Town of Orleans Massachusetts

Water Quality and Wastewater Planning

AMP - Water Quality Monitoring and Modeling Workshop

April 1, 2016

Agenda

- Introduction and Overview
- Summary Presentations on Water Quality Analytical Programs
- Preparing the Work Plan

AECOM

Town of Orleans Massachusetts

Introduction and Overview

Massachusetts Estuaries Project (MEP)
Total Maximum Daily Load (TMDL) Requirements

Nauset Harbor MEP Report (2012)

Table ES-2. Present Watershed Loads, Thresholds Loads, and the percent reductions necessary to achieve the Thresholds Loads for the Nauset Harbor estuary system.

Sub-embayments	Present Watershed Load [1] (kg/day)	Target Threshold Watershed Load [2] (kg/day)	Direct Atmospheric Deposition (kg/day)	Benthic Flux Net [3] (kg/day)	TMDL [4] (kg/day)	Percent watershed reductions needed to achieve threshold load levels
SYSTEMS						
Nauset Marsh	10.729	10.729	11.252	46.838	68.819	0.0%
Salt Pond	5.014	1.196	0.299	14.201	15.696	-76.1%
Woods Cove	0.745	0.745	0.241	4.657	5.643	0.0%
Mill Pond	4.932	4.932	1.068	3.219	9.219	0.0%
Rachel Cove	0.178	0.178	0.162	0.000	0.340	0.0%
Town Cove	31.595	11.968	5.230	41.520	58.718	-62.1%
System Total	**53.192**	**29.748**	**18.252**	**110.436**	**158.435**	**-44.1%**

(1) Composed of combined natural background, fertilizer, runoff, and septic system loadings.
(2) Target threshold watershed load is the load from the watershed needed to meet the embayment threshold concentration identified in Table ES-1.
(3) Projected future flux (present rates reduced approximately proportional to watershed load reductions).
(4) Sum of target threshold watershed load, atmospheric deposition load, and benthic flux load.

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Massachusetts Estuaries Project (MEP)
Total Maximum Daily Load (TMDL) Requirements

Pleasant Bay MEP Report (2006)

Table VIII-4. Comparison of sub-embayment ***total watershed loads*** (including septic, runoff, and fertilizer) used for modeling of present and threshold loading under one possible restoration scenario of the Pleasant Bay system. These loads do not include direct atmospheric deposition (onto the sub-embayment surface) or benthic flux loading terms.

sub-embayment	present load (kg/day)	threshold load (kg/day)	threshold % change
Meetinghouse Pond	6.197	1.058	-82.9%
The River – upper	2.773	1.737	-37.4%
The River – lower	3.879	2.444	-37.0%
Lonnies Pond	2.441	1.626	-33.4%
Areys Pond	1.304	0.915	-29.8%
Namequoit River	2.737	1.732	-36.7%
Paw Wah Pond	1.860	0.728	-60.9%
Pochet Neck	8.422	4.123	-51.0%
Little Pleasant Bay	7.496	5.240	-30.1%
Quanset Pond	1.781	1.079	-39.4%
Tar Kiln Stream	6.123	5.225	-14.7%
Round Cove	4.225	2.960	-29.9%
The Horseshoe	0.638	0.638	0.0%
Muddy Creek - upper	9.981	4.614	-53.8%
Muddy Creek - lower	8.477	2.137	-74.8%
Pleasant Bay	23.159	16.621	-28.2%
Pleasant Bay/Chatham Harbor Channel	-	-	-
Bassing Harbor - Ryder Cove	9.819	4.466	-54.5%
Bassing Harbor - Frost Fish Creek	2.904	0.704	-75.8%
Bassing Harbor - Crows Pond	4.219	4.219	0.0%
Bassing Harbor	1.668	1.668	0.0%
Chatham Harbor	17.099	17.099	0.0%
TOTAL - Pleasant Bay System	127.203	81.032	-36.3%

