Pond and Lake Management Technologies

AMBER UNRUH-SENIOR PROJECT MANAGER, SPECIAL PROJECTS

Types of Technologies:

1) Biological Controls

2) Chemical Controls

3) Physical Controls

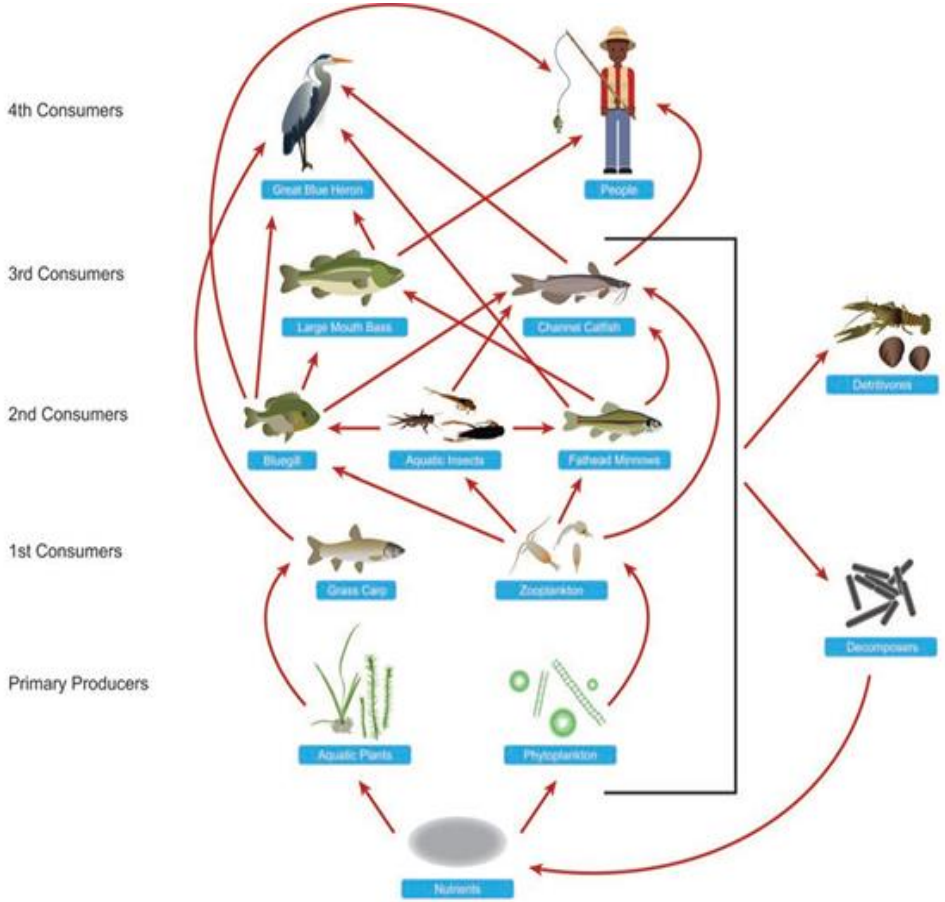
4) Watershed Phosphorus Loading Controls

Biological Controls

Address water quality impairments by altering the composition or relationships between the plants and animals in the pond, typically through shifting nutrients to other organisms

Examples:

- **Enhanced Grazing** – manipulation of food web to reduce algae levels
  - Limited effectiveness, possible permitting hurdles, not attempted on Cape Cod
- **Freshwater Aquaculture** – reintroduction or enhancement of native freshwater mussel populations to filter algae
  - Not attempted on Cape Cod due to permitting difficulties and challenges with sourcing of mussels



Chemical Controls

Address water quality impairments by addition of chemicals that alter water conditions to control algae, plants, and/or nutrients

Examples:

- **Algaecides**
- **Barley Straw**
- **Phosphorus Inactivation**
- **Selective Nutrient Addition** – manipulate phytoplankton community by adjusting nutrient ratios through addition of more nutrients

