

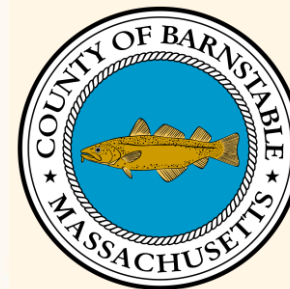


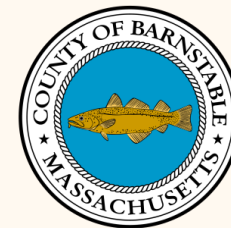
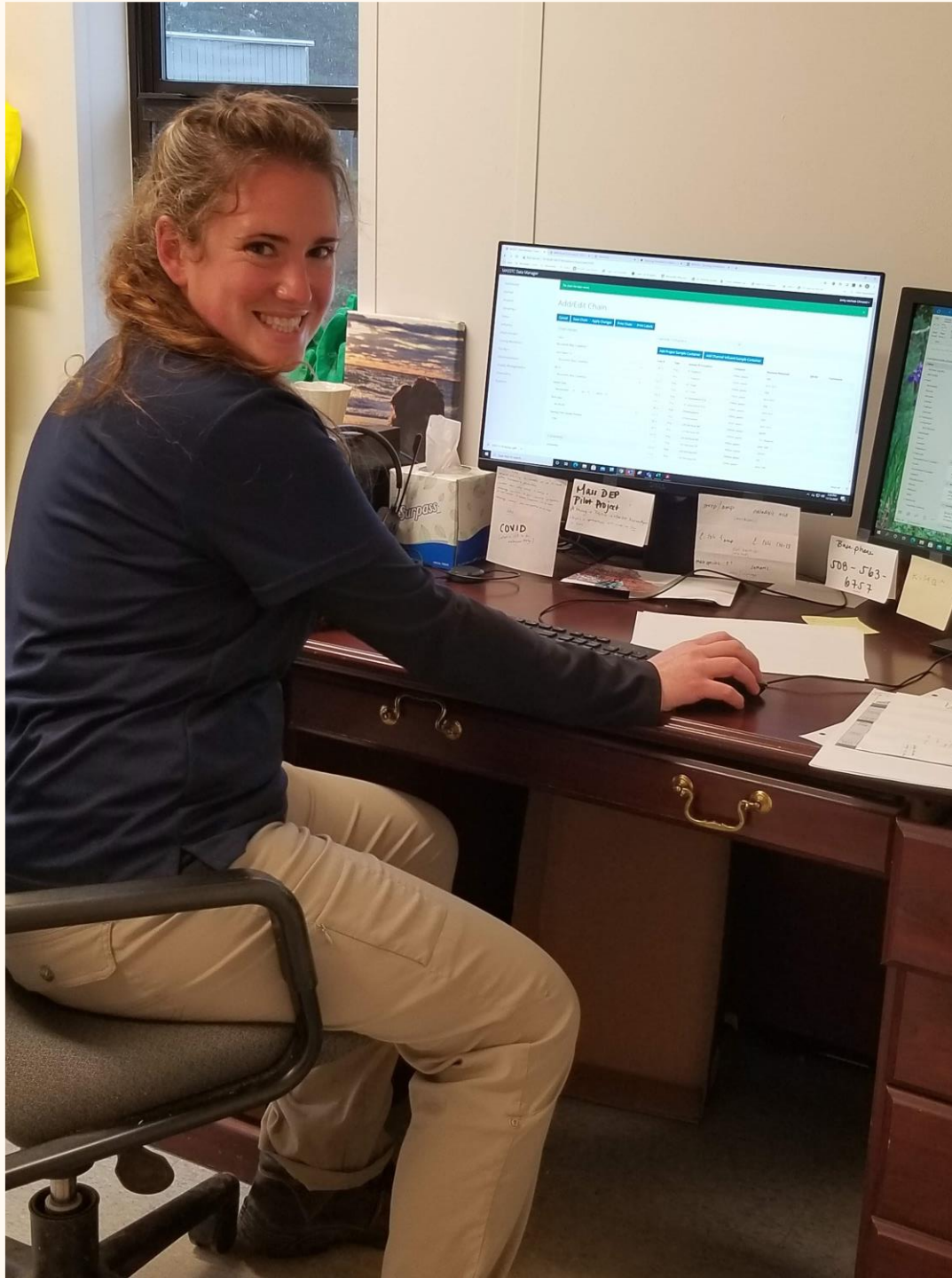
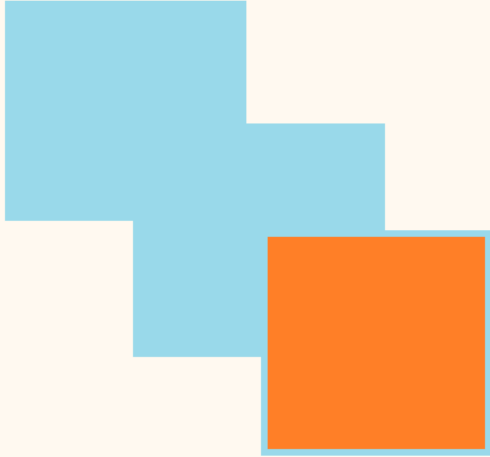
Phosphorus Removal in the Onsite Septic System Setting

MHOA

Wednesday, October 20, 2021

Emily Michele Olmsted
Environmental Project Assistant
Barnstable County



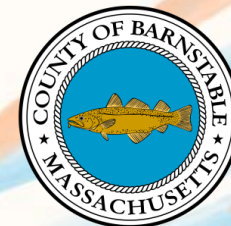
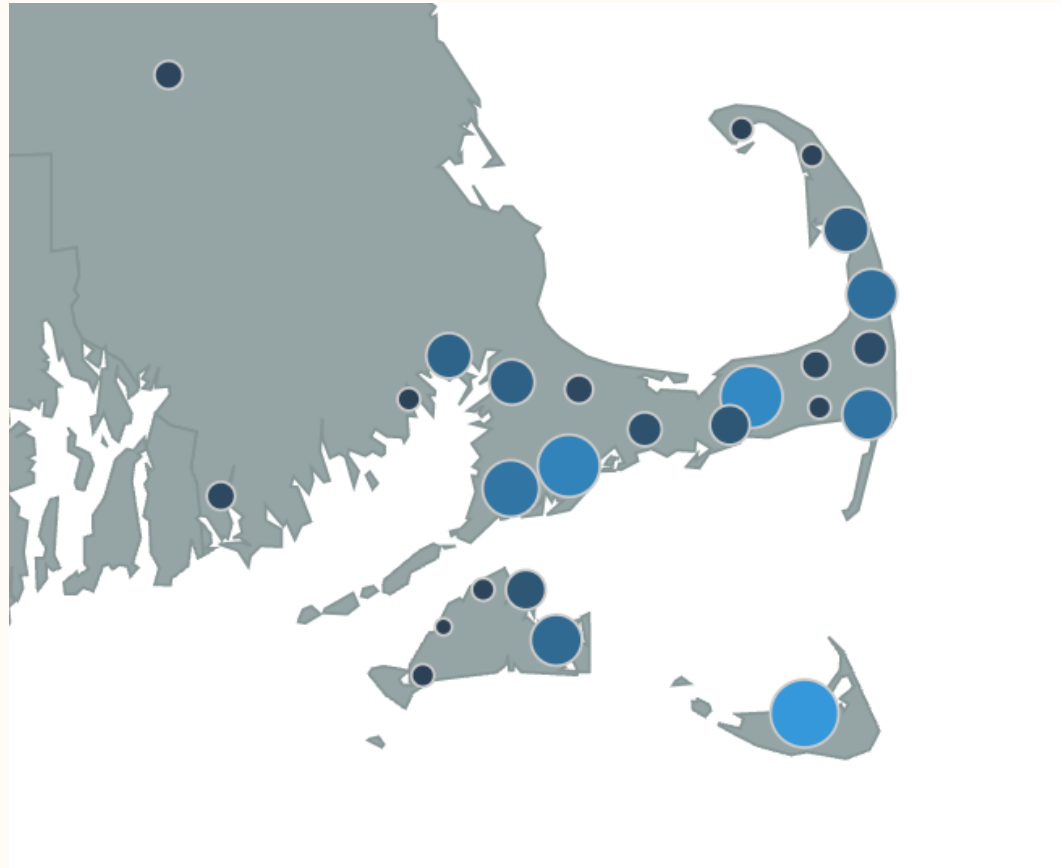


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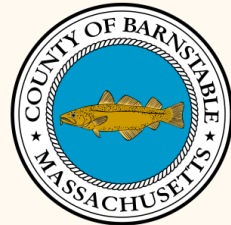
25 participating towns

Over 3500 active I/A systems (more than 4000 total)

Collaboration with MassDEP for Pilot Use systems

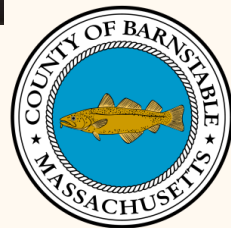


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Barnstable County Innovative/Alternative Septic System Tracking Program


<https://septic.barnstablecountyhealth.org/>

Barnstable County Septic Management Program Contact About Data and Statistics Connect ▾ Login Sign Up

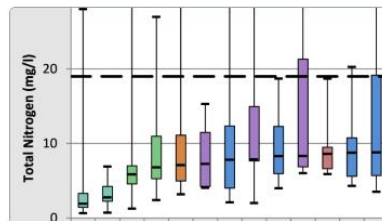
Licensed I/A Operators

Need an operator? Check out the of list of licensed wastewater treatment operators for one near you.

[View list >](#)



Data and Statistics



In order to provide information on innovative/alternative (I/A) septic systems to the

I/A Owners Guide

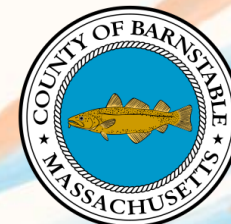


I/A system owners have the responsibility of keeping their system operating correctly at all

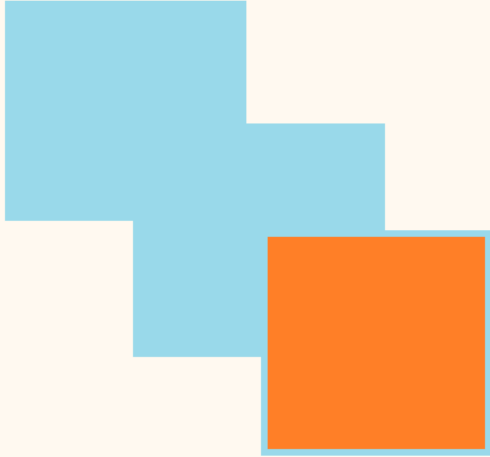
For I/A Operators



If you are an O&M Provider and need help with the database, check here first.



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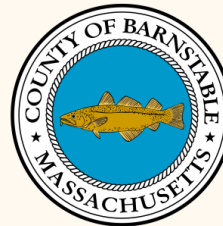


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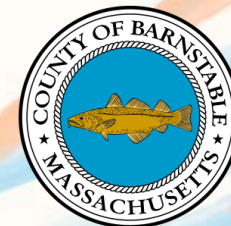
N

Nitrogen

14.007

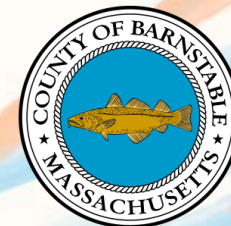


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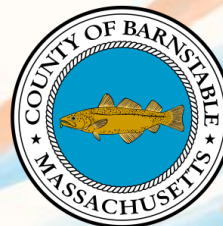
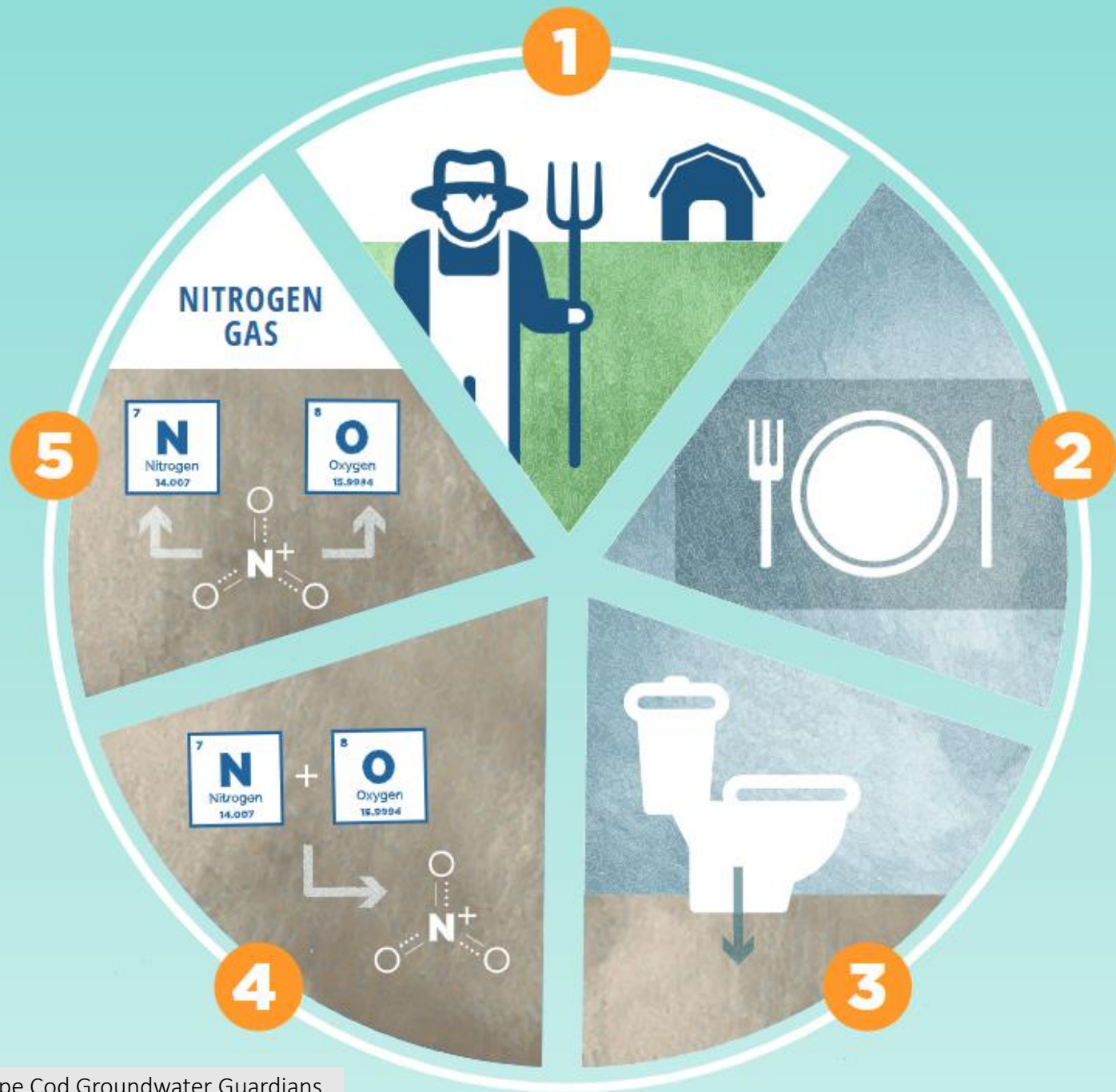
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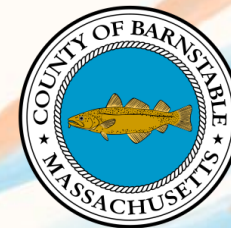
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15.214: Nitrogen Loading Limitations

- (1) No system serving new construction in Nitrogen Sensitive Areas designated in 310 CMR 15.215 shall be designed to receive or shall receive more than 440 gallons of design flow per day per acre except as set forth at 310 CMR 15.216 (aggregate flows) or 15.217 (enhanced nitrogen removal).
- (2) No system serving new construction in areas where the use of both on-site systems and drinking water supply wells is proposed to serve the facility shall be designed to receive or shall receive more than 440 gallons of design flow per day per acre from residential uses except as set forth at 310 CMR 15.216 (aggregate flows) or 15.217 (enhanced nitrogen removal).
- (3) It shall be the duty of the owner of the system or proposed system to ascertain whether or not the facility to be constructed will be in a nitrogen sensitive area. The Department will prepare and make available at locations generally accessible to the public maps portraying designated nitrogen sensitive areas within the Commonwealth.