Sub-embayment	Target Threshold Watershed Load [1] (kg/day)	Atmospheric Deposition (kg/day)	Benthic Input [2] (kg/day)	TMDL [3] (kg/day)
Meetinghouse Pond	1.06	0.58	7.86	10
The River – upper	1.74	0.29	4.10	6
The River – lower	2.44	2.24	8.52	13
Lonnies Pond	1.63	0.23	1.30	3
Areys Pond	0.92	0.18	4.93	6
Namequoit River	1.73	0.52	12.23	14
Paw Wah Pond	0.73	0.08	2.67	3
Pochet Neck	4.12	1.77	0	6
Little Pleasant Bay	5.88	24.09	35.22	65
Quanset Pond	1.08	0.17	4.79	6
Round Cove	2.96	0.17	6.74	10
Muddy Creek – upper	4.61	0.16	2.70	7
Muddy Creek – lower	2.14	0.21	0	2
Pleasant Bay	21.85	37.01	96.17	155
Ryder Cove	4.47	1.30	6.71	12
Frost Fish Creek	0.70	0.10	0	1
Crows Pond	4.22	1.39	0.61	6
Bassing Harbor	1.67	1.07	0	3
Chatham Harbor	17.10	14.15	0	31
System Total	81.25	85.71	194.55	359

MEP Updates Recommended

- MEP modeling based on data from 2003/2004
- MEP Report provides reasonable planning-level estimates for nitrogen-removal targets
- Updating MEP model will enable refinement of nitrogen-removal targets
  - Current water quality data is available
  - Hydrodynamic conditions have changed in both systems
  - Special Studies recommended to confirm system health (based on water quality data) in certain sub-embayments

Freshwater Ponds Program

- 63 freshwater lakes and ponds in Orleans; 25 with surface area > 1 acre
- Comprehensive Wastewater Management Plan (CWMP, 2010), selected the following freshwater ponds for further evaluation:
  - Bakers Pond, Bolands Pond, Cedar Pond, Crystal Lake, Ice House Pond, Pilgrim Lake, Sarah's Pond and Shoal Pond
  - Summary of evaluation in CWMP Table 3-4
- Water quality monitoring has continued

TABLE 3-4
POND TROPHIC STATUS, IMPAIRED USES AND WASTEWATER MANAGEMENT PRIORITIES

WATER BODY	TROPHIC STATUS	IMPAIRED USES	WASTEWATER MANAGEMENT PRIORITY
Bakers Pond	Oligotrophic	None	Second priority
Bolands Pond	Eutrophic	Aquatic life support Contact recreation	First priority
Cedar Pond	Eutrophic	Aquatic life support Contact recreation	Defer for MEP studies
Crystal Lake	Oligo-mesotrophic	Aquatic life support	First priority
Ice House Pond	Oligo-mesotrophic	None	Second priority
Pilgrim Lake	Mesotrophic	Aquatic life support	First priority
Sarah's Pond	Mesotrophic	Aquatic life support Contact recreation	No need
Shoal Pond	Eutrophic	Aquatic life support Contact recreation	Second priority

Freshwater Ponds Program (cont.)

Next Step: Ponds Management Plan

- Fiscal Year 2017
  - Update trophic status using ongoing monitoring data
  - Integrate stormwater and fertilizer information
- Fiscal Year 2018
  - Implementation of specific remediation measures

Consensus Plan Project and Goals - Hybrid Approach

- Maximize the use of non-traditional (NT) technologies, including:
  - Permeable Reactive Barriers
  - Floating Constructed Wetlands
  - Shellfish
- Collection and treatment in two areas where NT technologies cannot meet nitrogen-removal and other goals
  - Downtown Orleans
  - Meetinghouse Pond subwatershed
- Demonstration projects needed to validate nitrogen-removal efficacy and other parameters
- Adaptive Management to incorporate findings of demonstrations into future planning and implementation decisions

Program Schedule - Key Activities / Dates

- FCW / PRB Subcommittee Workshop – April 6, 2016
- Shellfish / Aquaculture – April 2016
- OWQAP – April 20, 2016
- Town Meeting – May 9, 2016

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Summary Presentations on Water Quality Analytical Programs

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A. Non-Traditional Project Monitoring
B. Freshwater Ponds
C. Cedar Pond Studies
D. MEP Modeling and Analysis

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E. Non-Traditional Project Monitoring

