SolarBee.
- In 2020 7th SolarBee was removed and the pond remains under advisory year after year.

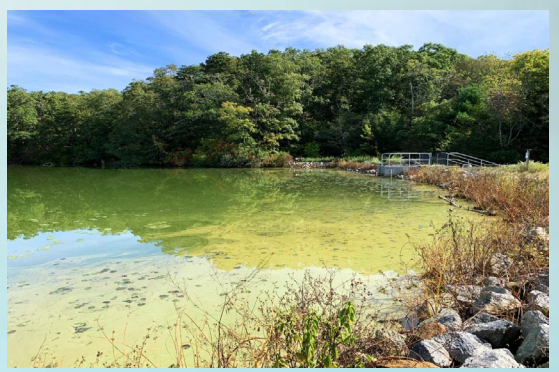


SolarBees are still deployed because they "may" still be adding some oxygen to bottom waters species within the pond.

Santuit Pond 2019, 2020, 2022, 2023 – SolarBees Still Deployed

2019

2020



2021

2022

Cyanobacteria Advisory Returns To Santuit Pond For Fourth Consecutive Summer

The Enterprise
MASHPEE

A Toxic Stew on Cape Cod: Human Waste and Warming Water

The New York Times

2023

Case Study – SolarBees St. Albans Bay VT

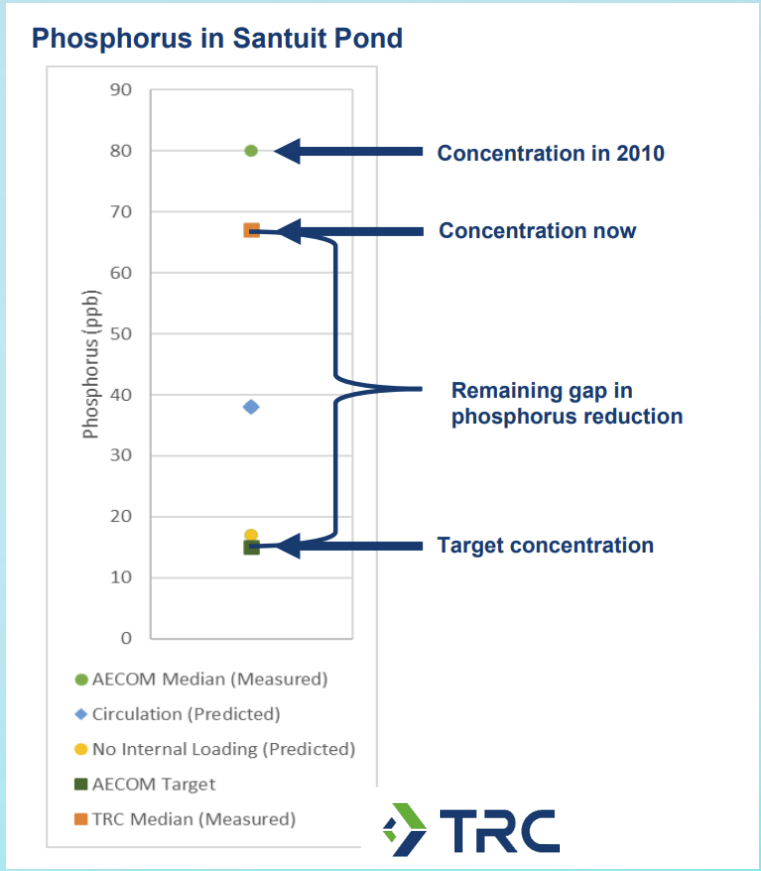
St. Albans Bay in Lake Champlain (Vermont) The monitoring program used a spatial control design in which water quality conditions within the presumed 35- acre treatment zone around each SolarBee unit were compared with conditions at greater distances from the devices. Mapping of the spatial distribution of chlorophyll-a and Secchi disk transparency data showed no consistent relationship with the treatment zones around the three SolarBee units, and no evidence of generally depressed algal growth or clear water within the treatment zones. A statistical analysis of the spatial data found that there were no significant reductions in mean chlorophyll-a concentrations or increases in Secchi disk transparency within the treatment zones when compared with levels immediately outside the treatment zones. The SolarBees did not produce a more uniform vertical distribution of chlorophyll-a in the water column than what was seen outside the treatment zones. The devices had no discernable effect in reducing the relative dominance of cyanobacteria within the phytoplankton community inside the treatment zones, based on microscopic examination of water samples. In conclusion, there was no evidence that the SolarBees in St. Albans Bay reduced algal concentrations, improved water clarity, or inhibited blue-green algae in the bay. The treatment goal of producing an approximately 100-acre zone of clear, low-algae water at the northern end of St. Albans Bay was not achieved by the SolarBee deployment.

