



→ Anastasia Rudenko PE, BCEE, ENV SP
Associate

Falmouth, MA Case Study

→ Implementing a water quality restoration program through an adaptive management approach

Welcome

> Outline

- ➊ Background and History
- ➋ Traditional nitrogen management strategies
- ➌ Pilot nitrogen management strategies
- ➍ Looking forward



Background and history

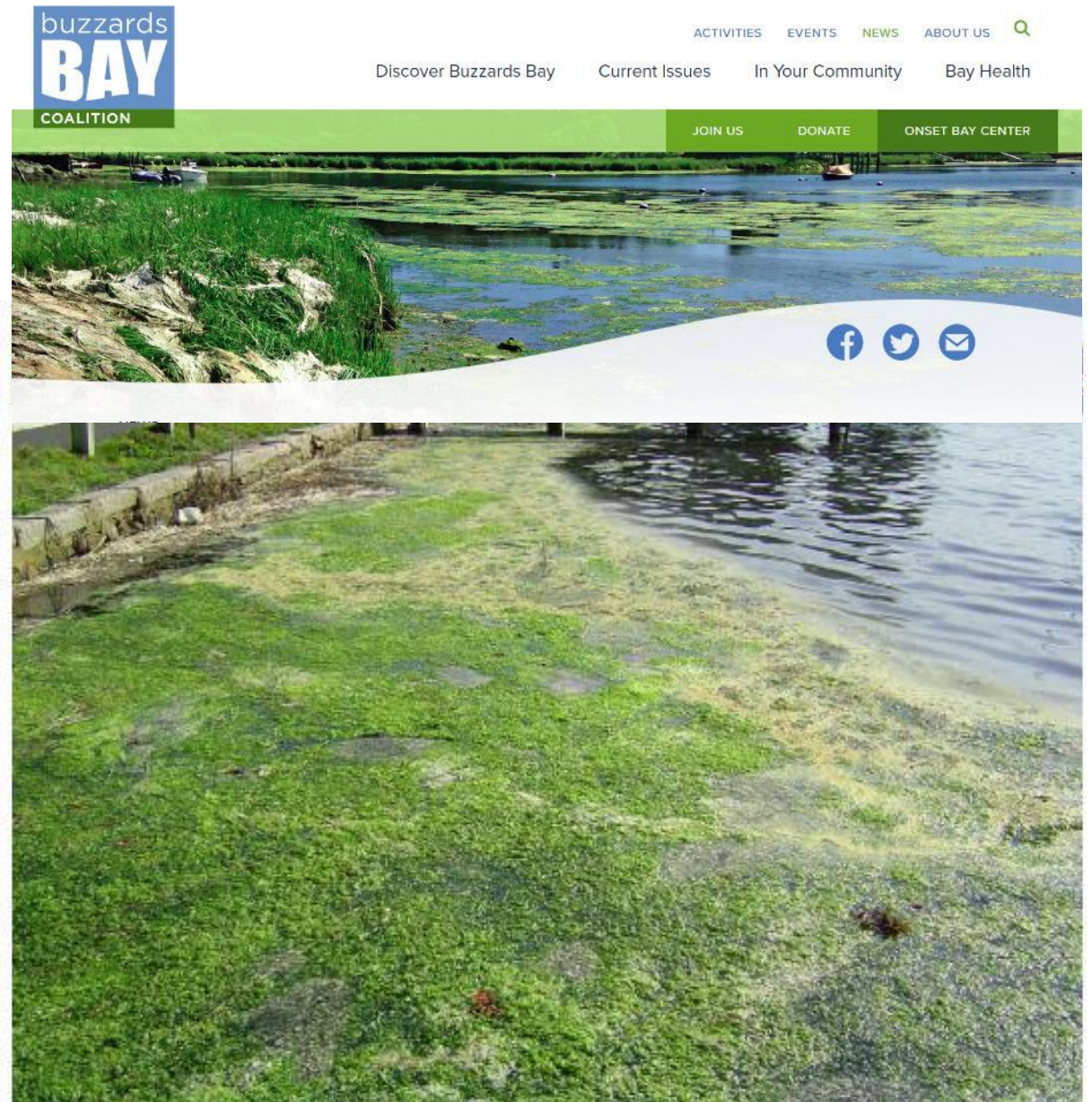
Setting

- – Falmouth is located on Cape Cod
- Coastline along Buzzards Bay, Vineyard Sound
- The town contains 15 coastal embayment / watersheds
- Population growth has led to excessive nitrogen inputs to estuaries