Shellfish Demonstration Monitoring

Key Water Quality Monitoring Parameters

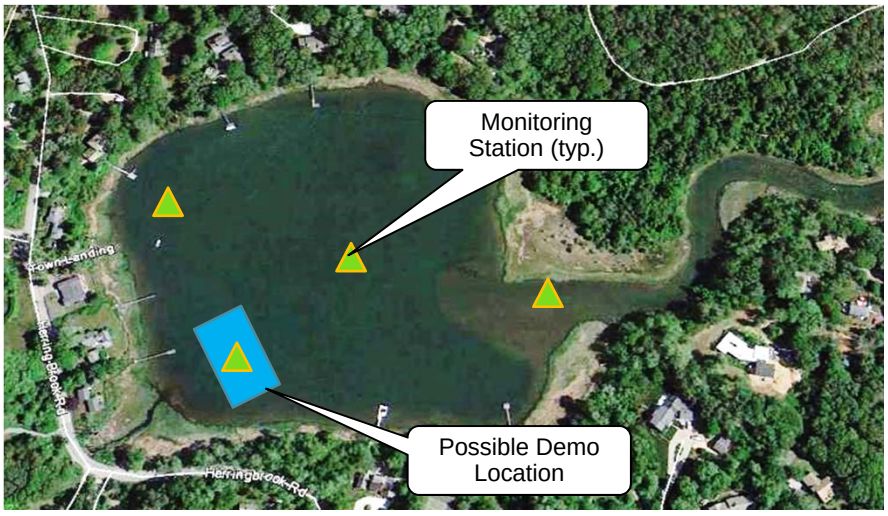
- Baseline water quality conditions
- Population survival and size classes by length for one year of growth
- Density of area covered by shellfish
- Review of environmental conditions of site for shellfish growth
- Assessment of operation and maintenance requirements
- Useful modifications to gear design
- Recommendations on the type of shellfish grown and whether there should be a mix of species
- Assessment of abutter compatibility and use conflicts

Shellfish Demonstration Monitoring (cont.)

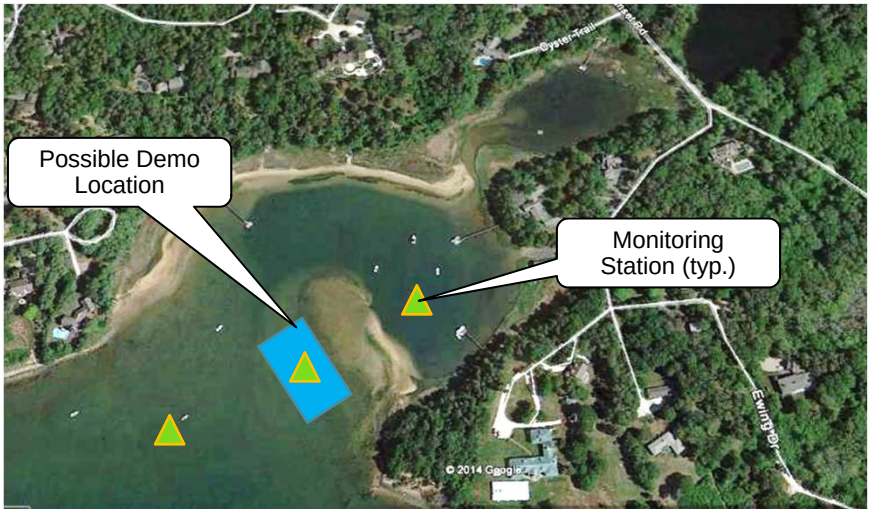
Key Baseline Water Quality Conditions

- Total Nitrogen
- Particulate Organic Nitrogen
- Particulate Organic Carbon
- Chlorophyll-*a*
- Water clarity (Secchi)
- Total Suspended Solids
- Sediment cycling/benthic flux
- Number and location of sampling stations depend on size of installation

Shellfish Demonstration Monitoring
Lonnies Pond



Shellfish Demonstration Monitoring
Quanset Pond



Floating Wetland Demonstration Monitoring

In-Situ Water Quality Analysis

- Monitoring stations located landward and seaward of installation
- Dataloggers: water quality and current data in 15-minute intervals (temperature, DO, turbidity, chlorophyll and salinity)
- Paired Grab Samples: weekly water quality measurements 4/15 – 9/30; monthly sampling 10/1 – 4/14 (nitrogen species, soluble reactive phosphorus, total suspended solids, and chlorophyll-*a*)
- Discrete probe measurements taken with grab samples (temperature, conductivity, salinity, DO, and pH)
- Seasonal (4X/year) water quality samples (nutrient and physical chemical measurements) at each inflow, as well as a minimum of three stormwater samples

Floating Wetland Demonstration Monitoring (cont.)