310 CMR 15.000: THE STATE ENVIRONMENTAL CODE, TITLE 5: STANDARD REQUIREMENTS FOR THE SITING, CONSTRUCTION, INSPECTION, UPGRADE AND EXPANSION OF ON-SITE SEWAGE TREATMENT AND DISPOSAL SYSTEMS AND FOR THE TRANSPORT AND DISPOSAL OF SEPTAGE



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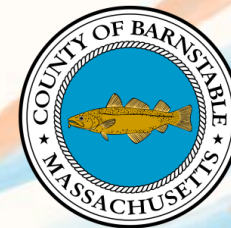
MassDEP limits for Total Nitrogen

4. Wastewater Loading and Effluent Concentration Design Standards

For new residential construction in an area subject to the Nitrogen Loading Limitations of 310 CMR 15.214, and the facility does not meet with the Nitrogen Loading Limitations pursuant to the aggregation provisions of 310 CMR 15.216, an increase in calculated nitrogen loading per acre is allowed for facilities with design flow less than 2000 gpd with limitations as follows:

- The design flow shall not exceed 660 gallons per day per acre (gpda) and the total nitrogen (TN) concentration in the effluent shall not exceed 19 milligrams per liter (mg/L); or
- The design flow shall not exceed 550 gallons per day per acre (gpda) and the total nitrogen (TN) concentration in the effluent shall not exceed 25 milligrams per liter (mg/L).
- TN is measured as the total of TKN (Total Kjeldhal Nitrogen), NO₃-N (Nitrate nitrogen) and NO₂-N (Nitrite nitrogen).

Taken from a MassDEP technology approval letter for technology with General Use for nitrogen reduction

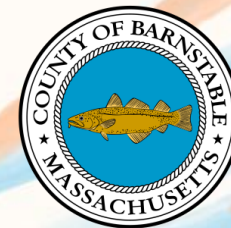


15.215: Designation of Nitrogen Sensitive Areas

The following areas have been determined by the Department to be particularly sensitive to the discharge of pollutants from on-site sewage disposal systems and are therefore designated nitrogen sensitive. The necessity of providing increased treatment of pollutants and reduction in nutrients discharged from on-site sewage disposal systems, including nitrogen, nitrogen as nitrate, phosphorous and pathogens in these areas warrants the imposition of the loading restrictions set forth in 310 CMR 15.214.

- (1) Interim Wellhead Protection Areas and Department approved Zone IIs of public water supplies;
- (2) Nitrogen sensitive embayments or other areas which are designated as nitrogen sensitive for purposes of 310 CMR 15.000 shall be mapped based on scientific evaluations of the affected water body and adopted through parallel public processes pursuant to both 310 CMR 15.000 and 314 CMR 4.00: *Massachusetts Surface Water Quality Standards*.

310 CMR 15.000: THE STATE ENVIRONMENTAL CODE, TITLE 5: STANDARD REQUIREMENTS FOR THE SITING, CONSTRUCTION, INSPECTION, UPGRADE AND EXPANSION OF ON-SITE SEWAGE TREATMENT AND DISPOSAL SYSTEMS AND FOR THE TRANSPORT AND DISPOSAL OF SEPTAGE





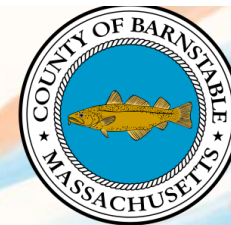
December 8, 2005

Town of Dennis Regulations for Subsurface Disposal of Sewage

Regulations for Subsurface Disposal of Sewage

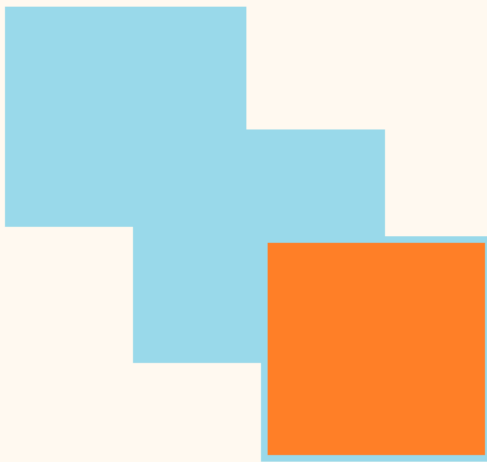
Page 9.

3. All new or repaired septic systems in an Environmentally Sensitive Area (ESA), as defined in Regulation 9.3A, shall have *nitrogen loading calculations submitted with the permit.
4. New and repaired septic system within 100' of surface water may have nitrogen reduction systems added to the septic plan, if the nitrogen loading exceeds *5 ppm .
5. Applicants for new construction in an ESA, as defined in Regulation 9.3A, must demonstrate that it is more likely than not that the construction and related septic system shall not adversely contribute to the decline of existing water quality or food sources.



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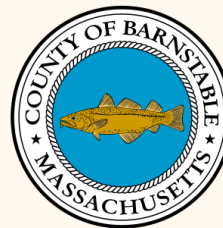


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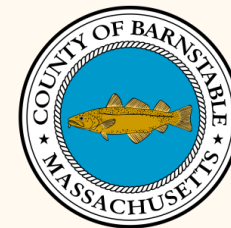
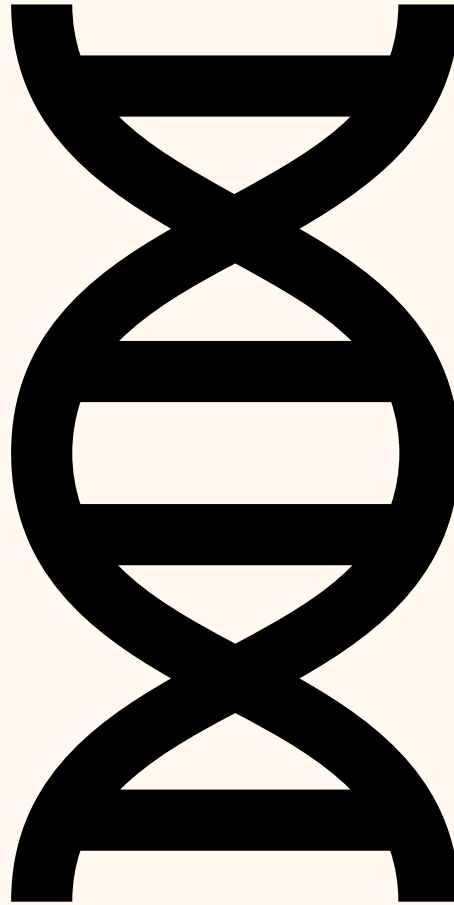
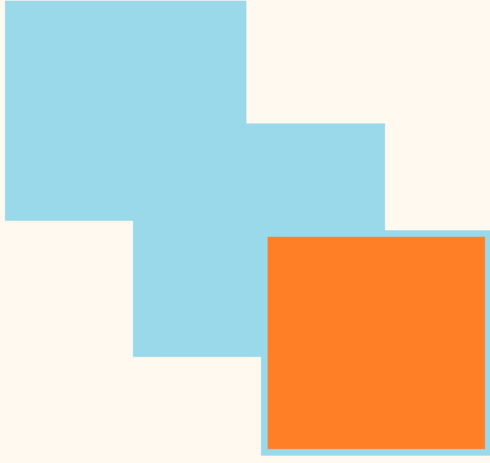
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Phosphorus

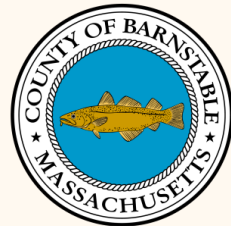
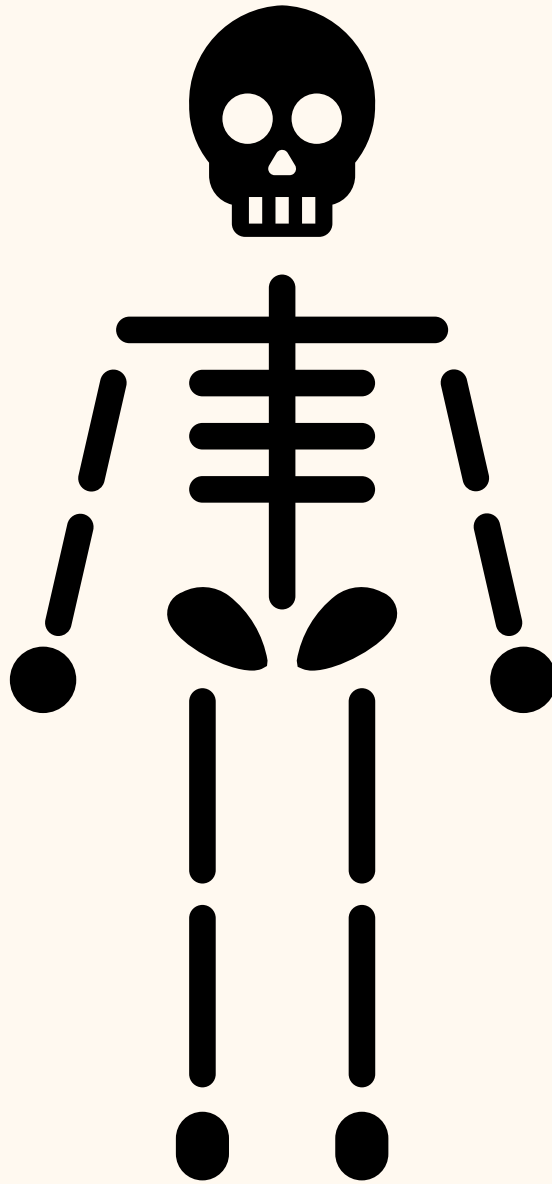
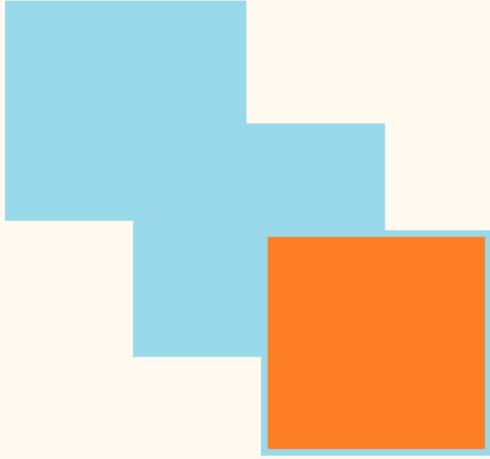
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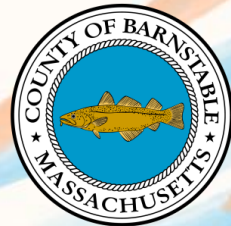
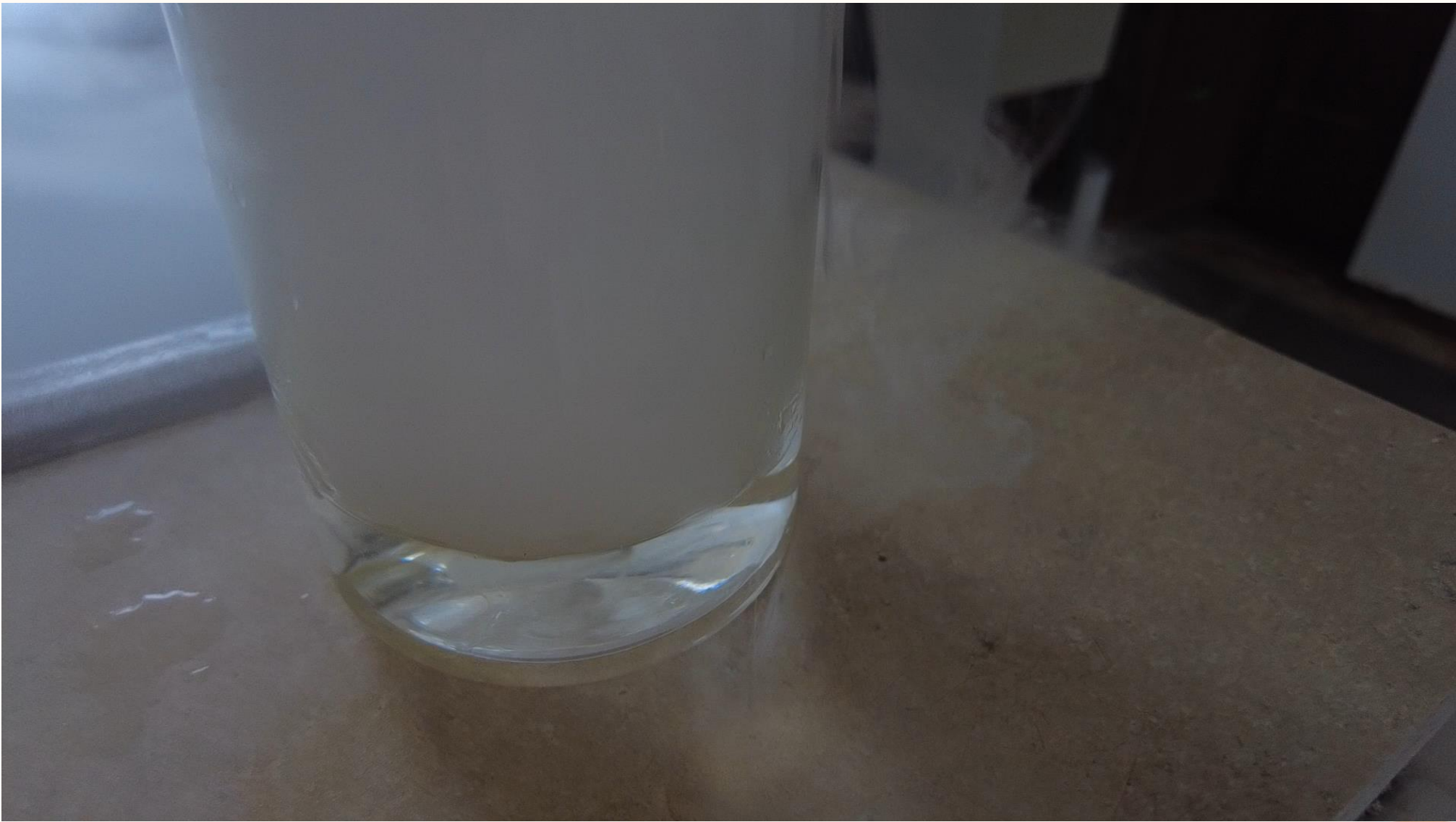