Alum application barge

Algaecides

- Kills cyanobacteria and algae; inhibits cyanobacteria growth
- Short-term control of cyanobacteria, requiring routine monitoring and maintenance
- Does not address nutrients
- Permits may require use restrictions for swimming, fishing, irrigation, agriculture, etc.
- Lysis of cyanobacteria cells may increase cyanotoxins in the short-term resulting in a pet or public health advisory
- Decaying algae increases oxygen, potentially releasing phosphorus from sediments
- Copper accumulation in pond sediments

- Types:
  - Copper-based – most common
  - Hydrogen Peroxide – most expensive, believed to be more environmentally friendly
  - Barley Straw – not currently permitted as an algaecide in MA

Algaecides – Cape Cod Examples

- Perera Pond, Yarmouth Port
  - 0.5-acre pond and privately owned
  - Completed treatment in 2022 with recommended follow up treatments in 2023
  - Two treatment doses required over July and August to control nuisance algae

- Long Pond, Falmouth
  - Public drinking water reservoir
  - Completed algaecide treatment in 2010 to control algae
  - Ultimately, Town of Falmouth upgraded the Water Treatment Facility in 2017 with Dissolved Air Floatation clarification and followed by filtration to remove bacteria, organics, particulates, and algae previously entering the system


Algaecide application


Long Pond New Treatment Facility

Barley Straw

- As barley decomposes, it produces hydrogen peroxide, suppressing cyanobacteria
- Shifts algal dominance from cyanobacteria to green/filamentous algae
- May release more phosphorus from the sediments due to lower oxygen levels as barley decays
- Not permittable as an algaecide in MA
- Example: Nashawannuck Pond, Easthampton
  - No reported cyanobacteria blooms 2023-2024
  - Requires community to fill, deploy, and remove 200 bags of barley straw