Massachusetts estuaries project (MEP)

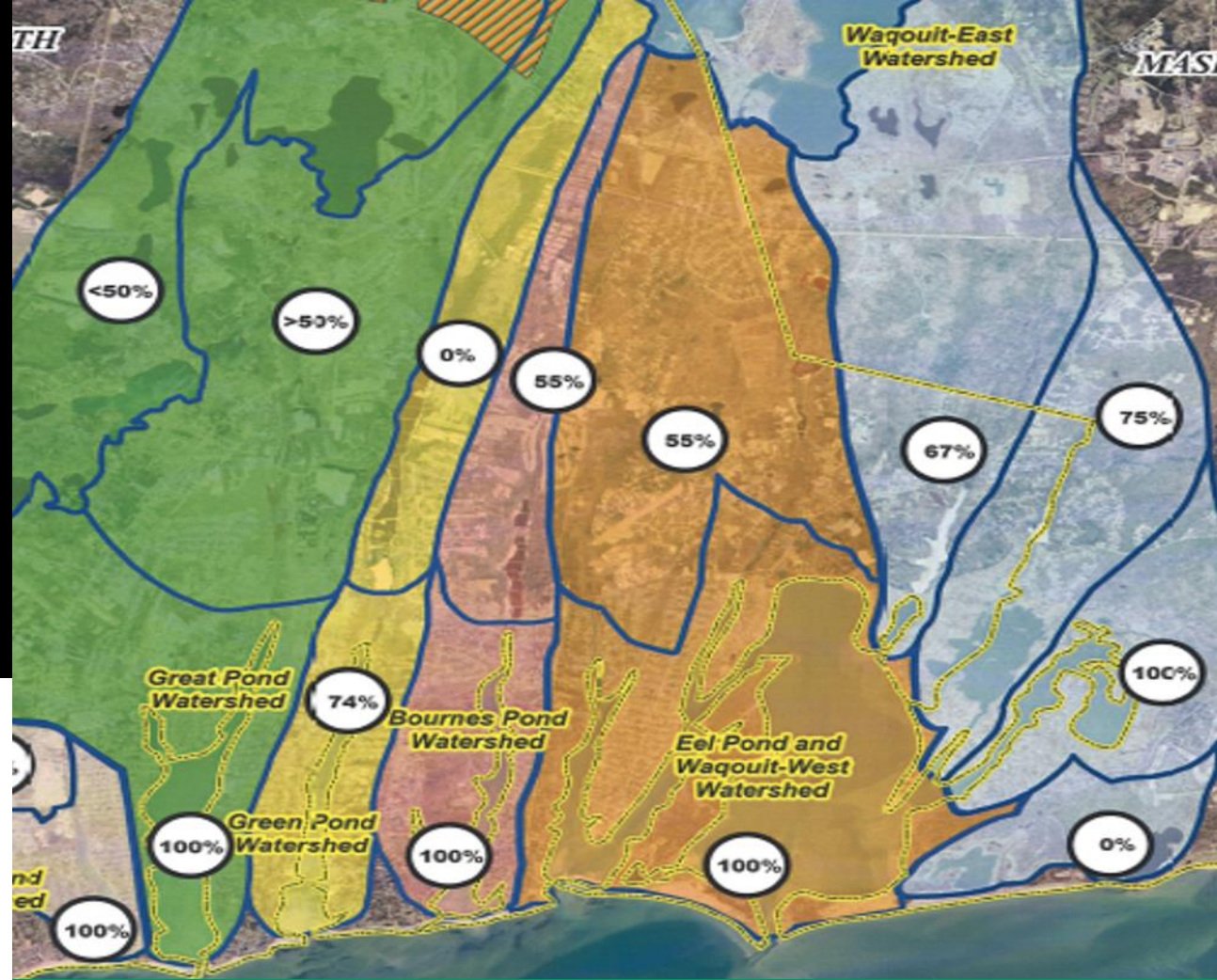
- Created in 2001 to:
 - Assess coastal estuary health
 - Determine nitrogen input reductions required to support a healthy ecosystem
- Collaborative effort between:
 - MassDEP
 - UMass Dartmouth
 - Southern Massachusetts communities
- Linked model used to evaluate nitrogen inputs to estuaries
 - Data used by MassDEP establish Total Maximum Daily Loads (TMDLs) for each estuary
 - Communities need to develop nitrogen management plan to meet TMDLs