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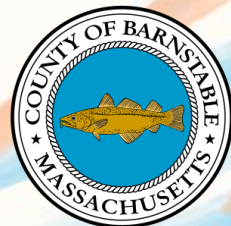
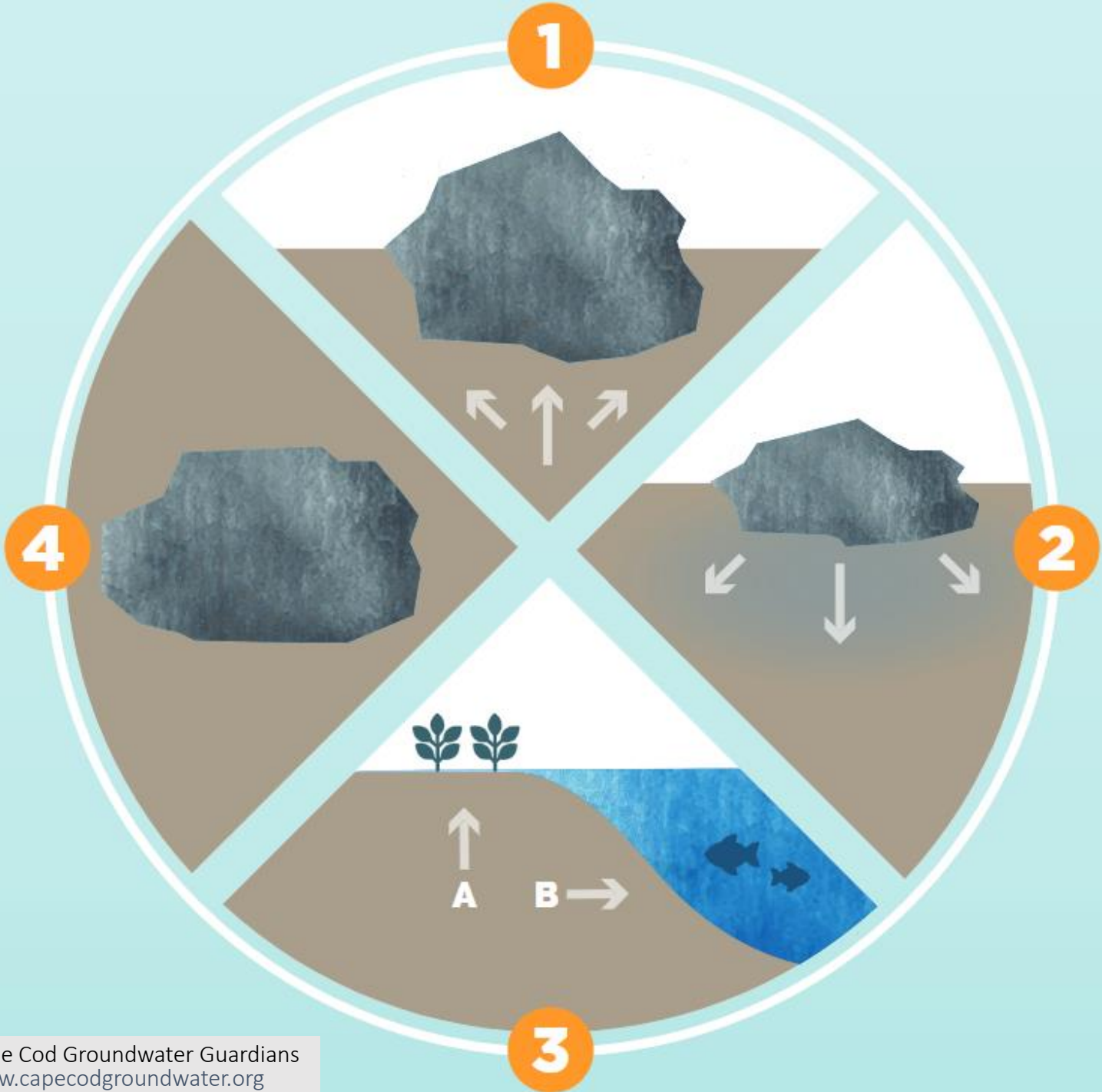
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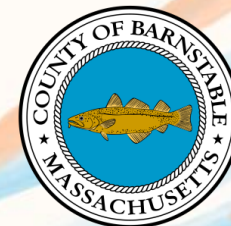
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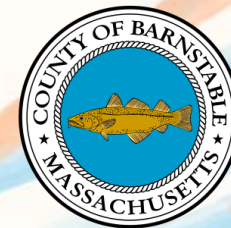
Phosphorus “limits” for technologies currently holding Pilot approval for phosphorus removal in Massachusetts are set based on what the Company claims for performance.



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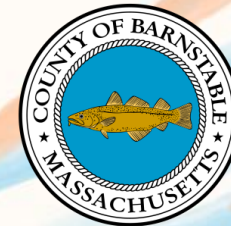
I. Purpose

1. The purpose of Piloting Approval ('the Approval') is to allow installation and use of no more than 15 on-site sewage disposal systems utilizing the Technology in Massachusetts in order to provide field testing and a technical demonstration that a particular alternative system can or cannot function effectively under relevant physical and climatological conditions (310 CMR 15.285).
2. The Approval requires that sufficient performance testing be completed so that the Department may determine whether the System is capable of consistently functioning to effectively reduce Total Phosphorus (TP) in on-site system sanitary wastewater effluent to less than or equal to 0.3 milligram per liter (mg/L) as claimed by the Company.



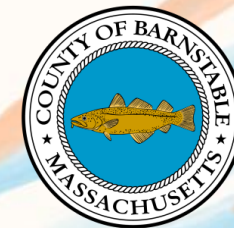
I. **Purpose**

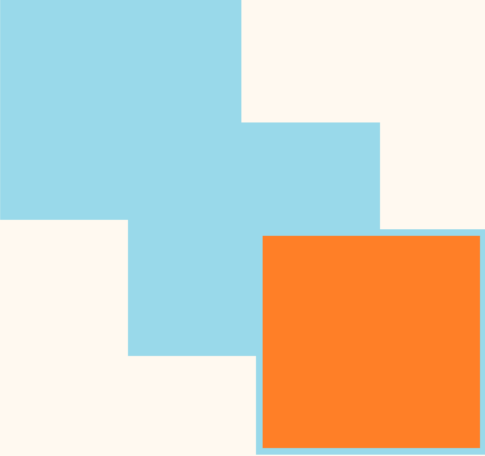
1. The purpose of this Approval (“the Approval”) is to allow installation and use of no more than 15 on-site sewage disposal systems utilizing the Technology in Massachusetts in order to provide field testing and a technical demonstration that a particular alternative system can or cannot function effectively under relevant physical and climatological conditions (310 CMR 15.285).
2. The Approval requires that sufficient performance testing be completed so that the Department may determine whether the System is capable of consistently functioning to effectively reduce **total phosphorus (TP)** in on-site system sanitary wastewater effluent to less than **1 milligram per liter (mg/L)** as claimed by the Company.



I. Purpose

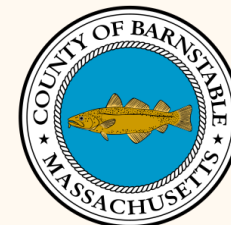
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2. The Approval requires that sufficient performance testing be completed so that the Department may determine whether the System is capable of consistently functioning to effectively reduce **Total Phosphorus (TP)** in on-site system sanitary wastewater effluent to less than or equal to **1 milligram per liter (mg/L)** as claimed by the Company.
3. The Approval authorizes the installation and use of the System, with the approval of the local approving authority, to serve facilities with design flows up to and less than 10,000 gallons per day, including new construction, an increase in flow at an existing facility, or an upgrade or replacement of an existing failed or nonconforming system. Installations must meet the specific siting conditions for piloting an Alternative System (310 CMR 15.285(2)), and the facility must meet the siting requirements of this Approval.

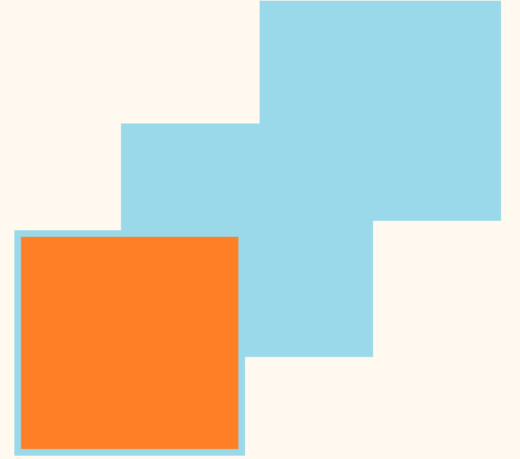




Phosphorus, why do we care?

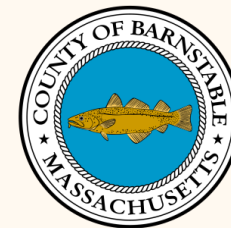
- Harmful algae blooms
- Fish kills
- Excessive plant growth
- Loss of recreational use of surface waters

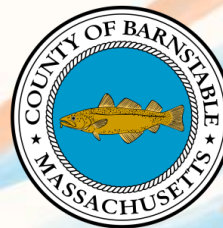





Most diagnostic/feasibility studies of Massachusetts lakes also indicate phosphorus as the limiting nutrient. Even in cases where nitrogen may be limiting, previous experience has shown that it is easier, more cost-effective and more ecologically sound to control phosphorus than nitrogen.

Excerpt from Total Maximum Daily Loads of Phosphorus for Selected Millers Basin Lakes
Commonwealth of Massachusetts Executive Office of Environmental Affairs
<https://www.mass.gov/doc/final-tmdls-of-phosphorus-for-selected-millers-river-basin-lakes/download>

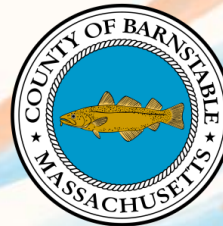
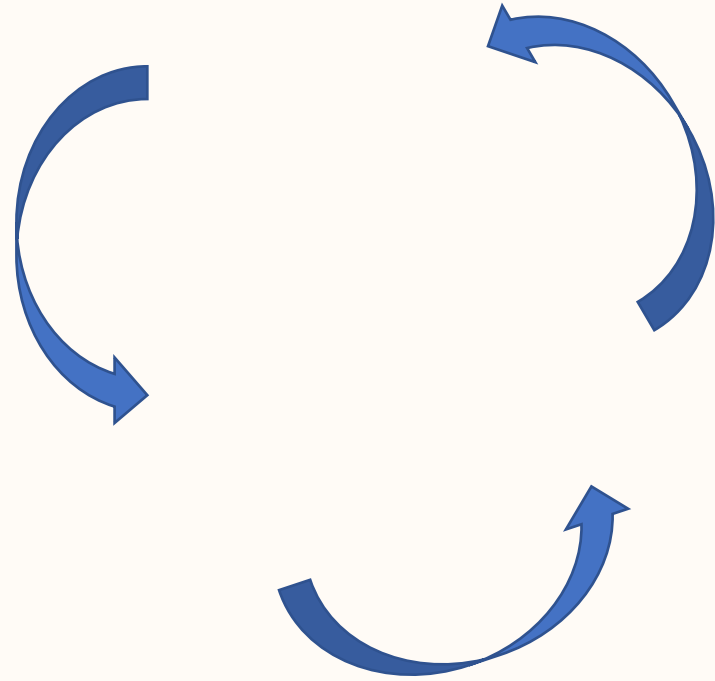




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Too much of a good thing



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CAUTION

PUBLIC HEALTH ADVISORY

CYANOBACTERIA BLOOM PRESENT



**Waterbody Unsafe for
People and Pets**



Do not swim.



Do not swallow water.



Keep animals away.

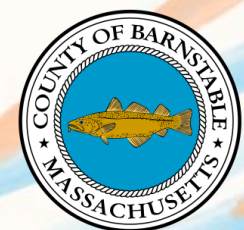


Rinse off after contact with water.

Call your local health department with questions:



Additional info on algae can be found at
www.mass.gov/dph/algae

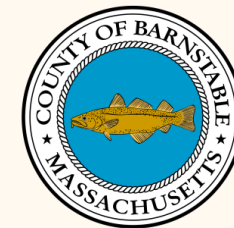


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Sources of impact

- Wastewater
- Stormwater
 - Fertilizer
- Natural sources (leaves)



Cyanobacterial Blooms and Animals

Cyanobacterial blooms can be deadly for pets and livestock.

When in doubt, keep animals out!



Cyanobacteria (also called blue-green algae) are microscopic organisms that can be found naturally in all types of water (fresh; marine; or a combination, which is also called brackish). Sometimes cyanobacteria rapidly grow out of control, or bloom. Cyanobacterial blooms are most commonly found in fresh water, such as lakes, rivers, and streams. Cyanobacteria can produce toxins (poisons), which can cause serious illness in animals.

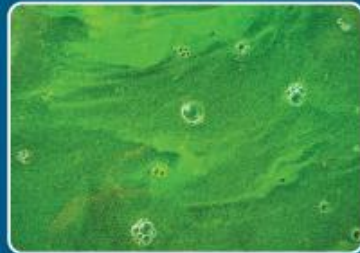
Signs of a cyanobacterial bloom



Foam, scum, mats, or paint-like streaks on the water's surface.



Different colors like green, blue, red, or brown.



As the bloom dies off, it may smell like rotting plants.

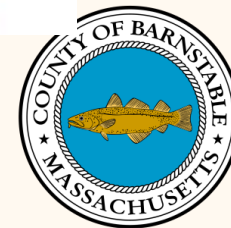


Cyanobacteria bloom more often in summer and fall, but can bloom anytime.

You cannot tell if a cyanobacterial bloom is toxic or not just by looking at it.