- Laboratory Analysis
- Aboveground biomass of vegetation on the FCW
  - Estimate of net primary production
  - Estimate of nutrient uptake
- Biofilm uptake using an array of pucks
  - Assess removal of nutrients by FCW mat material

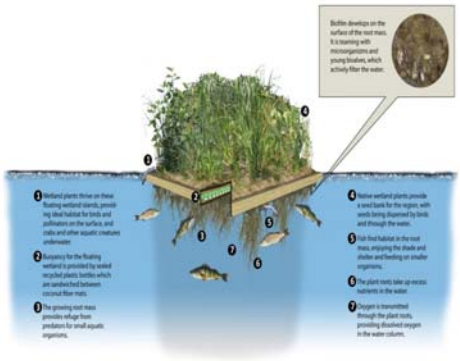
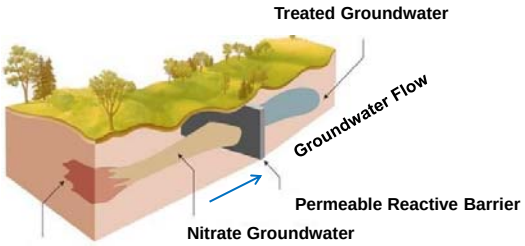


Figure 1: FCW Schematic and Installation

PRB Overview

- A PRB Consists of a Zone of Reactive Material Installed in the Path of a Dissolved Contaminant (e.g. nitrate) Plume
- Denitrification - Biological Process by Bacteria Ubiquitous in the Environment
  - Nitrate converted to inert nitrogen gas (N_2)
  - Requires anoxic (low oxygen conditions)



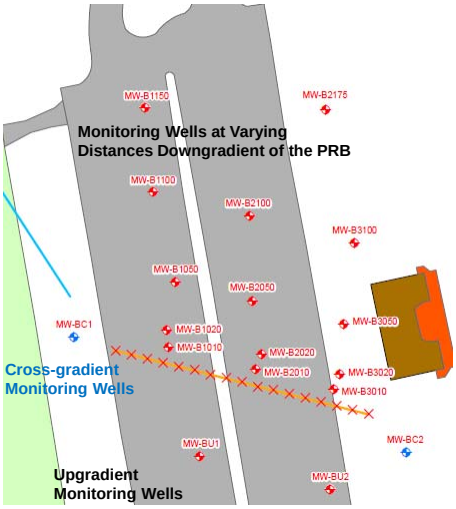
(ITRC, 2011)

PRB Demonstration Test Monitoring Overview

- PRB Demonstration Testing will Include Extensive Groundwater Sampling and Analysis Program
- Performance Monitoring
  - Evaluate Changing Nitrogen Concentrations and Load Reduction
  - Assess Size of Reactive Zone (Distance Downgradient of PRB)
  - Evaluate Migration of Carbon Substrate
- Evaluate Secondary Water Quality Impacts
- Engineering Design Optimization
- Monitoring Wells Located Upgradient and Downgradient of the PRB
- Similar to Other In-situ Biological Treatment Technologies

PRB Demonstration Test Monitoring Overview

- 50 to 200 feet long
  - Dimensions easily adjusted
- Monitoring Parameters
  - Total Nitrogen
  - Nitrate
  - Nitrite
  - Ammonia
  - Dissolved Metals
  - Sulfate
  - Dissolved Organic Carbon
  - Methane
  - Dissolved Oxygen
  - pH
  - Oxidation-Reduction Potential



F. Special Studies
G. Other
H. Summary of Key Monitoring Recommendations

Preparing the Work Plan

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Thank You