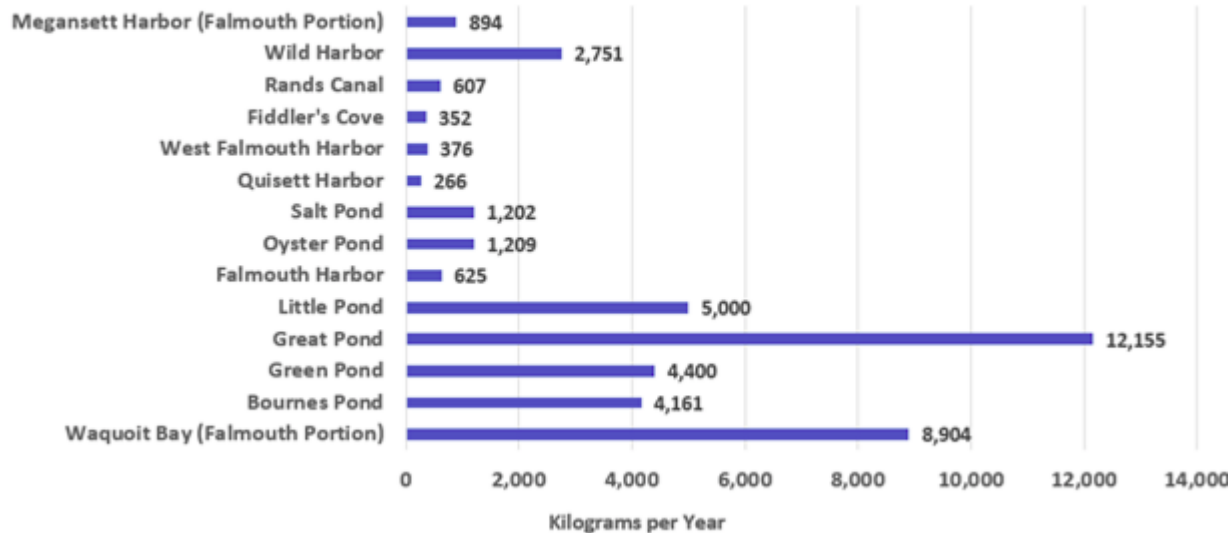
Nitrogen pollution fuels the growth of algae blooms, like this one seen in West Falmouth Harbor in 2012.

Southern embayment CWMP

- Developing targeted watershed management plans for each coastal estuary
- West to east



Nitrogen Required to be Removed to Restore Each Estuary (Massachusetts Estuaries Project)



Wastewater nitrogen reduction to meet TMDLs

CWMP challenges and strategy

Town challenges

- Scale of nutrient problem
- Cost of sewerage solution
- Interest in alternative / non-traditional solutions

Town strategy

- Move forward with sewers in one of most impacted watersheds
- Simultaneously pilot and gather data on alternative strategies
- Incorporate results into adaptive management solution for all watersheds
- Address watersheds systematically through targeted watershed management plans (TWMPs)
- Little Pond – First approved TWMP in the commonwealth

Traditional nitrogen management strategies

Prepared in cooperation with the U.S. Environmental Protection Agency's
Southeast New England Program

Evaluating the Effects of Replacing Septic Systems With Municipal Sewers on Groundwater Quality in a Densely Developed Coastal Neighborhood, Falmouth, Massachusetts, 2016–19