Content source: [Centers for Disease Control and Prevention](https://www.cdc.gov/habs/materials/posters.html)

<https://www.cdc.gov/habs/materials/posters.html>



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Protect your pets and livestock

- Keep pets and livestock away from the water if you see signs of cyanobacteria.
- Do not let your animals drink, swim in, or eat near discolored or scummy water.
- Keep animals from licking their fur, eating dead fish or other animals found near the bloom, or eating mats of cyanobacteria.

If your pets or livestock are exposed to a bloom

- **Immediately wash them with clean water** so they don't lick cyanobacteria off their fur.
- **Call a veterinarian** if your animal shows any of these signs
 - » Loss of energy
 - » Loss of appetite
 - » Vomiting
 - » Stumbling and falling
 - » Foaming at the mouth
 - » Diarrhea
 - » Convulsions
 - » Excessive drooling
 - » Tremors and seizures
 - » Any unexplained sickness that occurs within a day or so after being in contact with water

Pets and livestock can get very sick and die within hours to days after swallowing toxins made by cyanobacterial blooms.

Call **Poison Control** at **1-800-222-1222** if you have questions about cyanobacterial toxin poisoning.

Call the **ASPCA Animal Poison Control Center** at **1-888-426-4435** or the **Pet Poison Helpline** at **1-855-764-7661** if you have questions about your pet or livestock. (Note: There is a fee for these calls.)

Report cyanobacterial blooms or illnesses to your health department online or by phone.



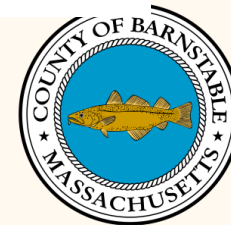
U.S. Department of
Health and Human Services
Centers for Disease
Control and Prevention

Learn more about cyanobacterial blooms: www.cdc.gov/habs

CS 319419-A

Content source: [Centers for Disease Control and Prevention](https://www.cdc.gov/habs/materials/posters.html)

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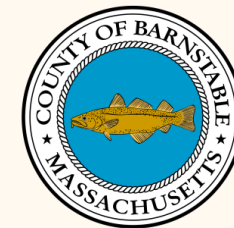
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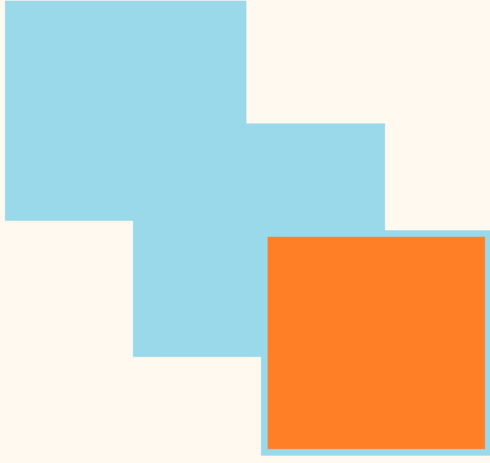
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Table 1. Features of lakes treated with aluminum between 1995 and 2015.

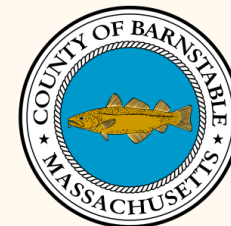
	Area	Depth		Detention	Tributaries	Hydrologic load		Phosphorus load		
		Mean	Maximum			Precipitation	Groundwater	Internal	Surface Flow	Groundwater
Lake	<i>ha</i>	<i>m</i>	<i>m</i>	<i>yr</i>		%	%	%	%	%
Hamblin	46	8.3	18.8	1	No	11	87	67	9	11
Ashumet	82	7	20	1.9	No	17	72	47	4	45
Long	296	8.8	21.2	3.5	No	51	44	64	17	9
Mystic	59	4.6	14.3	1	No	18	80	46	15	21
Lovers	15	4.6	10	1.2	No	39	55	43	27	12
Stillwater	7.5	6.8	13.9	1.2	From Lovers	13	25	55	32	5
Herring	17.7	6.2	10.9	2.8	No	42	55	40	1	46
Great	44.7	3.6	11	0.4	2 small ones	14	83	26	8	45
Lovell's	22	5.7	11.4	2.1	1 diverted	43	53	62	4	16
Cliff	83	8.6	26.7	5.3	No	71	23	67	5	6

Kenneth J. Wagner, Dominic Meringolo, David F. Mitchell, Elizabeth Moran & Spence Smith (2017) Aluminum treatments to control internal phosphorus loading in lakes on Cape Cod, Massachusetts, Lake and Reservoir Management, 33:2, 171-186, DOI: [10.1080/10402381.2017.1308449](https://doi.org/10.1080/10402381.2017.1308449)



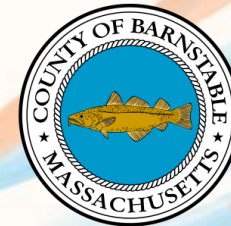


- Nitrogen removal ends in a gas (N_2)
- Phosphorus ends with a solid biproduct that must also be dealt with



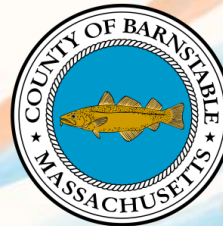
Our Project

- Install at least **6 systems** with technologies claiming to remove phosphorus from wastewater
- Provide **\$5,000 subsidy** as incentive
- Provide **donated equipment** (when possible)
- Provide at least **1 year of monitoring**



This project has been financed in whole or in part with funds (competitive grants or otherwise) from the Environmental Protection Agency (EPA) and/or the Massachusetts Department of Environmental Protection (MASSDEP). The contents do not necessarily reflect the views and policies of EPA or MASSDEP, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.

Any mention of a name, product, service, company, or institution does not constitute an endorsement by MASSTC or Barnstable County Regional Government.



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Contact from interested participant



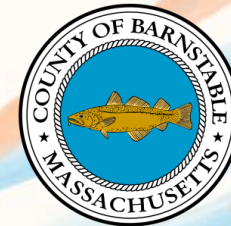
Communication with engineer and technology company



Board of Health approval



MassDEP approval



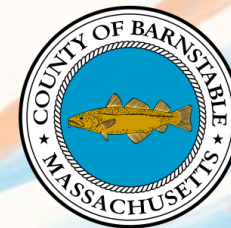
Massachusetts Department of Environmental Protection (MassDEP)

MassDEP's Technology Approval Process for I/A Systems

Piloting: Piloting involves installation, field testing, and technical evaluation to demonstrate that the technology can function effectively under the physical and climatological conditions at the pilot sites and provide environmental protection equivalent to a conventional Title 5 system.

- MassDEP will accept technologies for piloting when available data on the technology shows that it is likely to be able to provide a level of environmental protection at least equivalent to a conventional Title 5 system.
- Piloting of a particular I/A technology may be conducted either for new construction or in remedial situations. Up to 15 sites per technology may be piloted.
- Piloting must be done for at least 18 months and result in a full technical reporting of results. Piloting generally is not intended to address long-term operation and maintenance, although the information gathered during piloting should be used to understand these issues.
- When a technology completes pilot testing, MassDEP can allow the technology to proceed to the Provisional Use Approval stage, require additional piloting, or disapprove the system. Piloting is considered successful if at least 75% of the pilot sites performed at the expected level of treatment for at least 12 months.
- Piloting systems that meet performance goals are allowed to remain in place long-term. For piloting systems that exhibit problems, adjustments to system design and operation are necessary. In extreme circumstances, the piloting system may need to be replaced. To date, no piloting system has had to be replaced.

Content source: Massachusetts
Department of Environmental Protection
<https://www.mass.gov/guides/innovative-technology-and-title-5-systems>



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Contact from interested participant



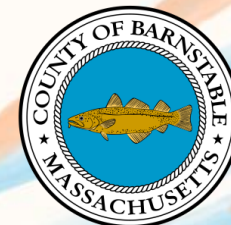
Communication with engineer and technology company



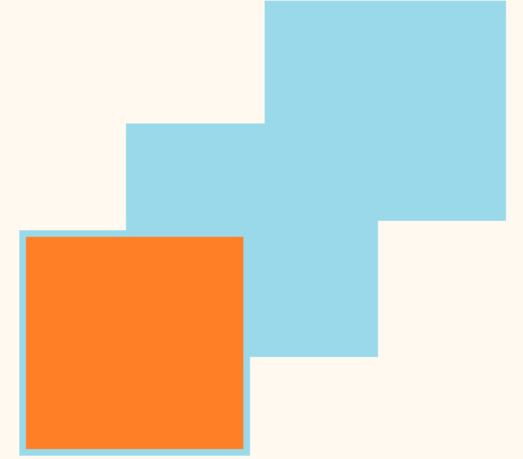
Board of Health approval



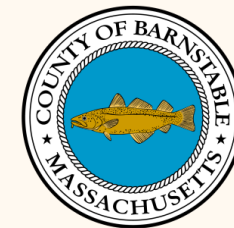
MassDEP approval



Phosphorus Removal Onsite Septic Systems



- Electrochemical
- Polymer (binding agents)
- Soils-based systems
- Other



Technologies

Soils-Based

- PercRite® by American Manufacturing Company, Inc.
- GeoMat™ by Geomatrix

Polymer Techs

- Phos-4-Fade® by Norweco®
- Busse by BusseNY®

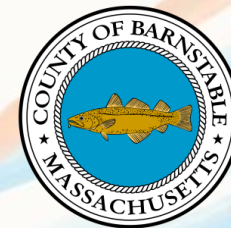
Electrochemical Techs

- EC-P® by Waterloo Biofilter
- CRX II by FujiClean USA™
- DpEC by Premier Tech Aqua

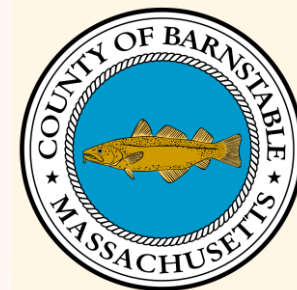
Reductive Iron Dissolution

- PhosRID™ by Lombardo Associates, Inc.

- Composting Toilet



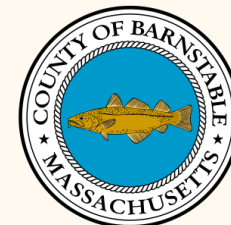
Electrochemical Technologies





EC-P[®] by Waterloo Biofilter

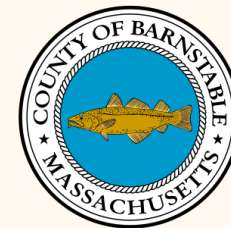
- iron electrodes are installed in the septic tank or chamber
 - small current is applied to the electrodes
- iron is dissolved into the sewage stream where it reacts with phosphorus to form insoluble iron-phosphate minerals.
- in the leachfield, the iron-phosphate minerals precipitate out preventing phosphorus from reaching the natural environment

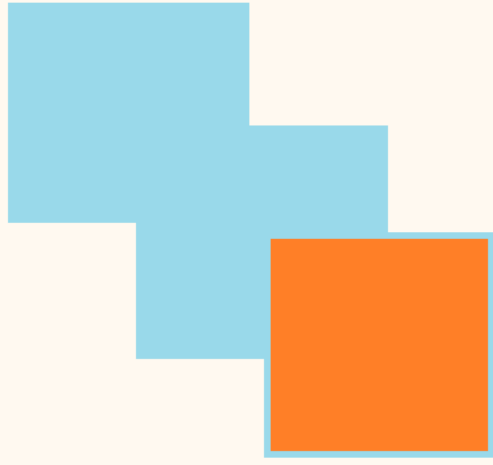




CRX by FujiClean USA TM

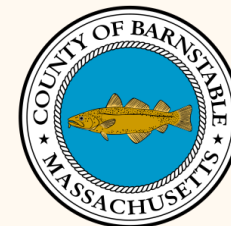
- iron electrodes are installed in a separate chamber
- electrodes release ferric ions that react with phosphate and orthophosphate in water
- insoluble biproduct settles to bottom of device



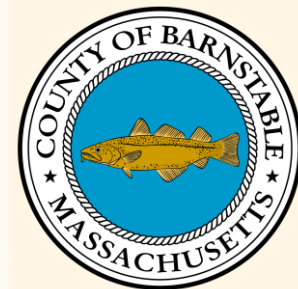


DpEC by Premier Tech Aqua

- low-intensity current between two submerged aluminum electrodes
- reaction zone and separation zone in unit
- electrocoagulation and separation



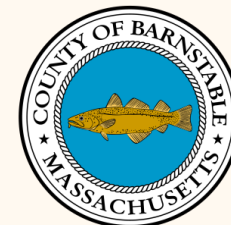
Polymer Technologies

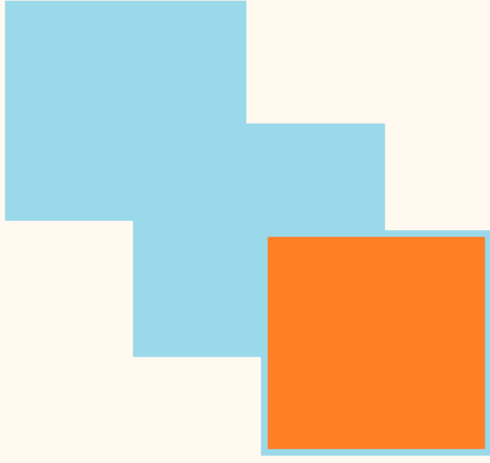




Phos-4-Fade[®] by Norweco[®]

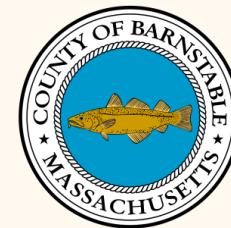
- adsorptive media
- installed downstream of a treatment unit (Singulair or Hydro-Kinetic)



