Stormwater Practices in the Coastal Zone: Designing for Climate Change

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Assessment of Climate Change Impacts on Stormwater BMPs and Recommended BMP Design Considerations in Coastal Communities

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Prepared for:
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Report available at:
Talk Outline

• Climate change impacts
• Field assessments
• BMP vulnerabilities
• Design recommendations and examples
• MA CZM pilot grant
Methods

- Review of climate change impacts
- Field evaluation of existing BMPs
- Review of sea level rise, storm surge, and flood risk modeling results
ANTICIPATED CLIMATE CHANGE IMPACTS:
sea level rise
ANTICIPATED CLIMATE CHANGE IMPACTS:
increased hurricane intensity and frequency

- Annual number of tropical cyclones in the North Atlantic (Emanuel 2005)
- Annual number of tropical cyclones vs SST Aug - Oct (Emanuel 2005)
- Post-1970 PDI v SST in the Atlantic (Emanuel 2005)
ANTICIPATED CLIMATE CHANGE IMPACTS:

increase in annual precipitation; increase in precipitation extremes

Table 2.1 (http://www.mass.gov/eea/docs/czm/cwq/cpr/climate-change-sw-bmps-report-no-appendix.pdf)

<table>
<thead>
<tr>
<th>Anticipated Climate Change Impact</th>
<th>Current Conditions</th>
<th>20 Year Planning Horizon (2035)</th>
<th>50 Year Planning Horizon (2065)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Annual Precipitation</strong></td>
<td>Existing conditions for the period 1961-1990: Total: 41 inches Winter: 8 inches; Summer: 11 inches</td>
<td>Estimated changes by 2035-2064: Total: 5-8% increase Winter: 6-16% increase; Summer: 1-3% decrease</td>
<td>An increase in annual precipitation is expected to occur in fall, winter and spring, with a slight decrease in rainfall volume in the summer.</td>
</tr>
</tbody>
</table>
ANTICIPATED CLIMATE CHANGE IMPACTS:

increase in groundwater elevation in coastal areas

Masterson et al., 2014
RESULTS: BMP Vulnerabilities

Rising sea level and submerged outfalls

Rising groundwater and shrinking separation distances

Physical impact of storm surge inundation

Increased flooding and drought

Chronic wind, sand and salt exposure

Clogged inlet; water cannot enter BMP

Extensive Phragmites stand

Submerged outfall, missing duckbill

Rain garden flooded by October king tide
Field Results: Site 1

Cohasset, MA

BMP: Constructed Wetland
Field Results: Site 1
Cohasset, MA

Existing Conditions

Modified Design
Field Results: Sites 8 & 9
Cohasset, MA
BMP: Infiltration Basin, Stormceptor
Field Results: Sites 8 & 9
Cohasset, MA
Field Results:
Sites 8 & 9
Cohasset, MA
Field Results: Site 31c
Marion, MA
BMP: Bioretention
Field Results: Site 31c
Marion, MA
Field Results: Site 32

Bourne, MA

BMP: Cultec Infiltration
Field Results: Site 32A
Bourne, MA
Field Results: Site 32B
Bourne, MA
Field Results: Site 34
Kingston, MA
BMP: Rain Gardens, Trench Drain
Field Results: Site 34
Kingston, MA
Design Recommendations

Using a 50-year planning horizon
Proper siting of practices
Selecting appropriate practices
Selecting BMP construction and landscape materials
Ensuring redundancy in design
Increasing flexibility in design
Choosing “green” over “grey”
The even greater importance of maintenance
Coastal Pollutant Remediation (CPR) Grant Program

- Coastal Habitat and Water Quality
- Assessment, Design and Construction of SW BMPs
- Role of climate change for coastal BMPs?

http://www.mass.gov/eea/agencies/czm/program-areas/coastal-water-quality/cpr/
### MA CZM 2017 BMP Retrofit Design Pilot Grants