Measuring the impacts of sewerage on little pond water quality

- Monitoring well installation
- Groundwater lens characterization
 - Thin freshwater lens (3 to 9 m)
 - Fine to coarse well sorted sands
 - Tidal response in all wells
 - Septic return flow ~ 20-25% of natural recharge
- 3-D MODFLOW modelling
 - Incorporates observed field conditions to simulate septic plume travel times
 - Estimated mean travel time = 2.5 years
 - Estimated maximum travel time > 10 years

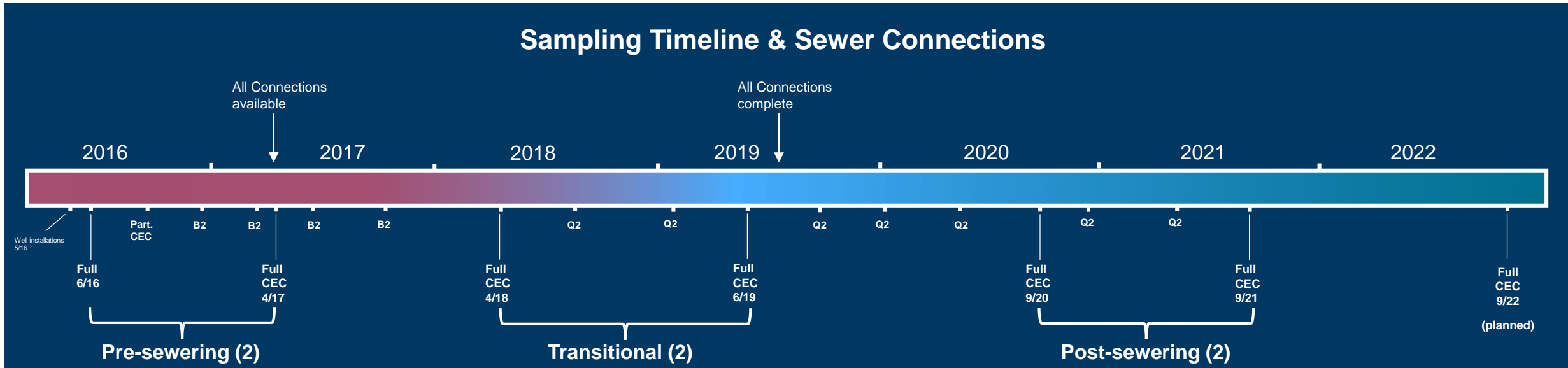
Monitoring program

– Field sampling

- Field parameters (PsC, pH, T, DO)
- Nutrients (nitrogen species, phosphorus)
- Boron, chloride

– Initial findings

- Decrease in nitrates and SpC, Increase in DO, pH
- Decreasing trend in median nitrate at 11 of 14 sites in September 2020 sampling
- Still very early in anticipated restoration



Pilot nitrogen management strategies

Alternative nutrient management solutions

Water Quality Management Committee – Leadership role in piloting, collecting data and evaluating these strategies

- Shellfish aquaculture
- Fertilizer management
- Inlet widening
- Permeable reactive barriers
- Improved stormwater management
- Enhanced I/A systems for non-sewered properties
- Monitoring effectiveness of sewer

Beginning in 2015 started installing monitoring wells around the perimeter of Little Pond with help of Woods Hole Partnership Education Program (PEP) students. 12 wells sampling 3-5 depths each for total of 46 discrete groundwater samples



Wyntin Goodman during summer 2015. *The Falmouth Enterprise* photo by Andrea Carter
https://www.capenews.net/falmouth/news/student-program-help-propel-local-scientific-research/article_031687a6-3213-11e5-884a-13533b71e5c3.html