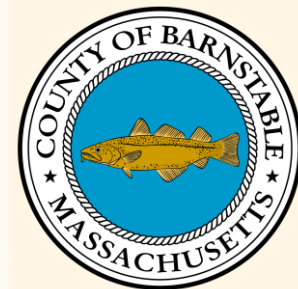


Busse by BusseNY®

- ferris alloy medium
- phosphorus binds to medium



Other Technologies

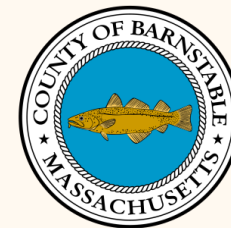


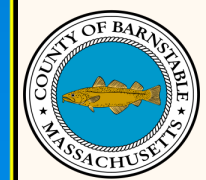
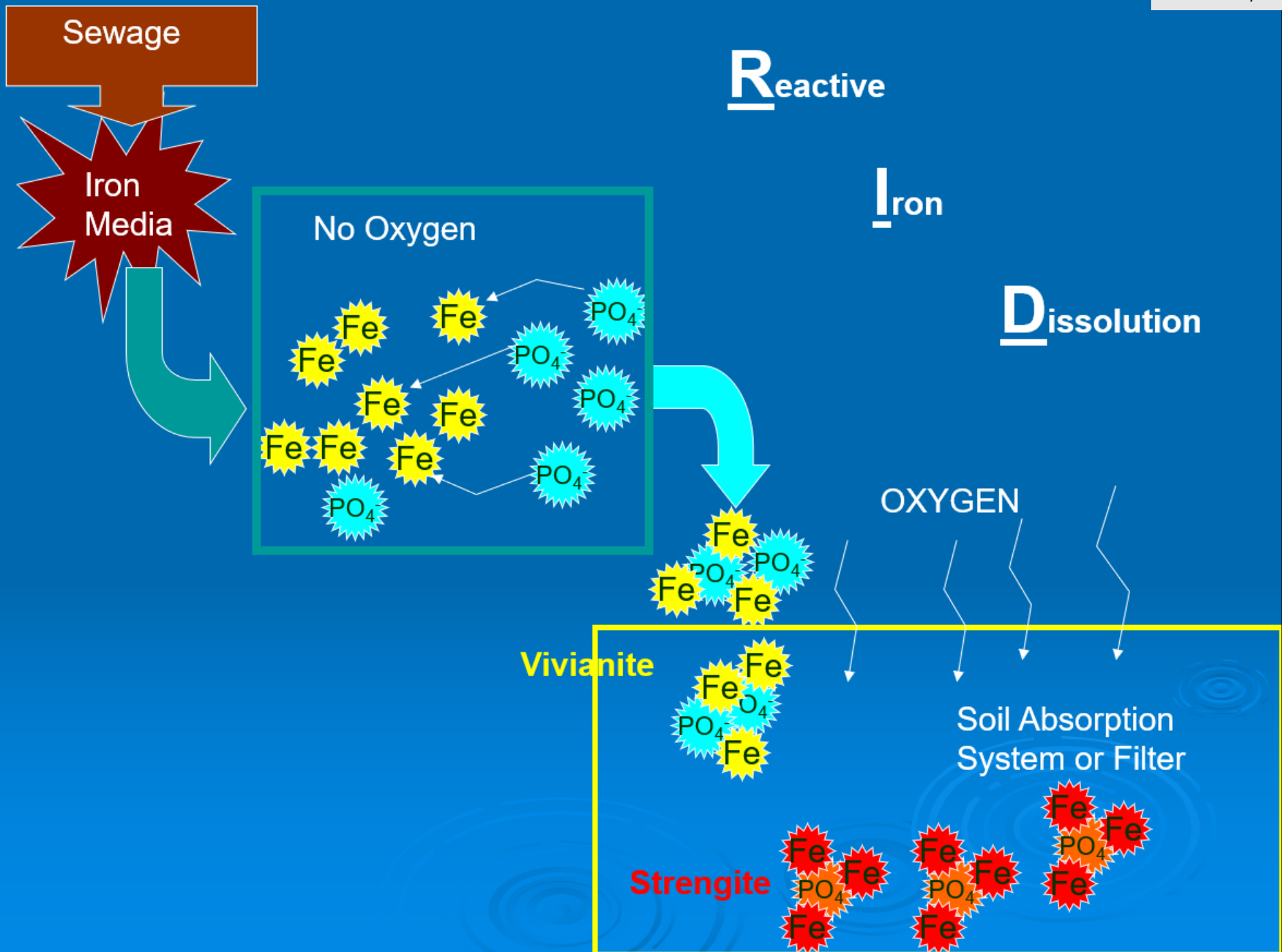


PhosRID™ by Lombardo Associates, Inc.

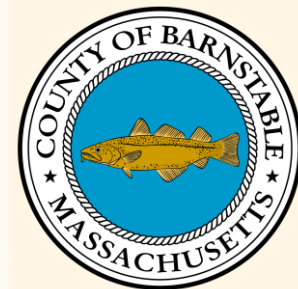
RID = reductive iron dissolution

-iron dissolving in an anaerobic environment and freed to combine or mineralize with phosphorus





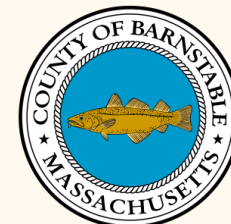
Composting Toilets





Composting Toilet

- waste broken down biologically under specific temperature, moisture, and aeration conditions
- not discharged to leachfield (or groundwater)



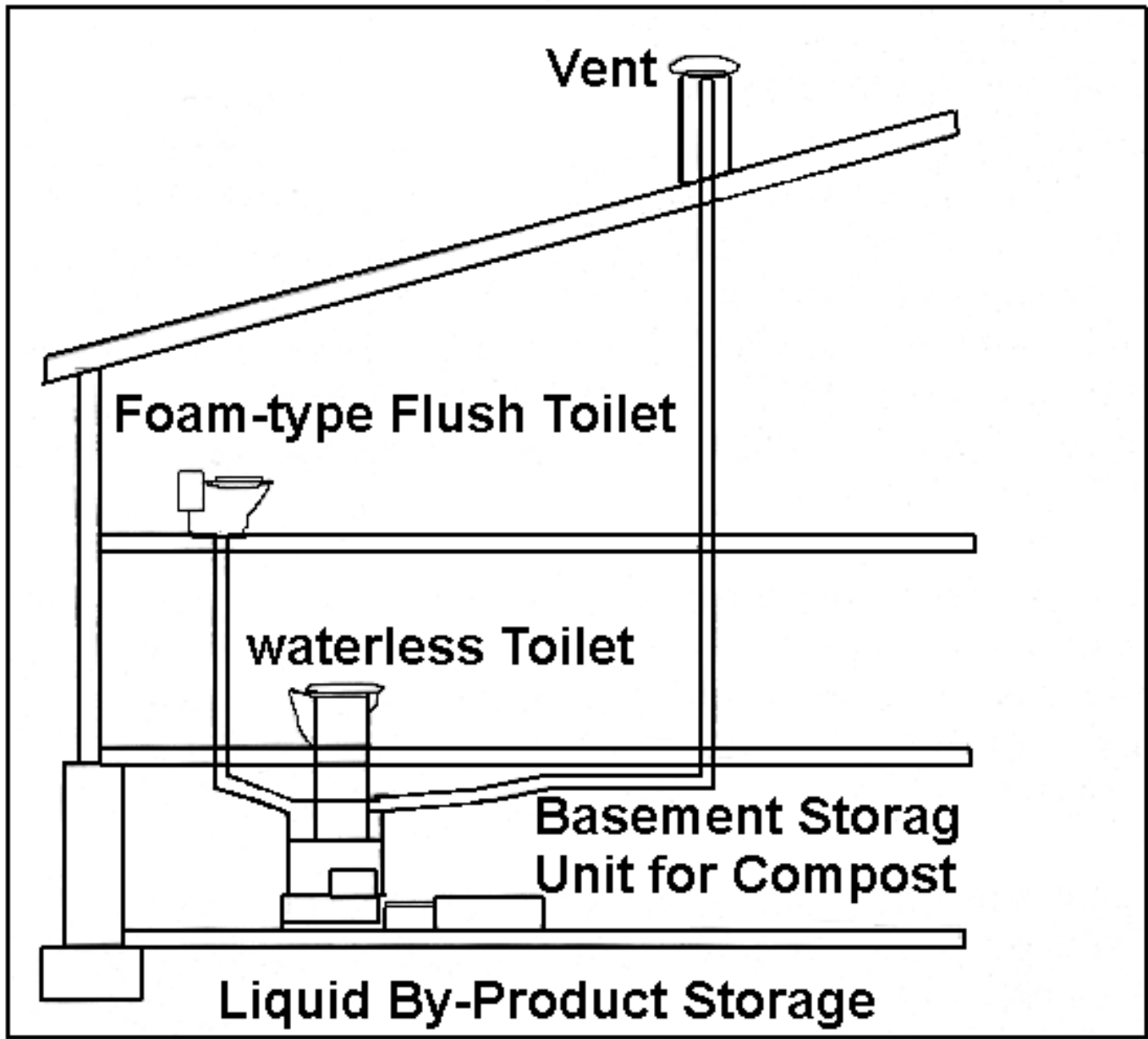
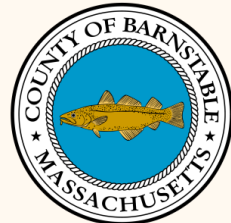
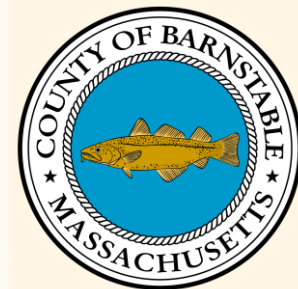


Image from Compendium of Information on Alternative Onsite Septic System Technology in Massachusetts (Heufelder & Rask)
<https://www.barnstablecountyhealth.org/resources/publications/compendium-of-information-on-alternative-onsite-septic-system-technology>



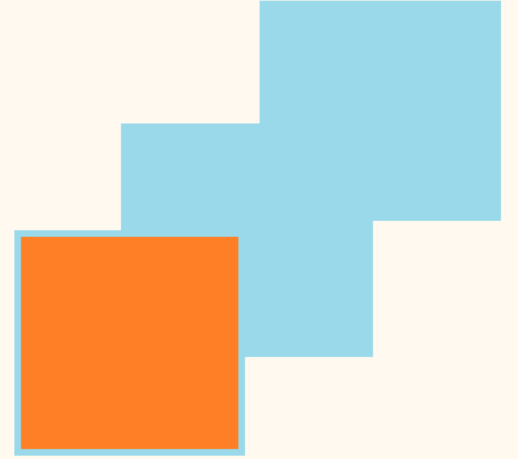
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Soil-Based Technologies

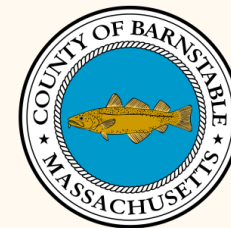


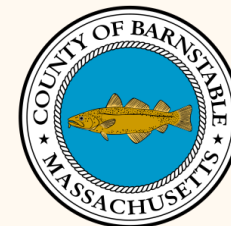
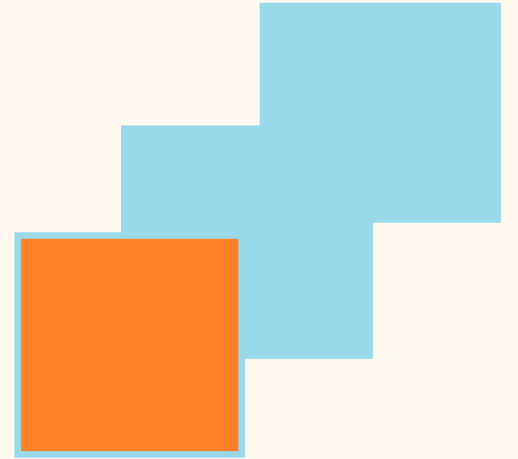
Technologies

**PercRite® by American Manufacturing Company, Inc.
and GeoMat™ by Geomatrix**

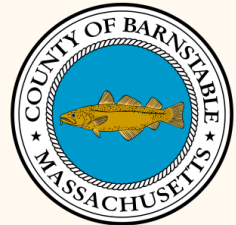
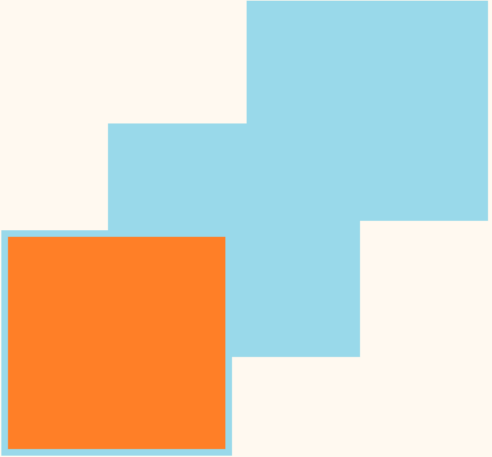
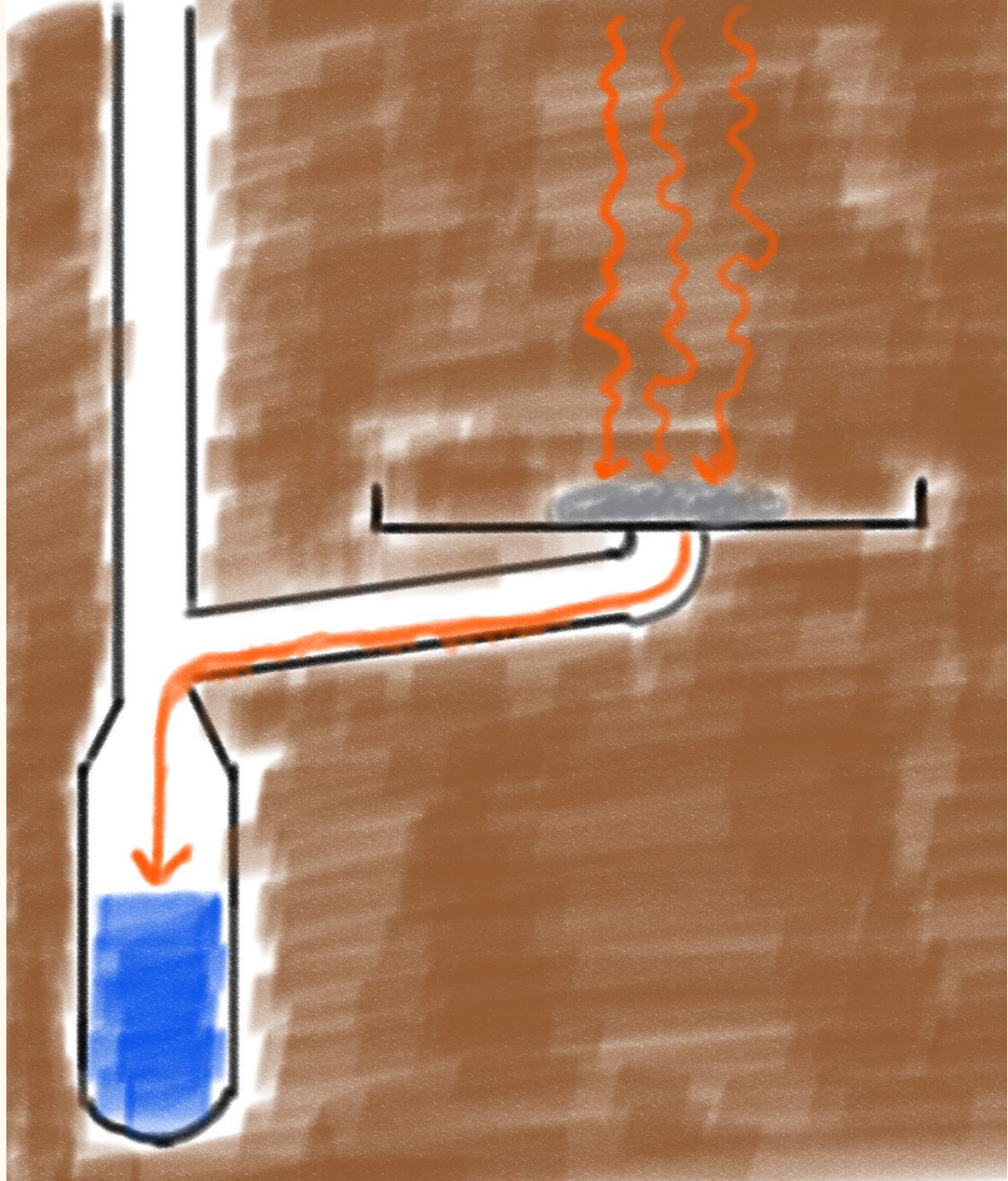