Deploying barley bags


Fresh barley bags

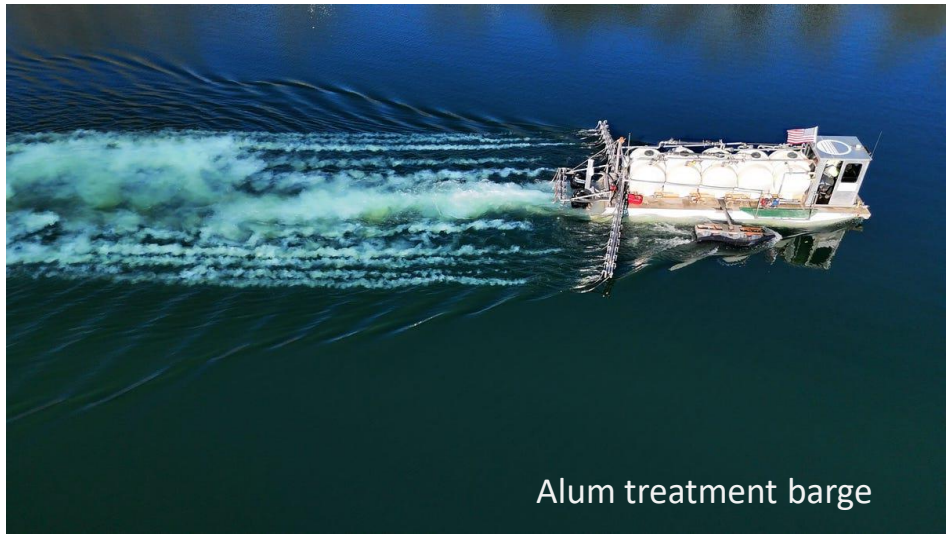

Cyanobacteria Monitoring

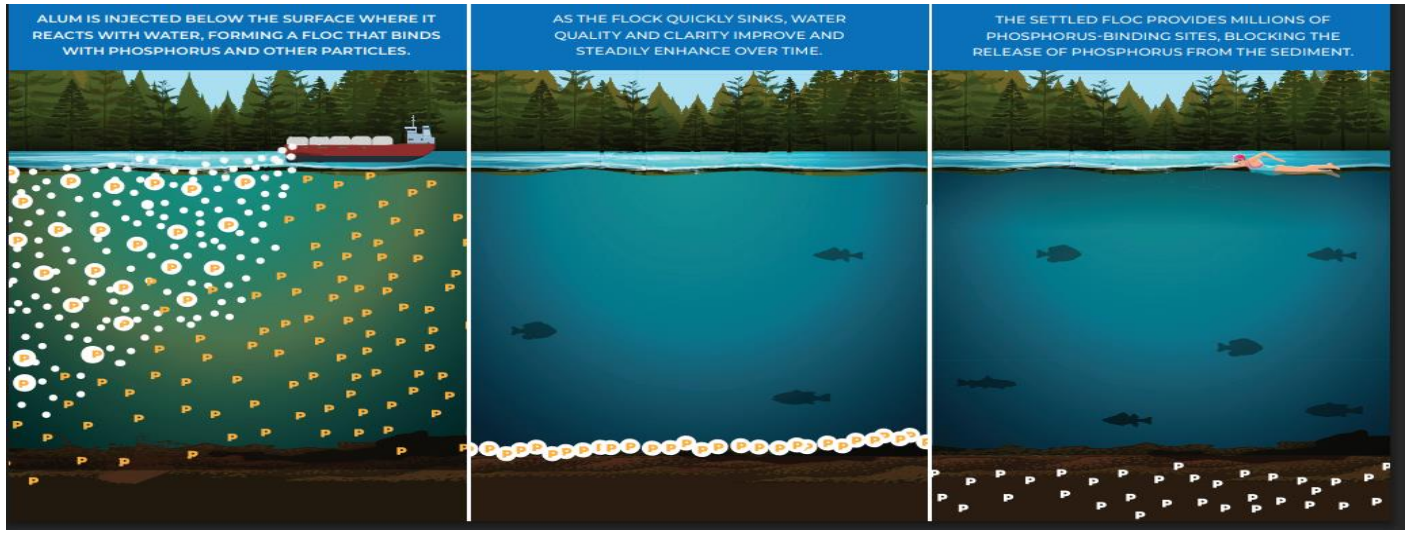

Barley bags in late season, only floats visible

Phosphorus Inactivation

- Provides rapid reduction of phosphorus levels through use of phosphorus-complexing compounds, particularly aluminum sulfate (alum) to strip phosphorus out of the water column and bind to phosphorus in the sediments
- May result in fish or mussel die-offs if not properly dosed or buffered
- Effectiveness may be short-term if phosphorus sources are not well understood or other inputs addressed; however, some treatment have provided improved water quality for 15+ years

- Cape Cod Examples: Several; including Hamblin, Mystic, Lovells, Shubael Ponds in Barnstable