Little pond aquaculture



Shellfish aquaculture – Municipal programs

- Water Quality Management Committee collaborated with Town Marine Environmental Services (MES)
 - Grew 1-2 million oysters in Little Pond 2013 - 2015
 - Monitored water quality – Overall TN levels in Little Pond did not change significantly but appeared to improve water clarity and reduce water TN concentration locally
 - MES grew > 3 million oysters in Little Pond in 2017, relayed to other ponds for recreational/commercial harvest.
 - Estimate nitrogen removal based on increase in oyster mass x N content (%) of shell and tissue
- Appealing/popular program – cultural history, recreation, not expensive, not “big pipe”




Eel river pilot contractor program

- 3 sites identified for floating gear
- Contractors selected in 2019
- Private growers responsible for purchasing, transporting, installing, maintaining and harvesting shellfish according to Town specifications
- Each grower must produce at least 18,600 kg net increase in harvest weight annually
- Growers report harvest weights annually and provide samples for independent analysis of nitrogen content
- Revenues from leases will be used to increase municipal propagation efforts

HOME WHAT WE GROW ABOUT RESEARCH & DEVELOPMENT PARTNERS HATCHI

Falmouth Farm (Eel River)

Falmouth commercial farm is located near Washburn island on Eel pond. The site's location is protected from high wind and wave activity, allowing for the use of surface gear.



Inlet widening

- Bourne pond widening project
- Doubling inlet width, from 45 ft to 90 ft to improve pond flushing
- Anticipated to achieve 50% of the required controllable load removal to meet TMDL
- Would not be equally effective everywhere - depends on bathymetry of pond, etc
- Concurrently designing improvements to protect access road





Protect Falmouth's Waters
Stop and think before you use fertilizer!

Falmouth has a nitrogen control bylaw that applies to all bodies of water – salt, fresh, and wetlands

- Do not fertilize lawns between mid-October and mid-April.
- Never apply fertilizer on paved surfaces; remove it immediately in the case of an accident.
- Do not fertilize within 100 feet of wetlands.
- For lawns farther away from wetlands, use fertilizers sparingly or use alternatives, including yard waste, compost, or other organic materials.
- Excess nutrients on lawns flow into ponds and disrupt ecological balance.

Cape Cod's beauty, home values, and our quality of life depend on sparkling waters, not fertilized waters, choked with vegetation.

Fertilizer management

- Town passed nitrogen control bylaw
- No fertilizer use within 100 feet of resource areas
- No application of fertilizer from October 16 through April 14
- No application of fertilizer during heavy rains in the growing season
- Golf course application limited to 1 lb of nitrogen per 100 sf for entire growing season
- Reminder letter each year

Improved stormwater management

- Stormwater runoff contributes 5-10 percent of the controllable nitrogen sources entering Falmouth's watersheds
- WQMC working with DPW to ID locations where BMPs could be installed to mitigate stormwater nitrogen input to coastal ponds