- soils adsorb phosphorus
- installed in shallow upper horizons
- cycle phosphorus in the vegetation above the septic system leachfield and attenuate the amount that migrates downward to the water table

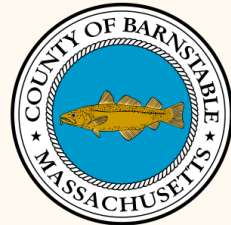
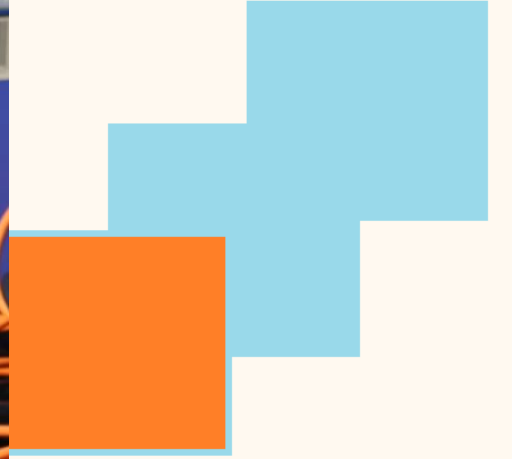




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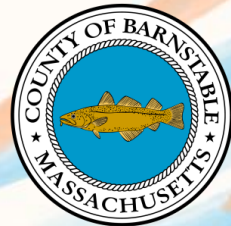
MASSTC
The Massachusetts Alternative
Septic System Test Center

A Division of the
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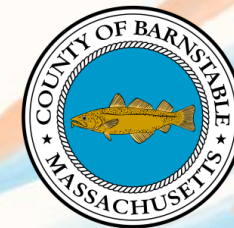
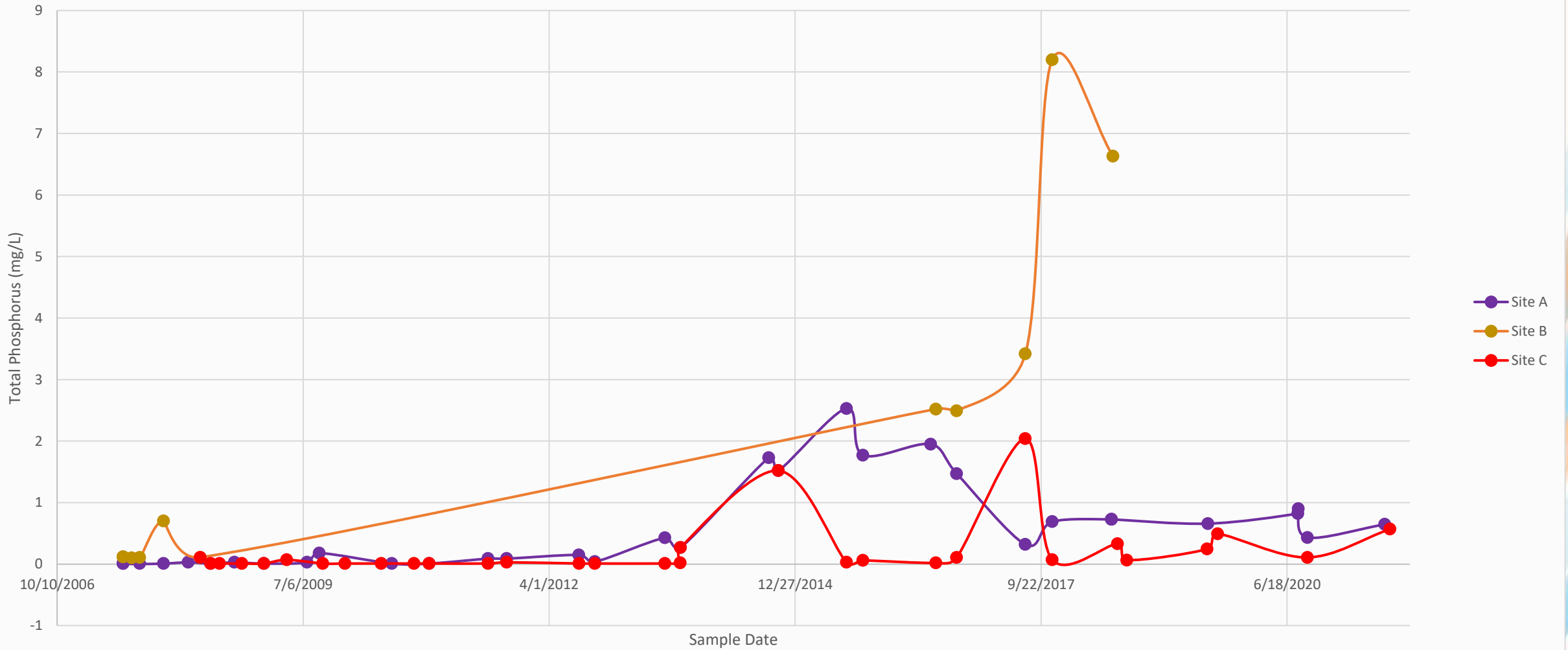
150HP

The data you are about to review derive from a self-reporting system for alternative onsite septic systems located in the towns in Barnstable County Massachusetts and other participating towns maintained by the Barnstable County Department of Health and Environment. The mention of any product on this website does not constitute an endorsement by Barnstable County. The validity of the data is qualified only by the licenses and integrity of Licensed Wastewater Treatment Operator who collected the sample and the Massachusetts Certified Laboratory that performed the analyses. This dataset includes samples taken at seasonally-occupied as well as full-time-occupied residences. Data during start up of the systems are also included. The reader/user is cautioned to understand the limits of these data in regard to assessing the performance of any technology and agrees that any re-representation or copying of these data will include the above qualification.

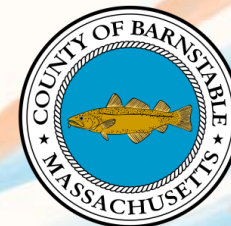
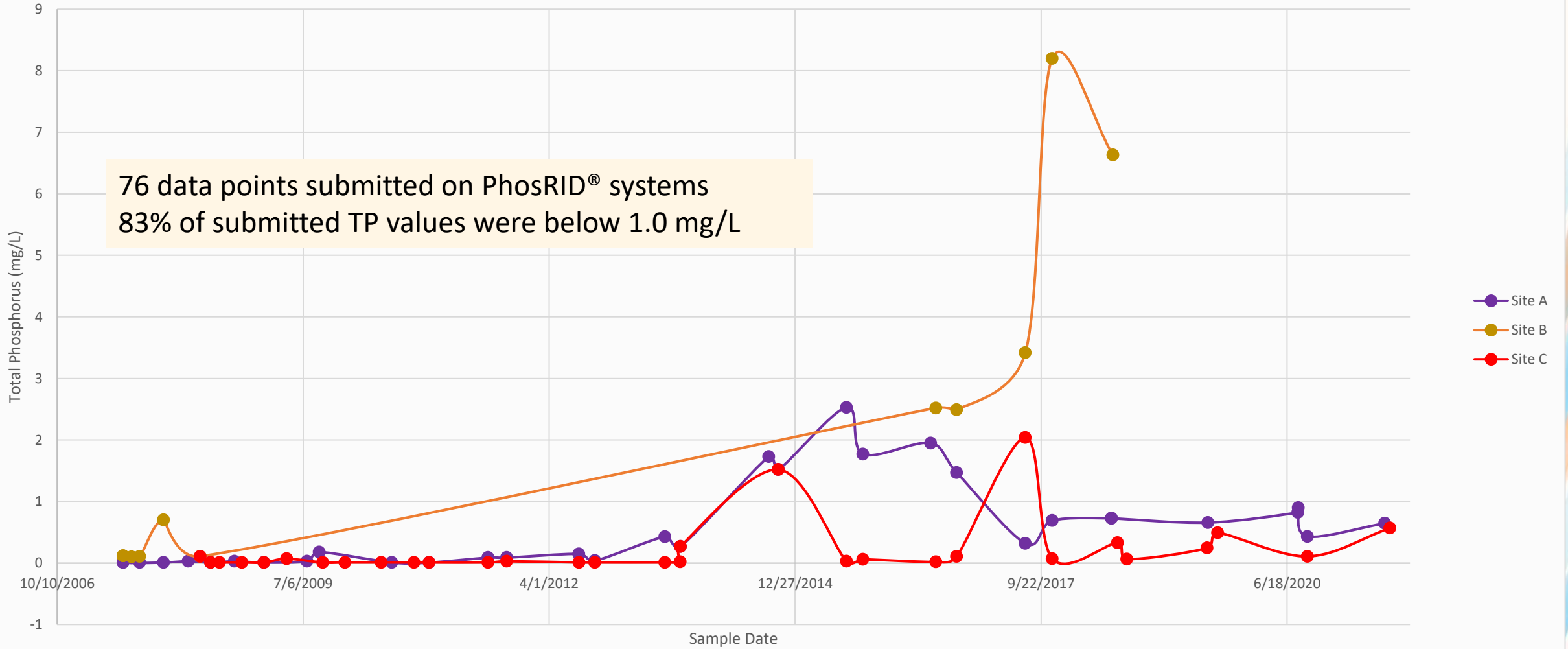


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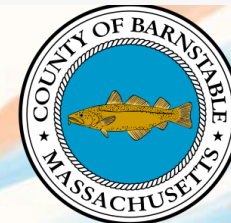
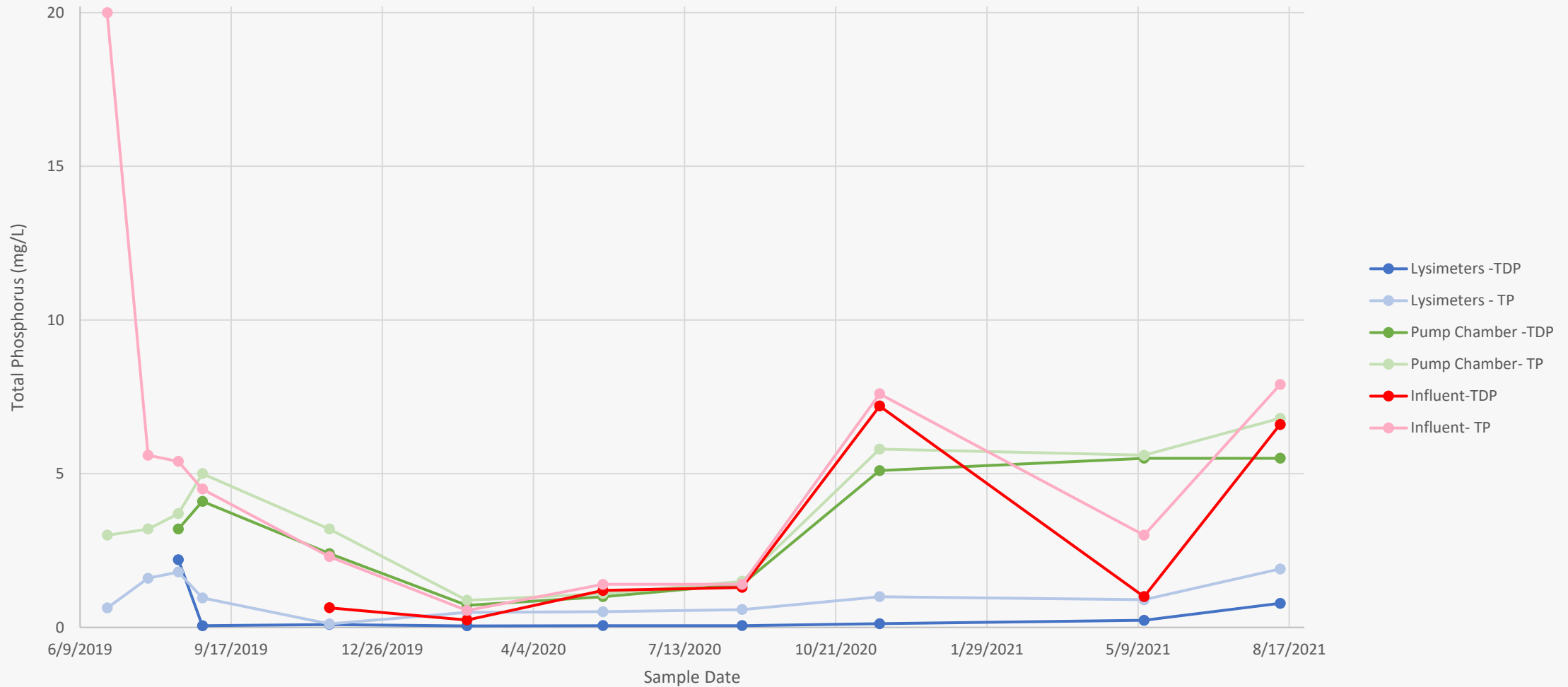
Total Phosphorus - PhosRID sites on Cape Cod