Town Action – Reassess Previous Recommendations from AECOM Study for Internal Loading Issues

- Dredging – Army Corps of Engineers Dredging Feasibility Study 2020 – 2023
- Nutrient Inactivation Treatment – SNEP Network / TRC Group Aluminum Sulfate Feasibility and Dosing Study

Of the in-pond management options available, only a few have a real possibility to achieve reductions at the **pond-wide scale** needed

- Algaecides:
  - Pro: Works fast to control developing blooms
  - Con: Does not address the underlying cause or prevent future blooms
- Nutrient Inactivation:
  - Pro: Works fast to address underlying cause and prevent future blooms
  - Con: Requires substantial site-specific testing to design
- Aeration / Circulation:
  - Pro: Improves dissolved oxygen while providing potential reduction in blooms
  - Con: Rarely achieves consistent pond-wide improvement, esp. unpowered units
- Dredging:
  - Pro: Increases water depth while directly removing accumulated sediments
  - Con: Requires disposal location – a big issue where sediments are contaminated



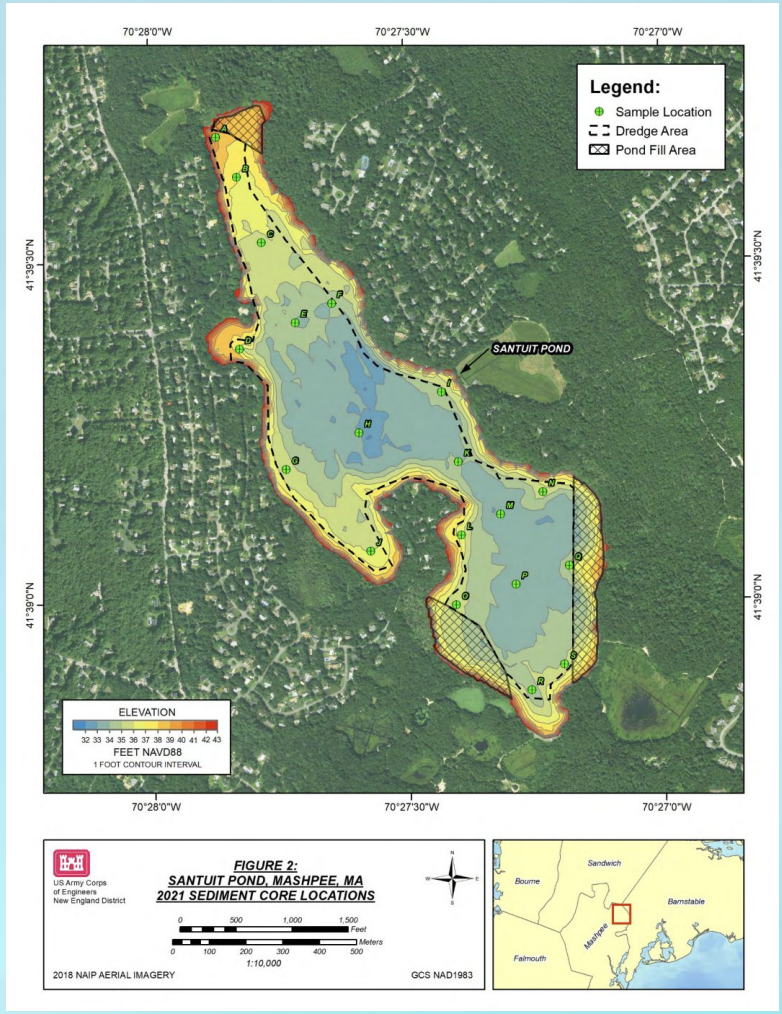
Dredging Feasibility Study – Army Corps of Engineers :

- Project funded by Federal Clean Water Act – Section 319 : $1.5 million between the government (USACE) and no-federal sponsors (Mashpee Wampanoag Tribe and the Town of Mashpee)

- Results:
  - USACE found high levels of arsenic in sediment samples preventing sediment reuse certifications
  - Dredge spoils would require impoundments of sections of the pond to the South near fish ladder and to the North near abandoned cranberry bog (bog still holds a water use permit) due to sheer volume and reuse restrictions.
  - Herring breading grounds would be altered and action was not favored by the Town / Tribe working group.