Enhanced innovative / alternative systems

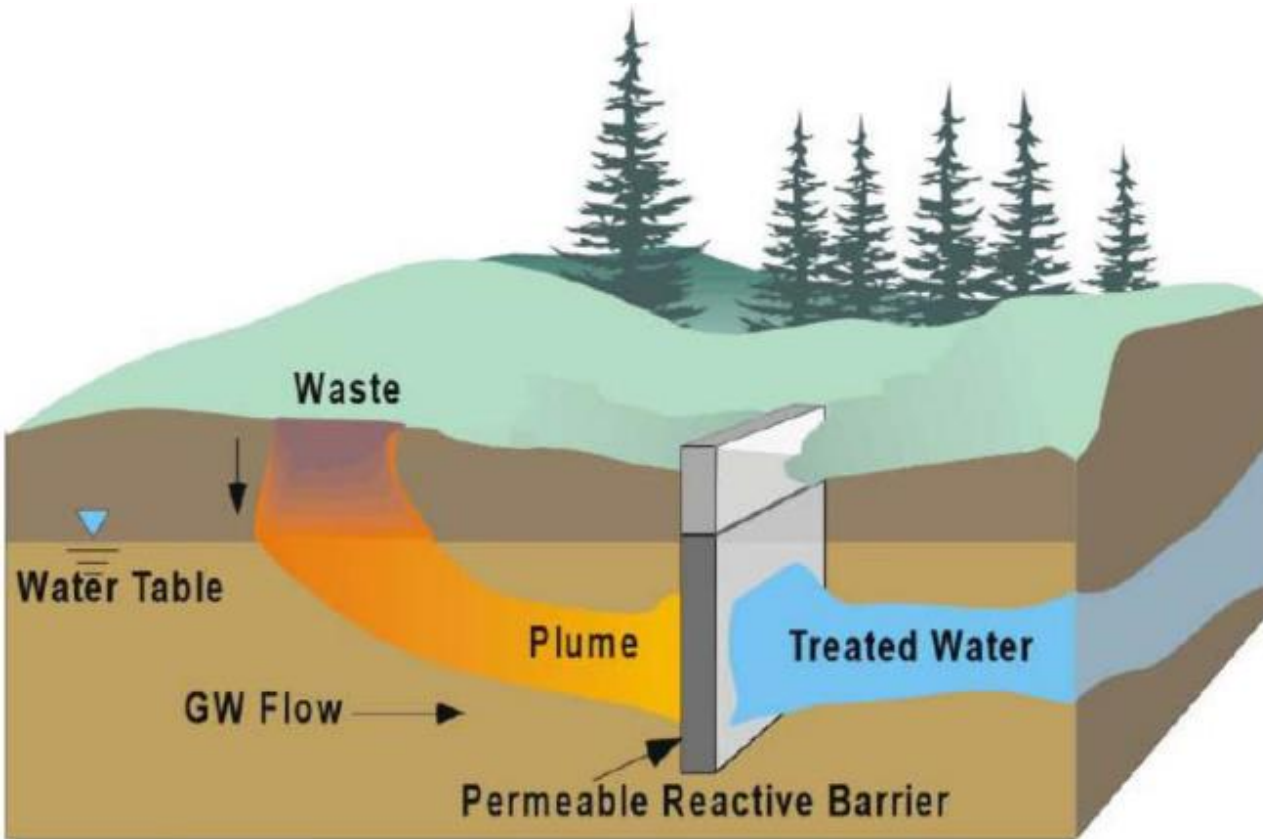
- West Falmouth Harbor Shoreline Septic System Remediation Program
- Collaboration: Buzzards Bay Coalition, Town WQMC
- 20 I/A systems in Phase 1, 10 more in Phase 2
 - Blackwater holding tanks
 - HOOT systems
 - Eliminate
 - Layered SAS

- Incentive/reimbursement (\$7,500-\$10,000)
- Intensive monitoring program
- Goal: enhanced I/A septic systems effluent standard of 10 mg/L nitrogen



Permeable reactive barriers

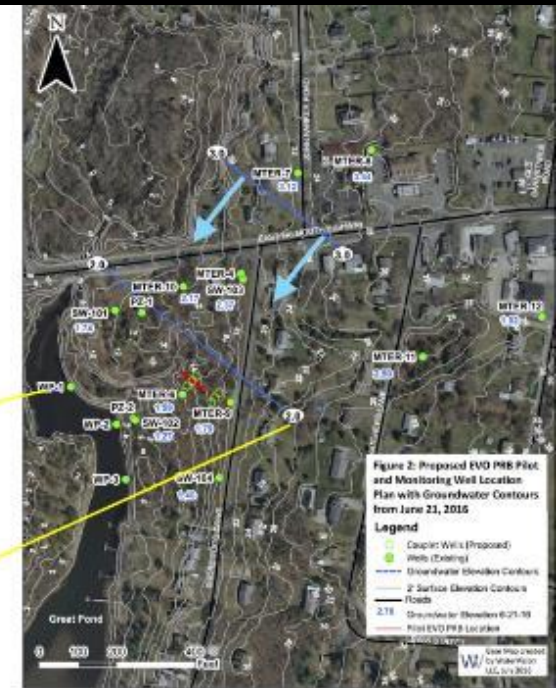
- Trench or injection of a liquid carbon source
- Evaluated sites based on depth to water table, distance from wetlands, and accessibility for monitoring wells
- Completed groundwater and soils investigations of sites in 2 watersheds



- Favorable sites have elevated nitrate concentration at shallow depth, high horizontal groundwater velocity
- Grant funding for a PRB pilot

Post-injection monitoring

- Two transects
 - WHOI 1, 3, 5, MTER-6 – monitors 1 year dose
 - WHOI 2, 4, 6, 8 – monitors 2 year dose



Sources: Aerial photography 2013-2014 and Roads from Mass GIS. Elevation contours from Cape Cod Commission. Site surveys completed by Falmouth Public Works Department and C&D in 2012. All vertical values, MTER 6 and locations are approximate.