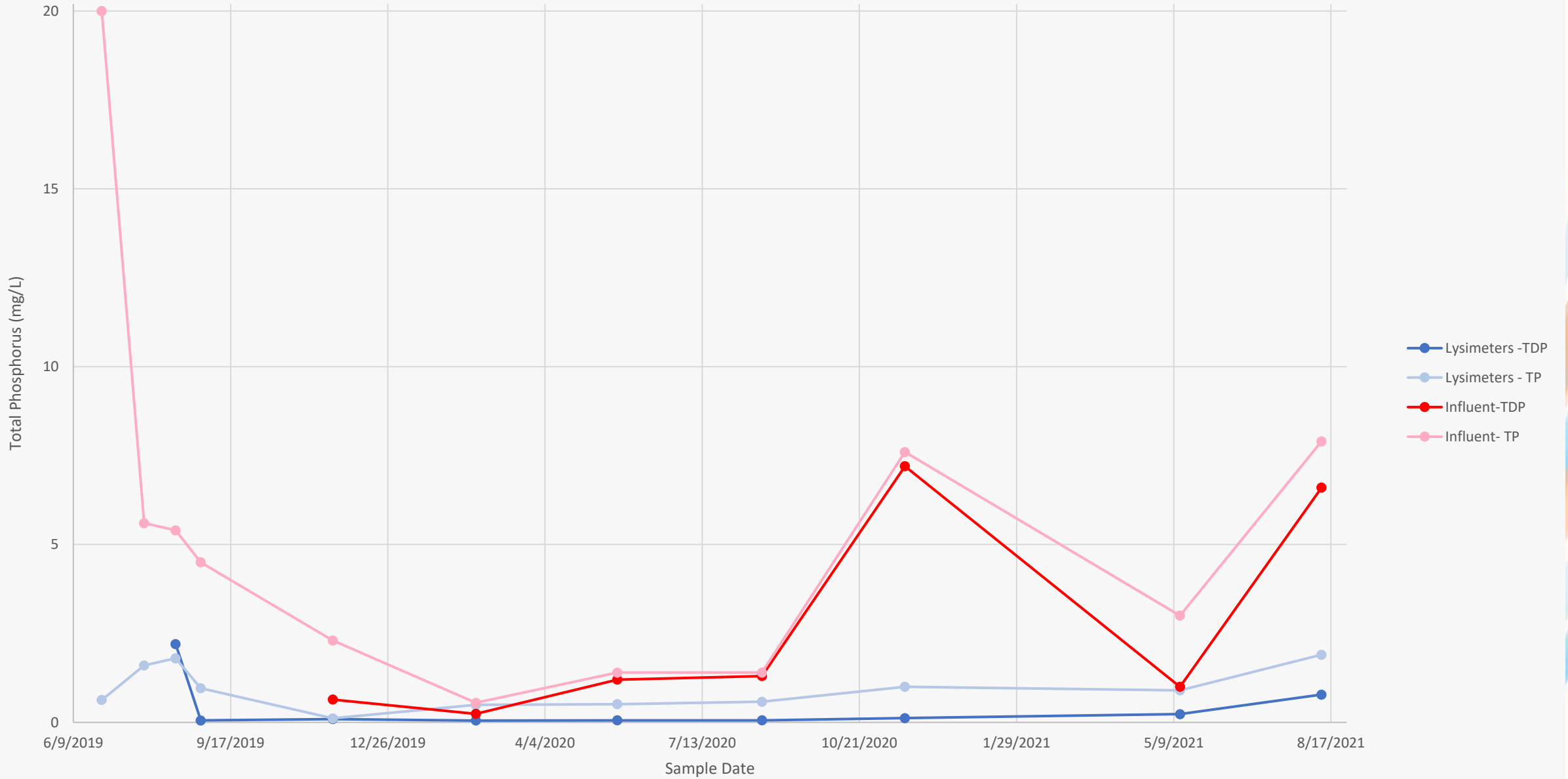
Total Phosphorus - PhosRID sites on Cape Cod



Waterloo EC-P[®] Installation - Total Phosphorus and Total Dissolved Phosphorus Results (mg/L)

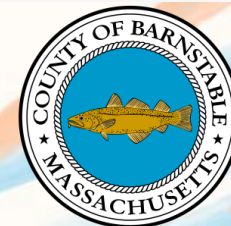
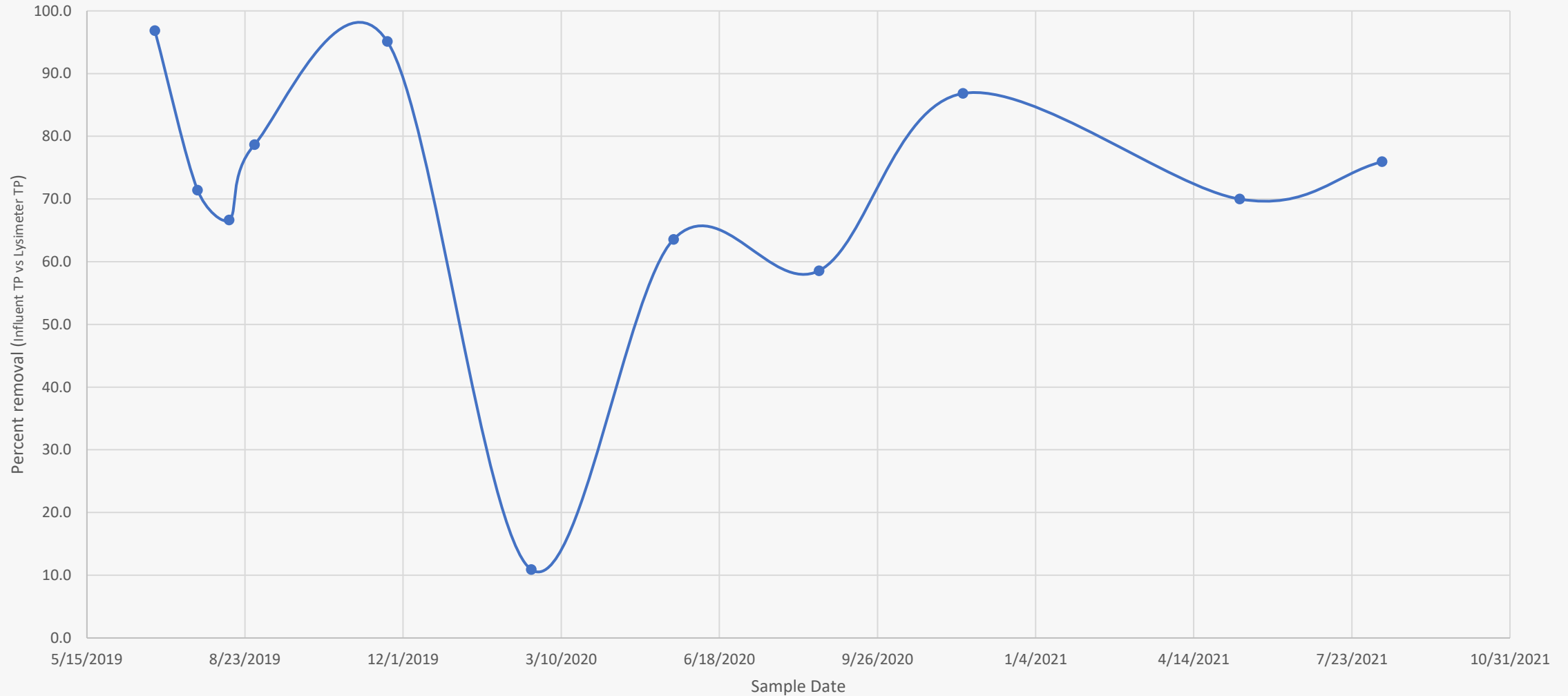


Waterloo EC-P[®] - Total Phosphorus and Total Dissolved Phosphorus Results (mg/L)

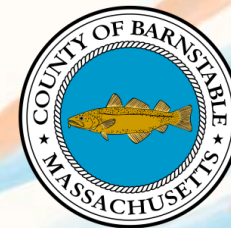


Percent Removal of Total Phosphorus - Waterloo EC-P

Based on Lysimeter vs Influent



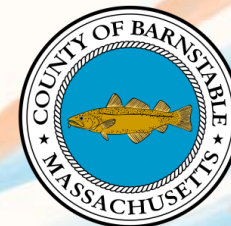
Sand bed



MASSTC
The Massachusetts Alternative
Septic System Test Center

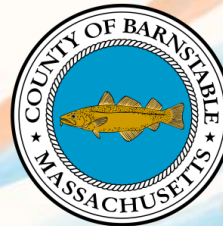
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Sand bed





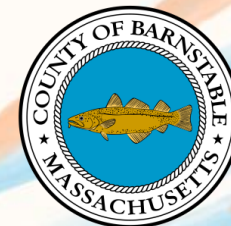
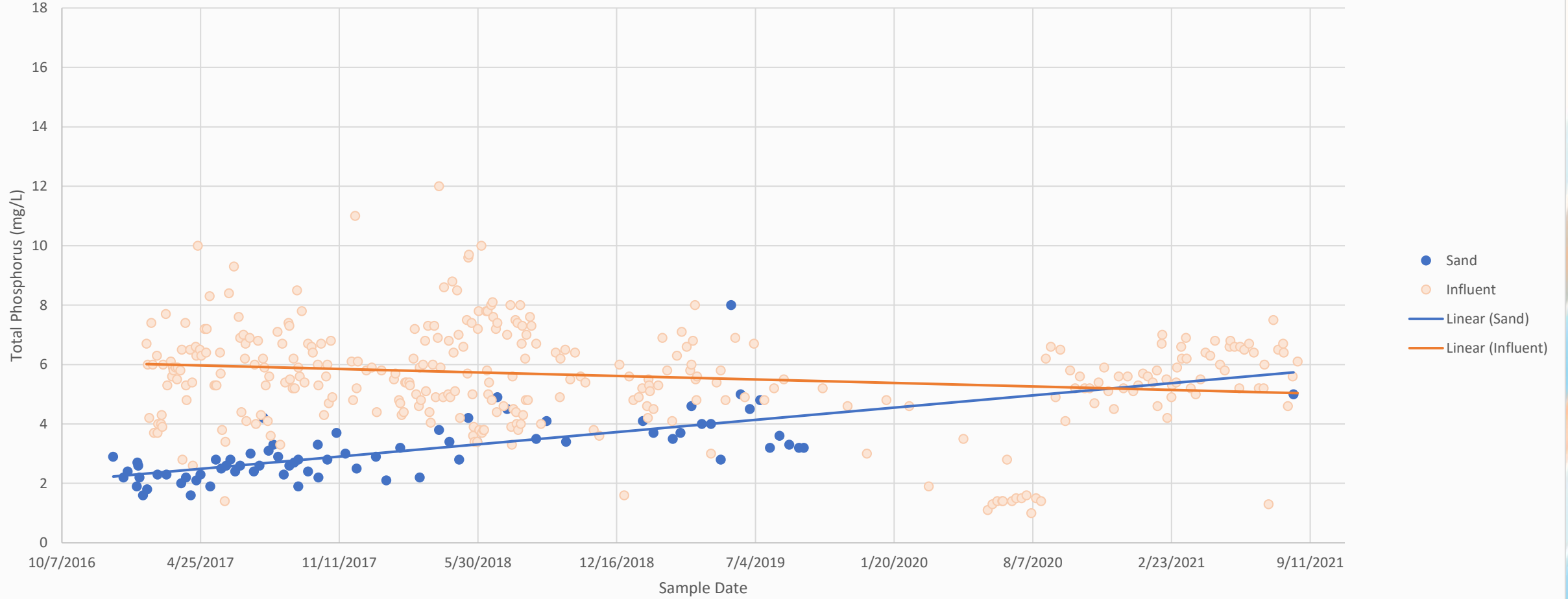
18 inches
C33 sand



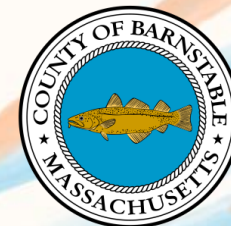
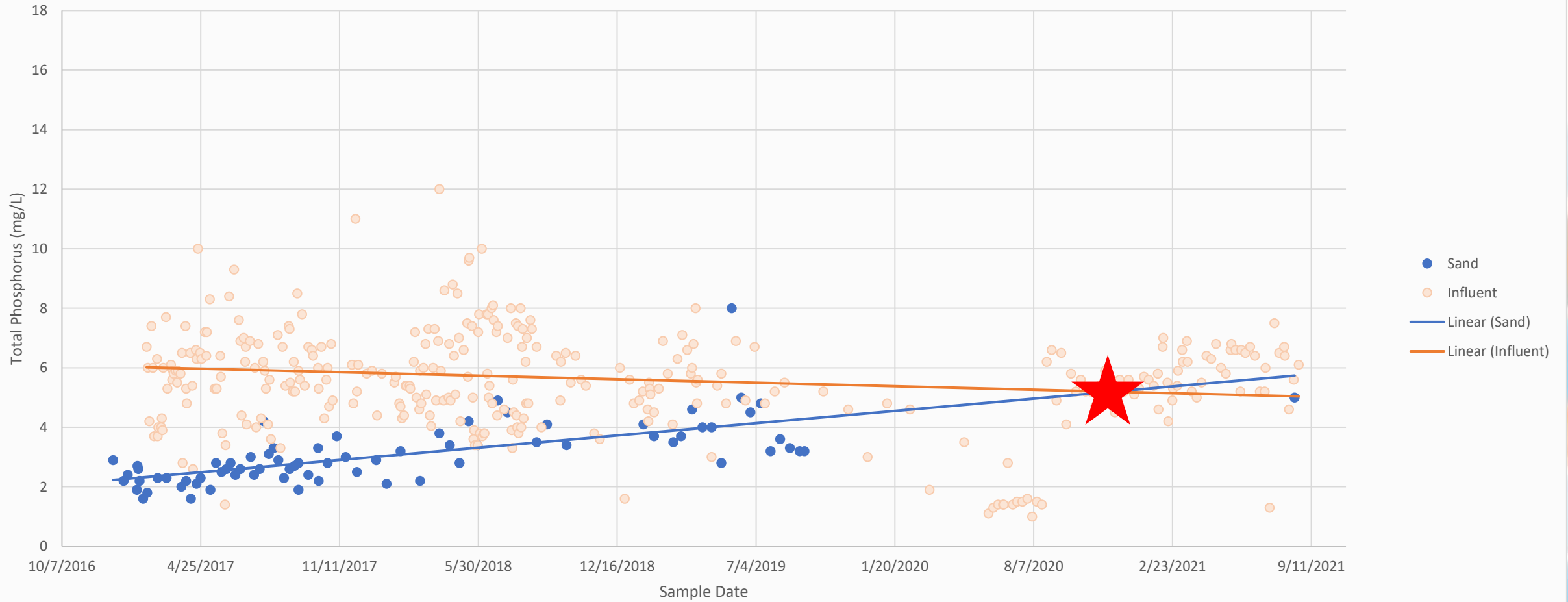
MASSTC
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Septic System Test Center