Recommendations :

- Project is not feasible and would cost upwards of 20 million per USACE



TRC Recommendations :

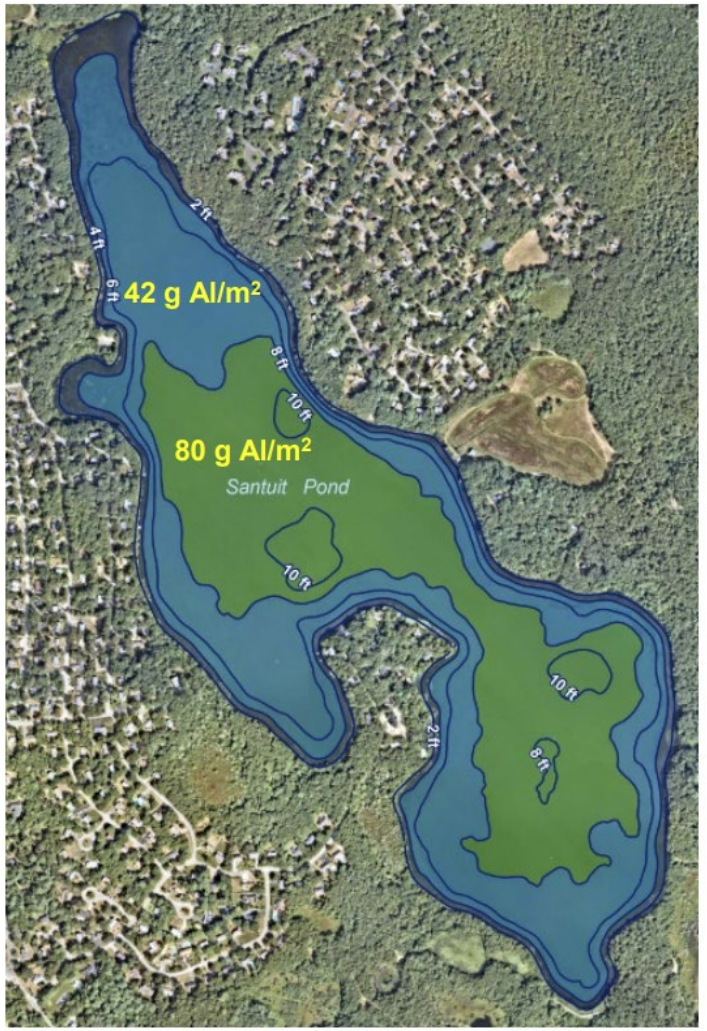
Recommended Solutions

- Nutrient Inactivation:

Factors that Favor Sediment-Targeted Nutrient Inactivation

- ☑ Excessive phosphorus is driving recurring algae blooms
- ☑ A substantial portion of the phosphorus is due to internal loading
- ☑ The flushing rate of the water body is not excessive
- ☑ A rapid improvement in water quality is desired
- ☑ Cleared space for staging and chemical storage
- ☑ Existing access for treatment vessels
- ☑ Cost-effectiveness is important

All apply to Santuit Pond



Future : Pursue an Aluminum Sulfate Treatment

Previously Treated Ponds on Cape Cod:

- Cliff Pond – Brewster
- Long Pond – Harwich
- Hamblin Pond – Barnstable
- Ashumet Pond – Mashpee / Falmouth / JBCC
- Great Pond – Eastham
- Herring Pond – Eastham
- Mystic Pond – Barnstable
- Lovells Pond – Barnstable
- Stillwater Pond – Chatham
- Lovers Pond – Chatham
- Parker Pond – Barnstable
- Shubael Pond – Barnstable

Public Concerns :

- Methyl-Mercury Release
- “It’s a Chemical”
- “The treatment will kill the pond!”