Alum treatment barge

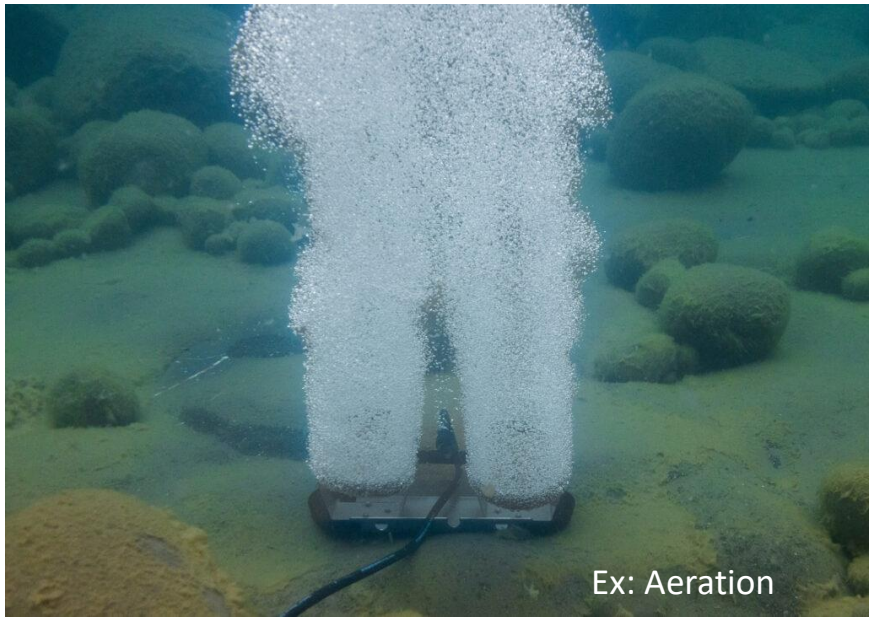


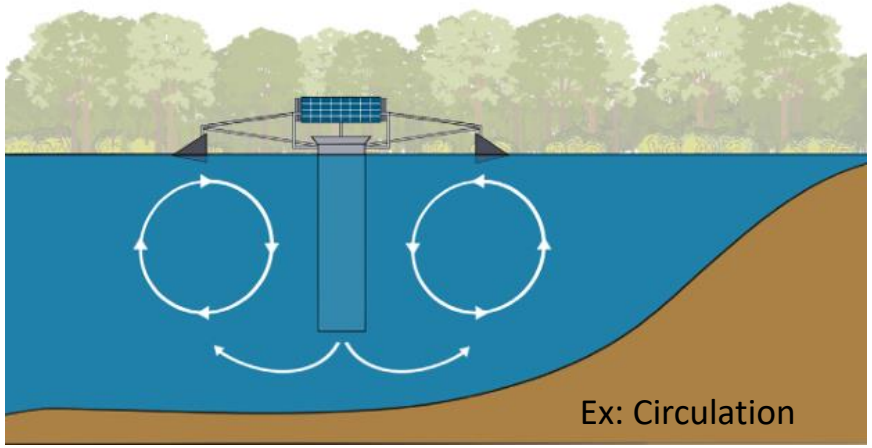
Physical Controls

Address water quality impairments by through alteration of water levels or inputs, aeration, mechanical harvesting of algae and plants, or dredging.

Examples:

- **Aeration**
- **Enhanced Circulation (e.g. Solar Bees)**
- **Hydrologic Manipulations**
- **Dredging of Sediments**
- **Dyes and Surface Covers to Restrict Plant Growth Surface Skimming**
- **Mechanical Removal of Plants**
- **Floating Treatment Wetlands**
- **Sonication**

