How About Here? Site Assessment for Permeable Reactive Barrier (PRB) Treatment of Nitrogen on Cape Cod

Waquoit Bay Workshop Using PRBs to Address Nitrogen Pollution Marcel Belaval EPA Region 1

U.S. Environmental Protection Agency

April, 2017

Project Partners/Acknowledgments

- Towns: Barnstable, Dennis, Falmouth, Mashpee, Orleans
- WaterVision (EPA Contract): Danna Truslow
- Technical Advisory Team
 - USGS: Denis LeBlanc, Jeffrey Barbaro
 - Cape Cod Commission: Tom Cambareri, Scott Michaud
- MassDEP
- Funded by the Southeast New England Program



The "big picture" of groundwater and nitrogen loading Assessing sites for PRBs Applying what we've learned

Outline 3



Source: Cape Cod Commission

The Big Picture: Cape Groundwater

Source: Walter, D. A., Masterson, J. P., & Hess, K. M. (2004). Ground-Water Recharge Areas and Traveltimes to Pumped Wells, Ponds, Streams, and Coastal Water Bodies, Cape Cod, Massachusetts. USGS Scientific Investigations Map I-2857, 1 sheet.





The Big Picture: Cape Cod's Coupled GW-SW System



Source: Walter, D. A., Masterson, J. P., & Hess, K. M. (2004). Ground-Water Recharge Areas and Traveltimes to Pumped Wells, Ponds, Streams, and Coastal Water Bodies, Cape Cod, Massachusetts. USGS Scientific Investigations Map I-2857, 1 sheet.



Nitrogen Sources on the Cape





Septic Nitrogen in Groundwater

What is the distribution of nitrogen in groundwater?





What makes a good PRB site?

Category	Favorable Conditions
Watershed	 High N load Density of N sources Site near receiving surface water requiring N load reduction
Hydrogeology	High flux of N through siteNarrow treatment target zoneShallow depth to groundwater
Site Access	 Town/public owned PRB alignment perpendicular to GW flow Open site, few underground structures/utilities



So where could PRBs go?





Onsite Data is Crucial









PRB Site Assessment Project

- Design a site screening and onsite assessment protocol
 - Demonstrate the level of effort needed to determine site suitability
- Apply the approach with town partners
 - Support towns in assessing the use of PRBs
 - Evaluate suitability of selected field sites
 - Support initial data requirements for potential PRB installation

Site Solicitation

June 2015, communities invited to nominate sites for hydrogeo characterization



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY Region 1 5 Post Office Square, Suite 100 Boston, MA 02109-3912

June 1, 2015

Dear Cape Cod Communities in Buzzards Bay and the South Coast:

EPA Region 1 would like to make you aware of a new and exciting opportunity to work with EPA and its partners to perform hydrogeological site characterizations. The objective of these site characterizations is for the design of Permeable Reactive Barriers (PRBs) as pilot technologies for reducing the concentration of nitrogen (N) compounds in groundwater. As part of its Southeast New England Program (SNEP), EPA Region 1 will partner with the United States Geological Survey (USGS) and the Cape Cod Commission (CCC) to:

- Help identify suitable locations for PRB nitrogen removal pilots,
- Fully characterize one or more sites to support PRB design, and
- Provide an example of the type of site characterization work necessary for a successful PRB installation.

EPA is undertaking this work directly because of EPA's strong interest in supporting MA Department of Environmental Protection's Cape Cod TMDLs for total nitrogen and the Clean Water Act section 208 water quality plan update developed by the CCC. EPA intends to take the lessons learned from this project to help demonstrate and encourage the priorities set forth by the Southeast New England Program. These priorities include the application of innovative technologies and the reduction of nitrogen pollution throughout southeast New England.





Regional Screening

Regional tools to evaluate site:

- MVP tool (loading)
- GW models

MEP Reports/TMDLs

н	I	J	K	L	М	N
Site Size / Type	Distance to receiving water	Depth to WT	GW flow direction relative to PRB	Total N Removal from MEP	Approx. MVP Load	N Loading Setting
	ft	ft		%	kg/yr	
Rd	200	<30	perpendicuar	74.0-88.2	600	residential
RD	800	<10	oblique	74.0-88.2	500	residential
Rd	460	<30	oblique/perp	74.0-88.2	400	residential
Rd	300	<20	perpendicular	74.0-88.2	370	residential
Rd	150	<30	perpendicuar	19.6-52.8	225	residential, some com.
4.54 acres	200	<20	perpendicuar	74-88.2	400	residential
Rd	1400	<30	perpendicuar	52.8-74.0	280	High density residential



Regional Screening: Site Example





Regional Screening: Site Example





Regional Screening: Site Example



www.watershedmvp.org

Nitrogen Load in zone: 1,150 kg/yr





Initial Onsite Assessment Protocol

- Install >5 wells at the water table plus vertical well cluster (6-10 wells)-
- Measure water levels
- Compile & analyze data
- Collect continuous core
- 2 rounds of sampling in all wells

- Groundwater hydrology
 - Depth to GW
 - Gradient (vertical & horizontal)
 - Rate & direction
- Subsurface materials
- Water quality
 - Vertical profile
 - Across site

Initial Onsite Assessment Protocol



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Onsite Assessment: Falmouth Water Table Map



Onsite Assessment: Dennis Water Table Map







Water Quality Profiles







Water Quality Profiles





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Assessing Suitability from Onsite Investigation Data

- Nitrate flux across site
- Vertical and horizontal flow
- Receiving surface water





Site Details Matter...









Nitrogen Load Comparison



Full Hydro Assessment Underway at Dennis Site



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Next Steps



- Completion and reporting of Full Assessment at Dennis
- Synthesis report in development
- Continue to communicate findings with towns
- Determine monitoring needs

Questions?

Initial Site Characterization reports available at: https://www.epa.gov/snecwrp