Looking forward

Next steps

- Continue nitrogen management planning for South Coast Estuaries
- Implement traditional and pilot projects
- Monitor water quality to gauge improvement over time
- Incorporate data from traditional and pilot projects into next phases of planning through adaptive management



Acknowledgements

- Town of Falmouth and the Board of Selectmen
- Town of Falmouth Department of Public Works
- Town of Falmouth Water Quality Management Committee
- Science Wares, Inc.
- Applied Coastal Research and Engineering, Inc.

Questions

Anastasia Rudenko PE, BCEE, ENV SP
Anastasia.Rudenko@ghd.com

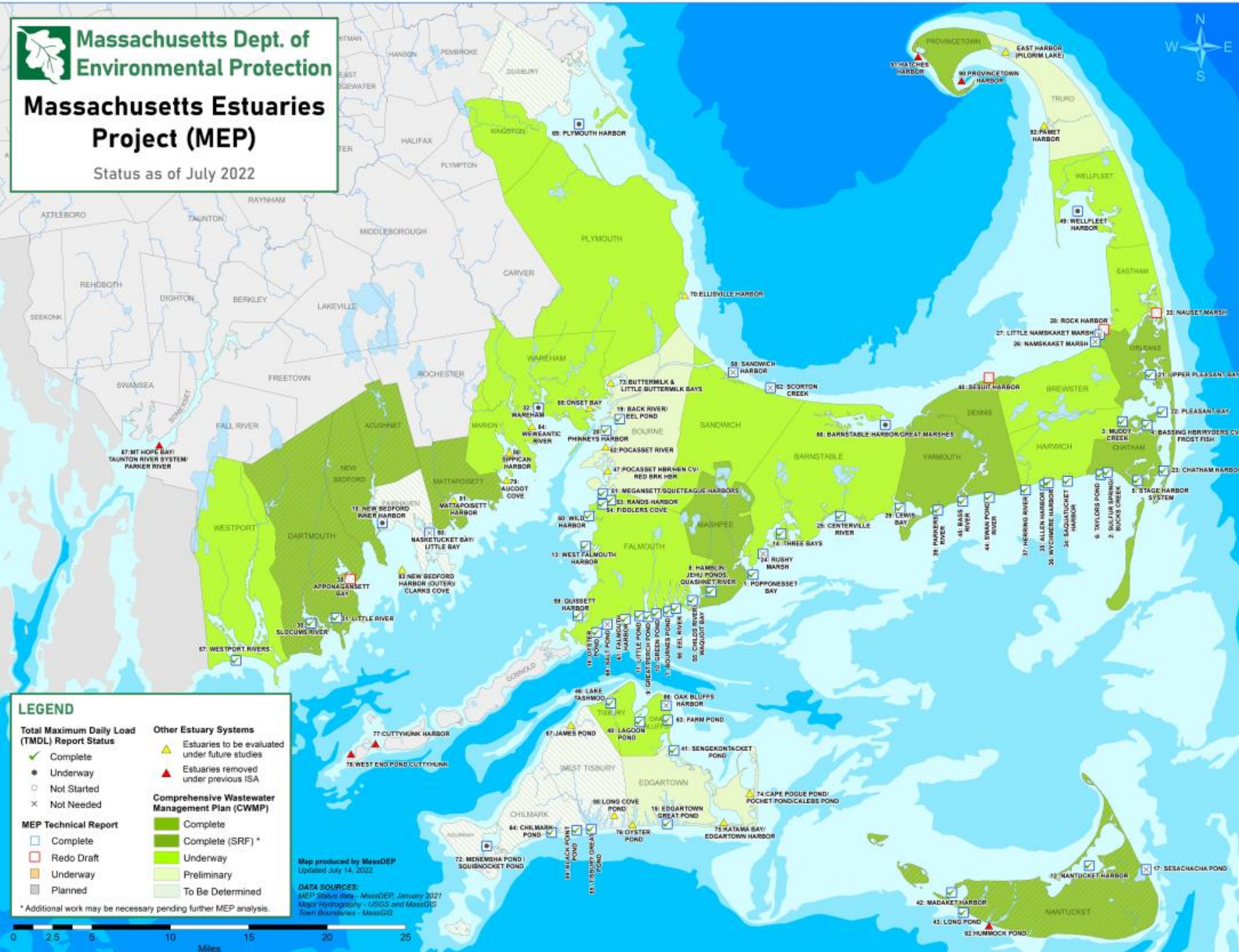


*** Thank You**



Massachusetts Estuaries Project (MEP)

Status as of July 2022



LEGEND

Total Maximum Daily Load (TMDL) Report Status

- ✓ Complete
- Underway
- Not Started
- × Not Needed

MEP Technical Report

- Complete
- Redo Draft
- Underway