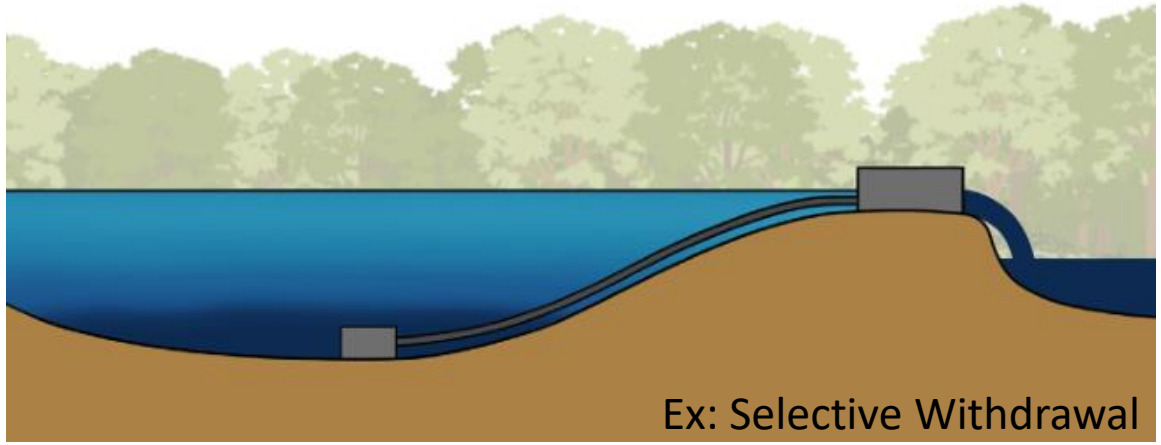

Ex: Aeration


Ex: Circulation

Hydrologic Manipulations

- Involves manipulation of water inflow/outflow or water removal/addition to control cyanobacteria levels and growth
- May reduce nutrient levels and improve dissolved oxygen levels, but sends nutrient-rich water somewhere else
- May be expensive and difficult to permit
- May result in unintended consequences to aquatic organisms

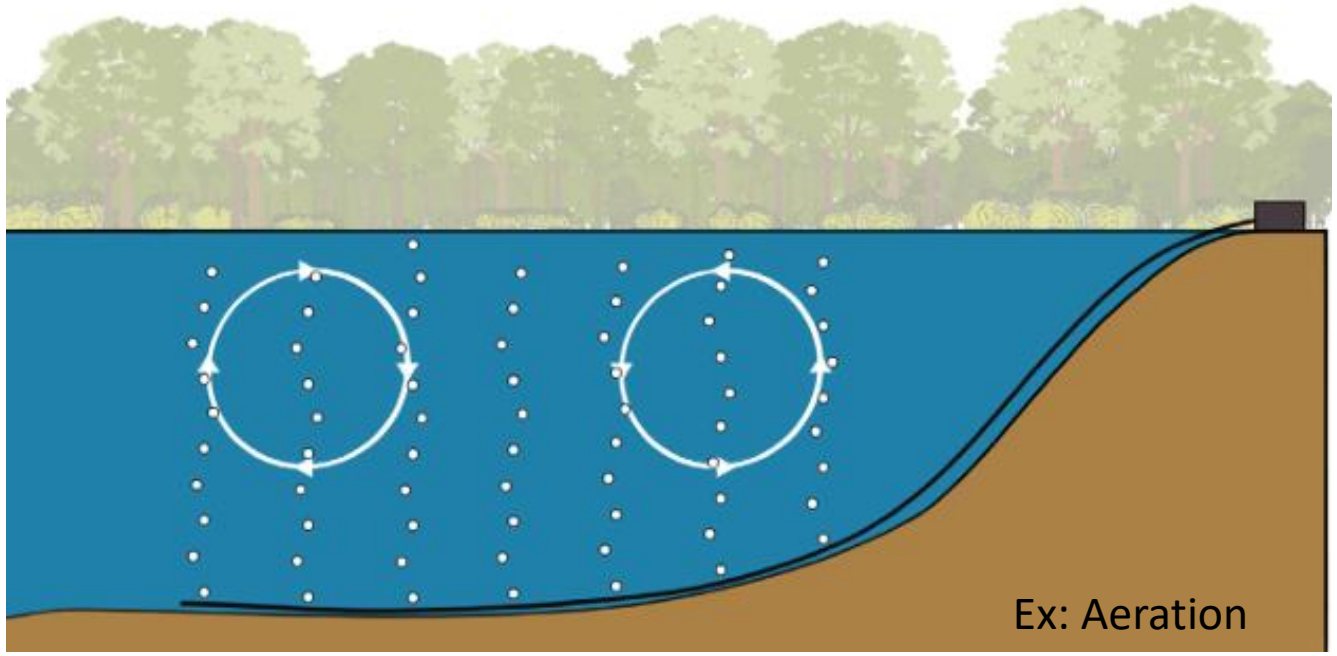
- Types:
  - Dilution – add water to reduce nutrient levels and decrease water residence time
  - Drawdown – exposes cyanobacteria to dry conditions
  - Selective Withdrawal – removal of nutrient rich bottom waters



Ex: Selective Withdrawal

Aeration

- Controls sediment nutrient release through aeration of water column to breakdown stratification and eliminate low oxygen in bottom waters
- Provides algae control when operational and improves oxygen levels
- Requires constant operation to be effective
- Less cost effective than alum