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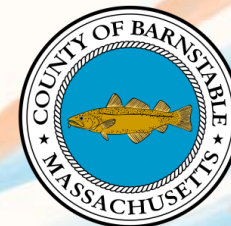
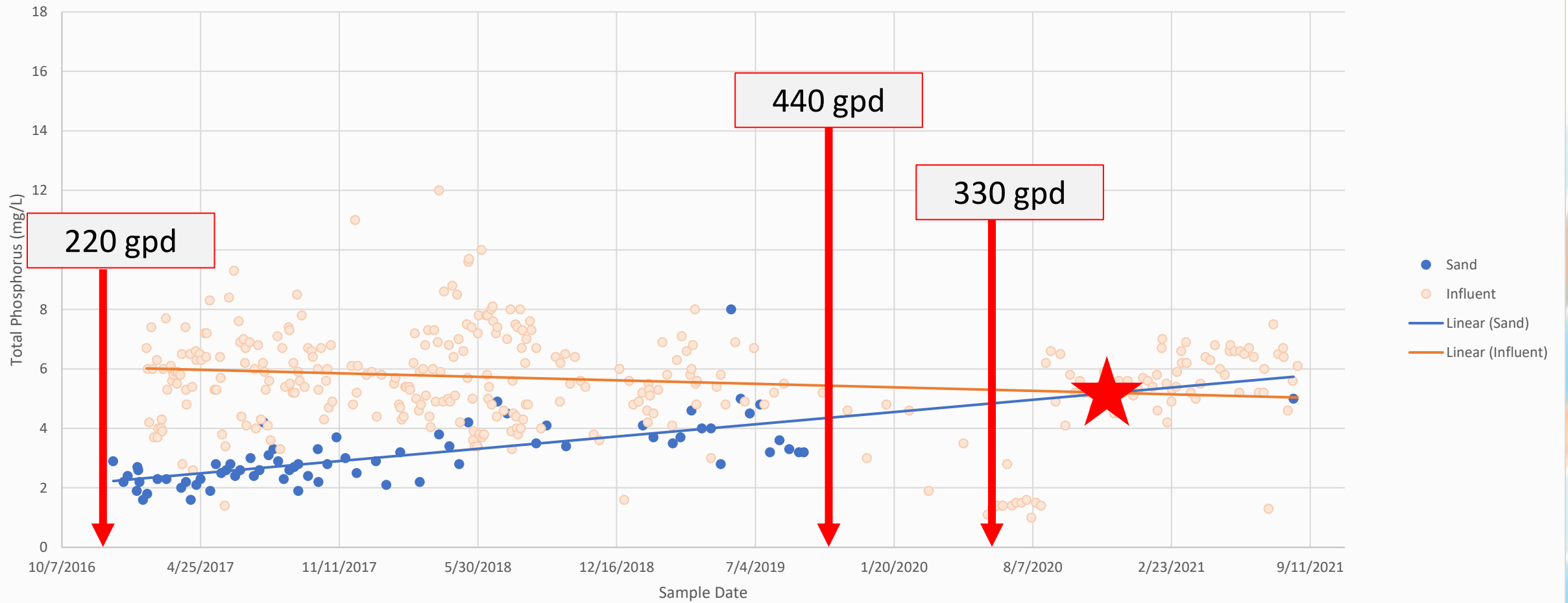
Total Phosphorus - Sand vs. Influent



Total Phosphorus - Sand vs. Influent



Total Phosphorus - Sand vs. Influent



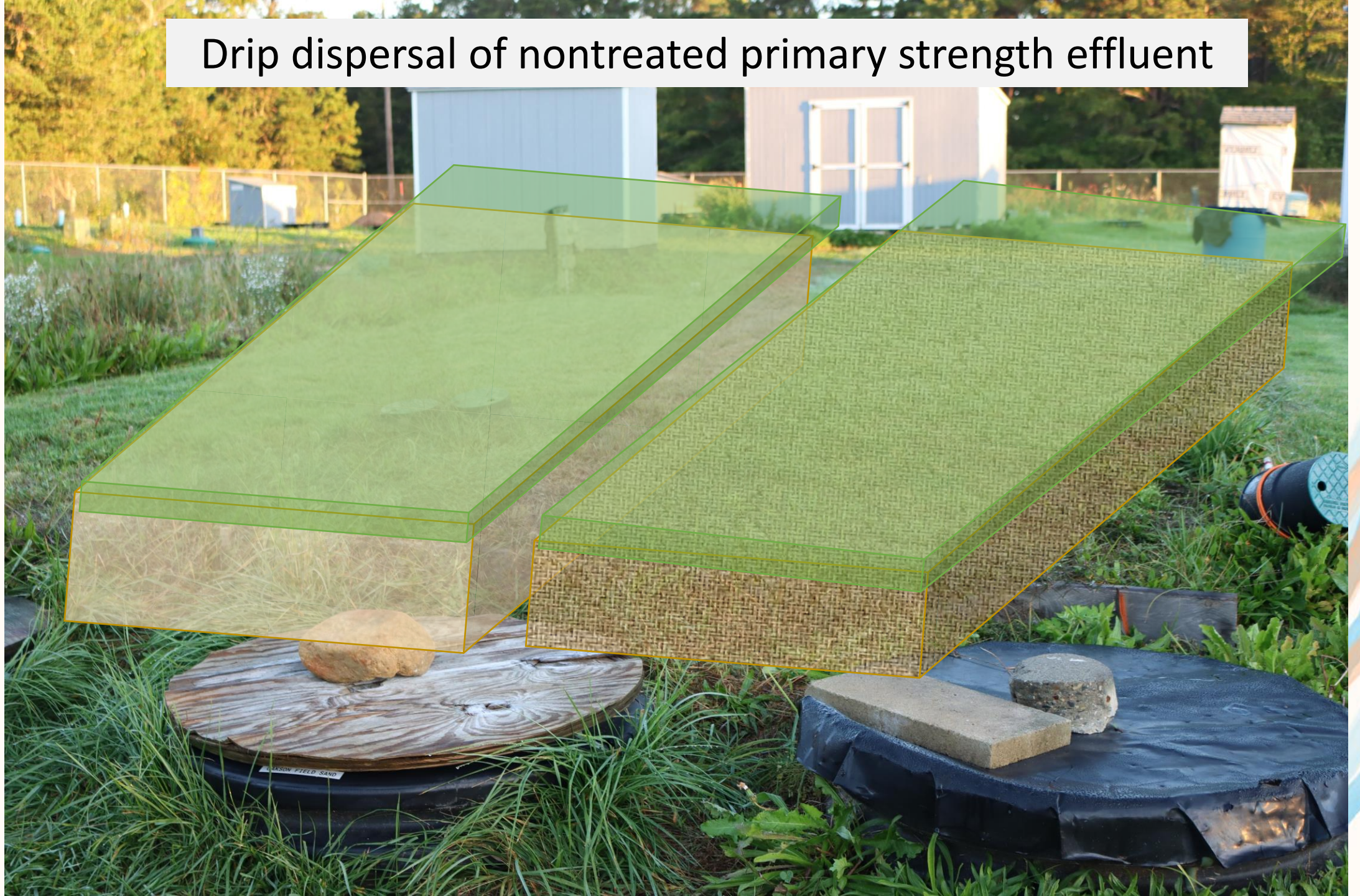
Drip dispersal of nontreated primary strength effluent



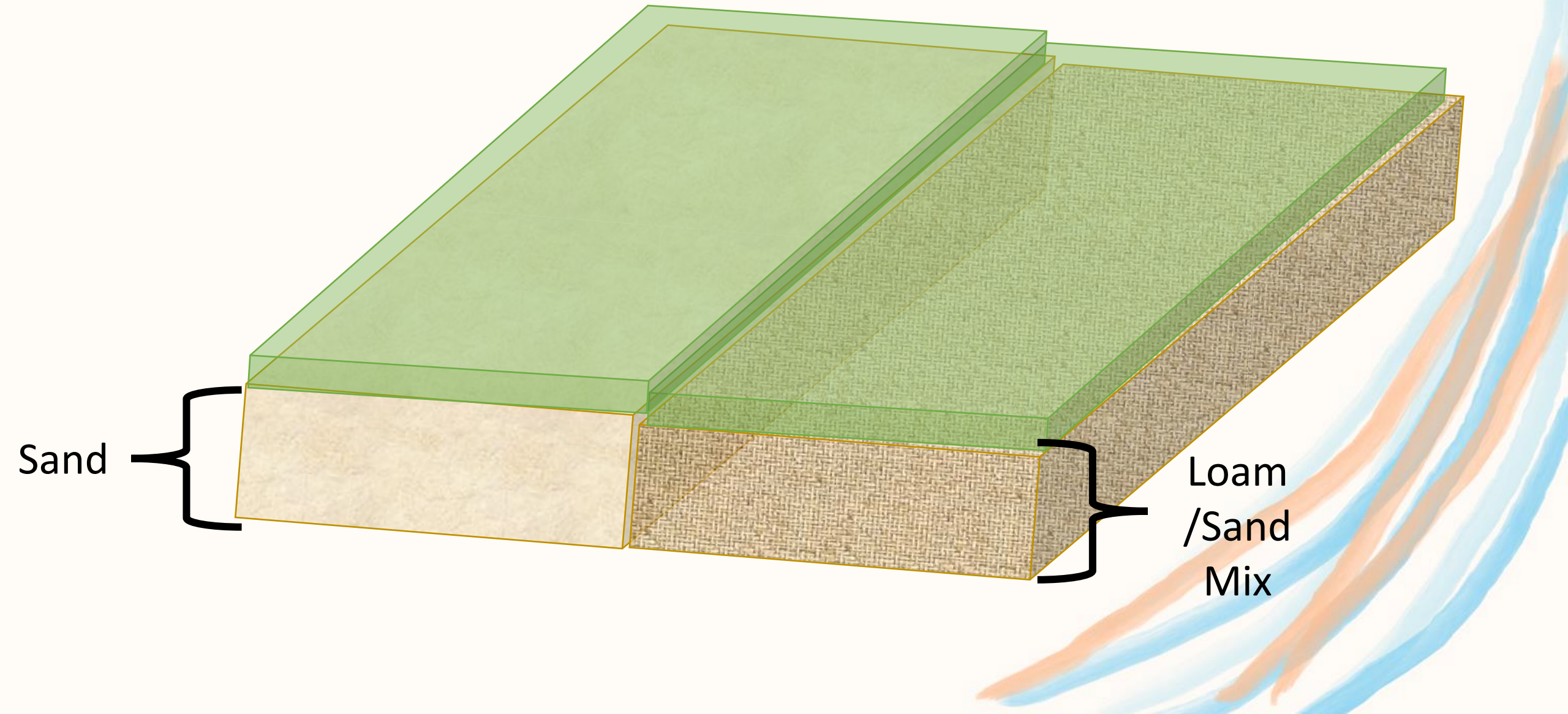
Drip dispersal of nontreated primary strength effluent



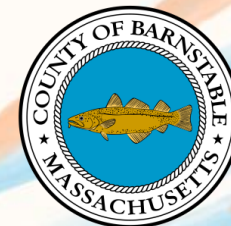
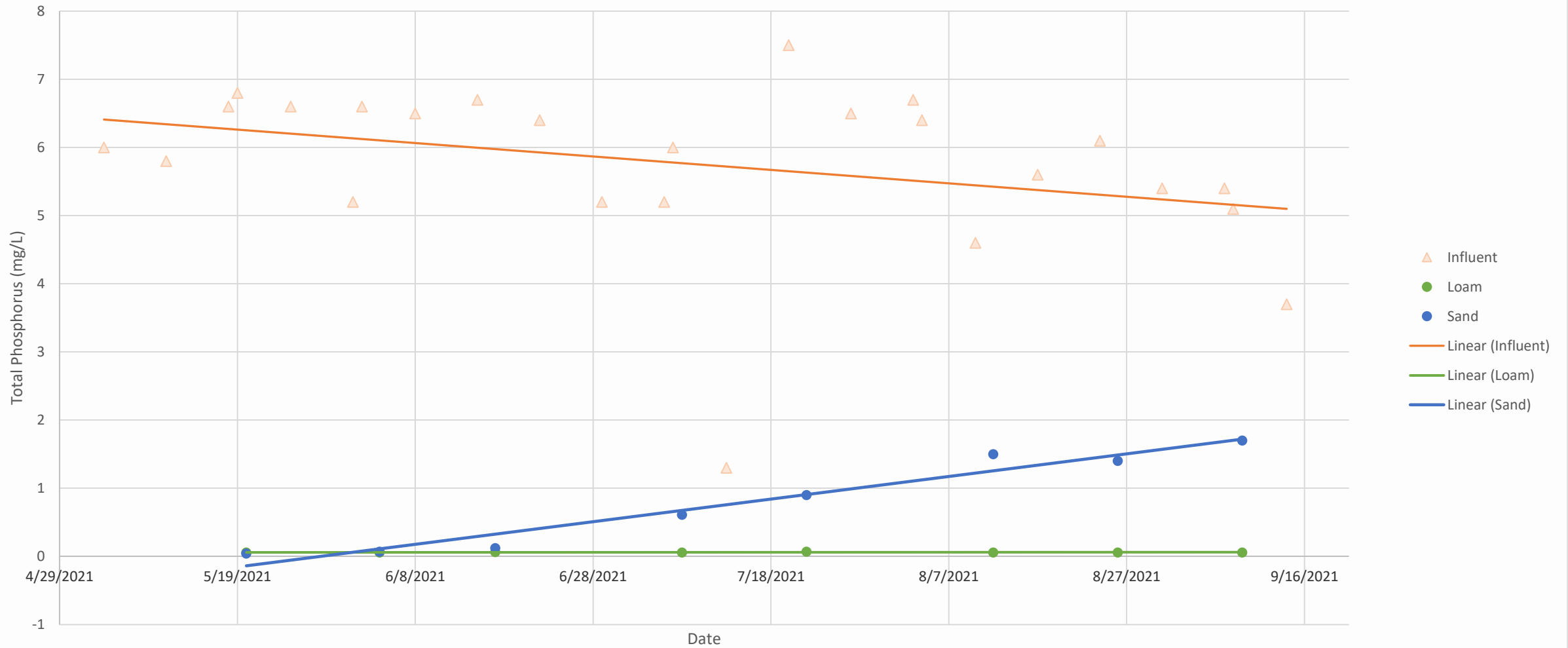
Drip dispersal of nontreated primary strength effluent



Drip dispersal of nontreated primary strength effluent



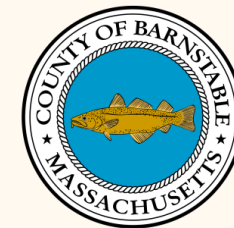
Total Phosphorus - Drip Dispersal vs. Sand vs. Influent





Sources of impact

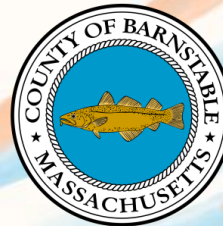
- Wastewater
- Stormwater
 - Fertilizer
- Natural sources (leaves)



The Algal Bowl – Lakes and Man

John R Vallentyne

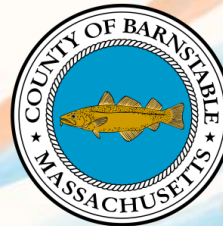
1974



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“The question was not whether people could have clean clothes *and* clean lakes, but whether North American Society could maintain its standard of cleanliness and sanitation without any phosphate in its detergents.”

-Vallentyne, The Algal Bowl – Lakes and Man



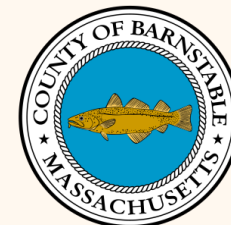
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Emily Michele Olmsted
Environmental Project Assistant
MASSTC/Barnstable County

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(508) 375-6901



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