- Planned

Other Estuary Systems

- △ Estuaries to be evaluated under future studies
- ▲ Estuaries removed under previous ISA

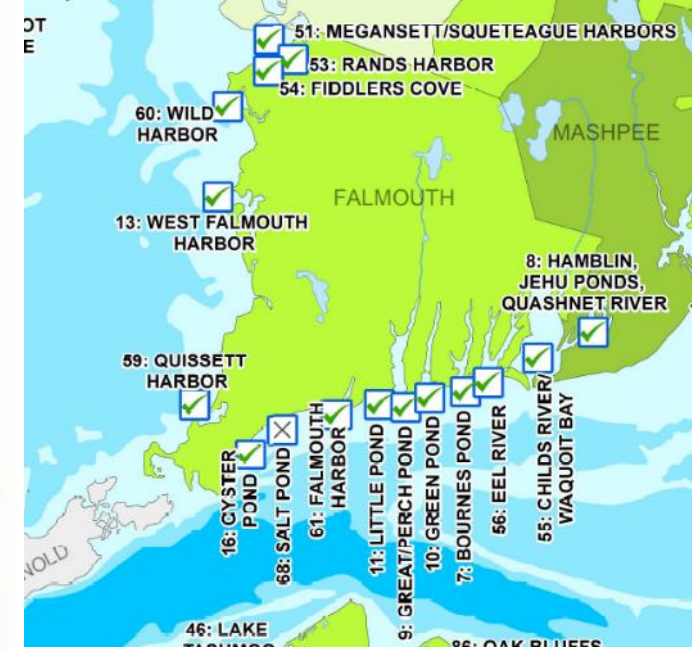
Comprehensive Wastewater Management Plan (CWMP)

- Complete
- Complete (SRF) *
- Underway
- Preliminary
- To Be Determined

* Additional work may be necessary pending further MEP analysis.

Map produced by MassDEP
Updated July 14, 2022

DATA SOURCES:
MEP Status data - MassDEP, January 2022
Map Hydrography - USGS and MassGIS
Town Boundaries - MassGIS



- 51: MEGANSETT/SQUETEAGUE HARBORS
- 53: RANDE HARBOR
- 54: FIDDLERS COVE
- 60: WILD HARBOR
- 13: WEST FALMOUTH HARBOR
- 8: HAMBLIN, JEHU PONDS, QUASHNET RIVER
- 59: QUISSETT HARBOR
- 16: CYSTER POND
- 68: SALT POND
- 61: FALMOUTH HARBOR
- 11: LITTLE POND
- 9: GREAT/PERCH POND
- 10: GREEN POND
- 7: BOURNES POND
- 86: EEL RIVER
- 55: CHILDS RIVER/VIAQUOIT BAY
- 46: LAKE TASHWOOD
- 9: OAK BLUFFS