Aeration – Cape Cod Examples

- Lovells Pond, Barnstable
  - Installed bottom aeration in 50-acre pond
  - Aeration in 2009, 2010, 2011
  - Temporary breakdowns in aeration pumps resulted in stratification, which exacerbated the algae problem when aeration was restored
  - Due to difficulties in maintaining constant aeration the aerator was decommissioned in 2012

- Sarah's Pond, Orleans (5.8-acres & max depth 17.5ft)
  - Installed Nanobubble technology in 2019 and 2020 with limited effectiveness
  - Installed Oxygen Saturation Technology in 2021 to improve oxygen levels and control cyanobacteria
  - Took two years of troubleshooting to achieve desired effectiveness


New aeration piping in 2022 for Sarah's Pond OST

Floating Treatment Wetlands

- FTWs assimilate phosphorus into the plant biomass, which can later be harvested, permanently removing phosphorus from the pond
- Previous studies indicate phosphorus removal effectiveness varies ranging from 0.1 kg to 1.8 kg per 100 sq. ft. of FTW
- Provides habitat for aquatic organisms


2020- Charles River, Boston


2025- Long Pond, MM


2025- Eagle Pond, MM

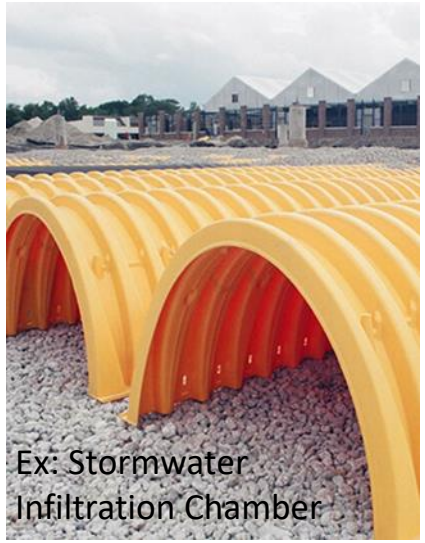
Watershed Controls

Address water quality impairments by managing nutrient inputs from the watershed

Examples:

- **Sewers**
- **Phosphorus Reducing Septic Systems**
- **Fertilizer Reductions**
- **Pond Buffer Enhancement**
- **Stormwater Control Measures**
- **Permeable Reactive Barriers**