Recommended Solutions

Nutrient Inactivation

- Recommended approach is use of alum and sodium aluminate to achieve inactivation of sediment phosphorus
- Alum (aluminum sulfate) has been used safely for decades in Massachusetts
  - Same chemical used in drinking water treatment processes
  - Injected underwater, forms flocculent and sinks to the bottom
  - Cost per kilogram of phosphorus removed is very low ($100s) compared with most other approaches
  - Works immediately and is effective for extended periods of time, especially if external phosphorus loading is reduced
- Liquid sodium aluminate serves as a buffer to stabilize pH during treatment

Education and Public Outreach:

- SNEP Network Grant – Education and Outreach with TRC Group
  - Mutltiple outreach events
  - TRC Group to assist
  - Field Trips to Ponds Treated
- 319 Proposal for Alum Treatment in FY26

Town Action: Pursue Grant Funding

SNEP Network / 319 / 604b / MVP – Stormwater Improvements and Aluminum Sulfate Treatment

Storwmater Projects: MVP / 604b

Alum Dosing and Treatment – 319/SNEP

Increasing Resilience to Harmful Algal Blooms in Santuit Pond Stormwater Retrofit Implementation Phase 1

MVP Municipal Vulnerability Preparedness

Mashpee FY23

https://www.mashpeema.gov/natural-resources/mvp-grant-award-watershed-based-solutions-increase-resilience-harmful-algal-blooms

AWARD $469,037 **MATCH** $159,366

PROJECT TYPE Construction and On-the-Ground Implementation

CORE PRINCIPLES DEMONSTRATED Employing Nature-Based Solutions; Supporting Strong Partnerships with Climate Vulnerable Populations

DESCRIPTION

- Constructed a priority green infrastructure stormwater retrofit along Timberlane Drive to reduce loadings of phosphorus, sediment, and other pollutants to Santuit Pond
- Developed a refined concept for repurposing of the Town Landing site that reflects stakeholder input and advances the Town's water quality and climate resilience goals
- Continued partnership between Town of Mashpee and Mashpee Wampanoag Tribe

Table 5. Recommended Alum and Sodium Aluminate Dosing

Element	Value		Unit
Aluminum Dosing	**4- to 8-foot contour**	**Below 8-foot contour**	
Targeted Binding Ratio Al:Al-P formed	150	100	
Estimated Active Layer	4	4	cm
Total Aluminum Dose	42	80	g Al m^{-2}
Alum and Sodium Aluminate Treatment Volumes			
Treatment Area	78	67	acre
Total Mass Aluminum Applied	13,173	21,575	kg
Liquid Alum Composition	0.22	0.22	kg Al/gallon
Liquid Sodium Aluminate Composition	0.57	0.57	kg Al/gallon
Total Treatment Volume as Alum	59,877	98,068	gallon
Targeted Ratio of Alum to Sodium Aluminate	2:1	2:1	
Final Alum Dose*	26,085	42,723	gallon
Final Sodium Aluminate Dose*	13,042	21,361	gallon
Check	13,173	21,575	total mass Al applied in kg
Alum Dose per Acre	334.42	637.66	gallon
Sodium Aluminate Dose per Acre	167.21	318.82	gallon

Take Away Messages

- Nutrient remediation should be addressed based on initial recommendations from a water body diagnostic study or Watershed Management Plan.
- Nutrient contributions are specific to each pond based on watershed size, development, internal, and external loading.
- Not one treatment will result in a complete restoration. Alum, oxygenation, and other treatments are typically used as a "band aid" approach. Sewering, stormwater improvements, and land use practice changes are necessary to coincide with all treatments to ensure longevity.
- For in pond treatments, municipalities and or non-profit groups / organizations need to weigh effectiveness and total cost for all treatment methods. Look to other success stories.
- Ask how many ponds have undergone treatment and ask for spatial data. Treatments should show consistent P reduction and DO improvements throughout.
- Pay attention to biased scientific reports. Some data can be manipulated. Make sure the peer review process exists. Determine fact vs. fiction.