Ex: PR Septic- Fuji Clean CRX

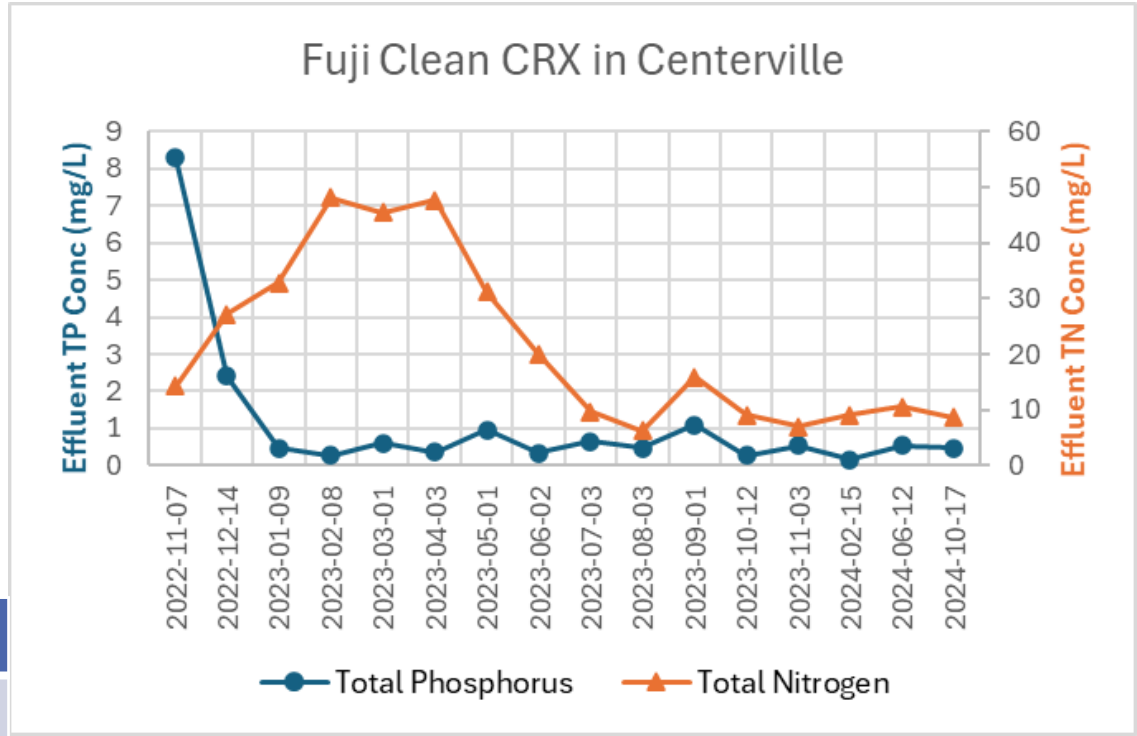


Ex: Stormwater Infiltration Chamber

Ex: Stormwater Swale

Phosphorus Reducing Septic Systems

- Fuji Clean CRX
  - Fuji Clean CRX systems integrate iron electrolysis into its standard denitrification treatment process to simultaneously maximize reduction of both nitrogen and phosphorus nutrients as well as BOD and TSS.
  - Pilot Approval TP <1mg/L and TN <10 mg/L

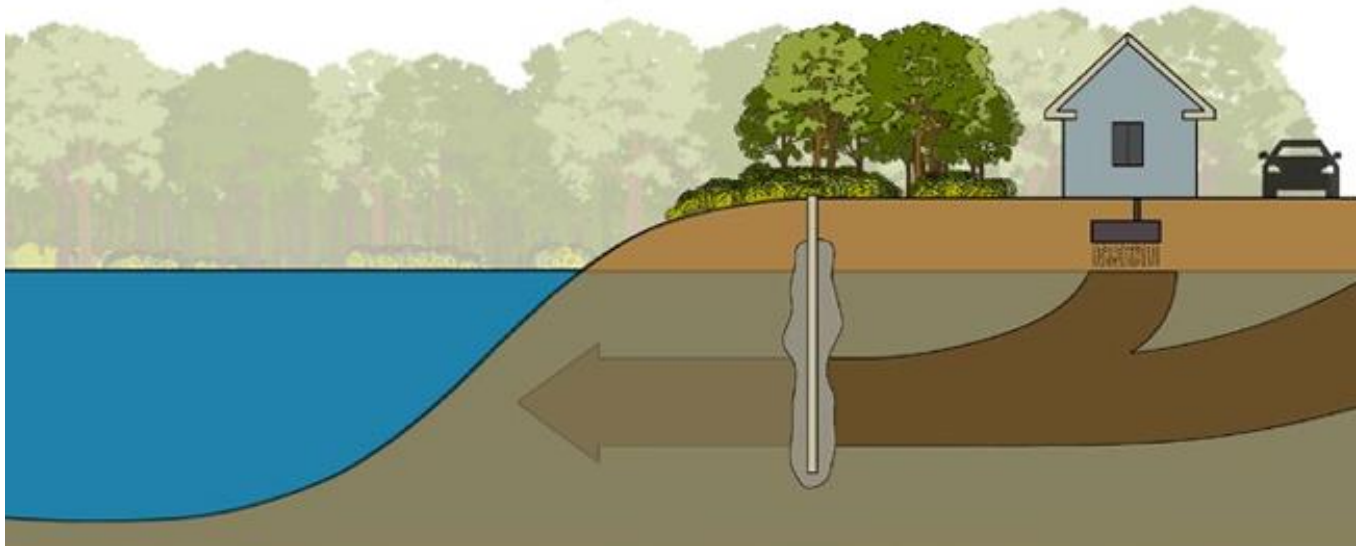


PR-Septic Type	Approval Status	Effluent TP
Phos-4-Fade	Pilot	<0.3 mg/L
PhosRID	Pilot	<1 mg/L
Waterloo EC-P	Pilot	<1 mg/L

Source: https://www.mass.gov/info-details/approved-title-5-innovativealternative-technologies#approved-for-piloting-use

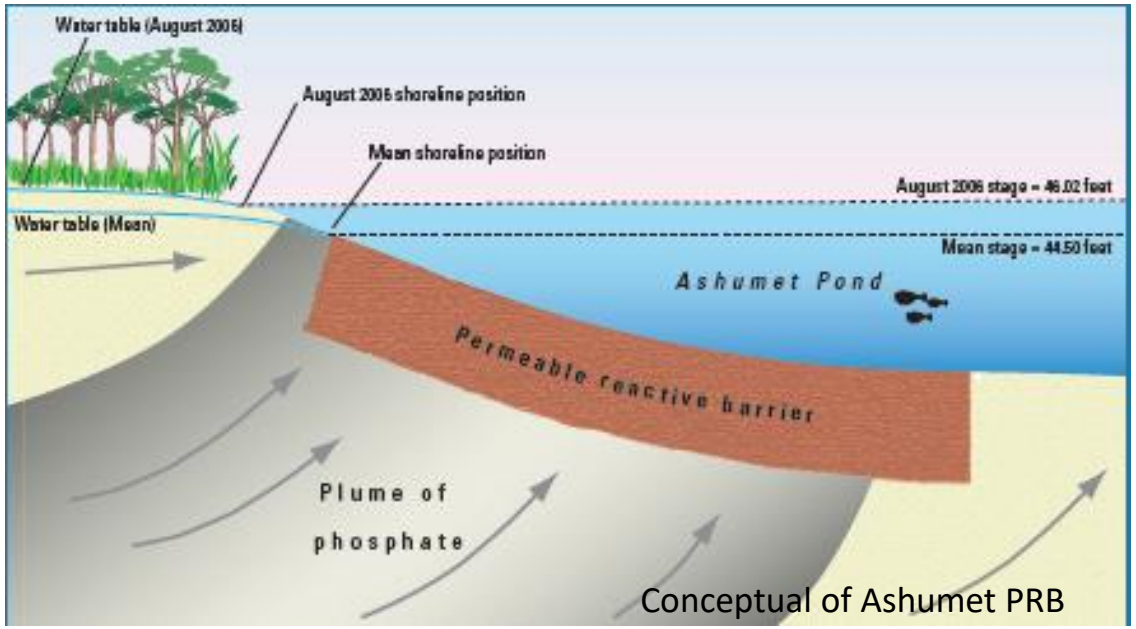
Permeable Reactive Barriers

- Controls phosphorus with an underground permeable “wall” that binds to the target nutrient
- Effective for reducing phosphorus in groundwater
- Requires detailed groundwater monitoring and modeling to determine contaminated groundwater flow path
- Extensive permitting for near shore installation
- Need public space to install



PRB - Cape Cod Example

- Ashumet Pond, Falmouth/Mashpee
  - Phosphorus plume created from 60-years of treated wastewater disposal in upgradient watershed
  - Plume entered the pond within 60-ft of the shore along about 400-ft of shoreline
  - USGS / EPA installed and monitored approximately 200 sampling points to determine effectiveness of an Iron-based PRB
  - Successful removal of phosphorus and nitrate passing through the PRB



Conceptual of Ashumet PRB


Coffer Dam installation to install PRB

QUESTIONS?

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Visit https://capecodcommission.org/our-work/cape-cod-freshwater-initiative/ for more information on pond treatment technologies