<table>
<thead>
<tr>
<th>Community</th>
<th>Site Vulnerabilities</th>
<th>Design Recommendations</th>
<th>Water Quality Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manchester</td>
<td>Flooding from increased precipitation</td>
<td>Porous asphalt parking lot to reduce stormwater volume flow</td>
<td>Reduce sediments and other pollutants entering Smelt spawning habitat</td>
</tr>
<tr>
<td>Melrose*</td>
<td>Flooding from increased precipitation</td>
<td>Upsized bioretention areas to handle larger volume</td>
<td>Reduce pollutants entering an impaired waterbody</td>
</tr>
<tr>
<td>Winthrop</td>
<td>Flooding from increased storms and SLR</td>
<td>Upsized piping and treatment chambers, bioretention areas and permeable pavers for infiltration</td>
<td>Reduce pollutants, esp. pathogens discharging to a swimming beach</td>
</tr>
<tr>
<td>Yarmouth*</td>
<td>Flooding from increased storms, SLR, and rising groundwater</td>
<td>Conversion of infiltration to filtering BMPs, upsized sw storage, shallower infiltration structures</td>
<td>Reduce pollutants, esp. pathogens and nutrients to impaired waterbodies</td>
</tr>
</tbody>
</table>

* 2018 Grant for Construction
Yarmouth Project: Assessment & Prioritization of BMPs in Support of Climate Change Resiliency

- Evaluate existing BMPs vulnerable to climate change
- Two-part study: desktop GIS and field inspections
Yarmouth Project

Vulnerabilities

- Coastal and inland flooding
- Storm surge from SLR
- Rising groundwater tables
- Wind, salt and sand
Yarmouth Project

Desktop GIS Evaluation (21 BMPs)

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inundation during Hurricane Event</td>
<td>4 points max for Category 1 Hurricane</td>
</tr>
<tr>
<td>Located in an AE and/or VE FEMA Flood Zone</td>
<td>2 points each</td>
</tr>
<tr>
<td>Sea Level Rise Inundation</td>
<td>3 points max for 2 ft SLR</td>
</tr>
</tbody>
</table>
## Yarmouth Project

### Field Evaluation & Prioritization (9 BMPs)

<table>
<thead>
<tr>
<th>Type</th>
<th>Conceptual BMP Description</th>
<th>Candidate Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>End-of-Pipe</td>
<td>Retrofit infiltration impoundment to an aboveground green infrastructure BMP</td>
<td>Impoundment #1</td>
</tr>
<tr>
<td>Roadside</td>
<td>Retrofit infiltration impoundment to filtering BMP</td>
<td>Impoundment #9</td>
</tr>
<tr>
<td>Leaching Basin</td>
<td>Retrofit leaching catch basin to allow shallower infiltration in high groundwater</td>
<td>Leaching catch-basins town-wide</td>
</tr>
</tbody>
</table>
Yarmouth Project: End-of-Pipe Conceptual Design

**Infiltration Basin (∼1500 ft²)**
- Residential area and public beach

**Climate Change Impacts**
- Sand fill from neighboring beach
- VE flood zone
- Category 1 Hurricane and 2 ft SLR
Yarmouth Project: End-of-Pipe Conceptual Design

- SW Flow
- Install New Flare End Section
- Proposed Riprap Armored Sediment Forebay
- Existing Pond Bottom
- Enlarged BMP
- Approx. 1'
- Approx. 2'
- Native Salt, Wind, and Sand Tolerant Plants
- Proposed Pavers
- Profile View
- Scale = NTS
Yarmouth Project: Leaching Catch Basin Design

Climate Change Impacts

- Increased flooding
- Decreasing depth to groundwater

Separation Distance (at least 2 feet)

Image from MA SW Handbook
Yarmouth Project: Leaching Catch Basin Design

- NEW CATCH BASIN
- RETROFIT WITH OIL WATER SEPARATOR
- LEACHING GALLEY
- SOLID PIPE
- FILL
- OPEN BOTTOM
- MANHOLE COVER
- PERFORATED LEACHING TRENCH
- ASSUMED NEW GWT ELEVATION
- ASSUMED MINIMUM EXISTING GWT
Yarmouth Project: Leaching Catch Basin Design

- Catch Basin Grate
- New Catch Basin
- Pavement
- Crushed Stone
- Fabric on Sides and Top of Pipe
- Leaching Galley
- Drill 1" Vent Hole in Cover
- Provide Inspection Ports for Maintenance

Perforated Pipe
Tools for Implementation

BMP Selection

• BSWC Stormwater Best Management Practices Guidance:
• EPA and MassBays NEP Green Infrastructure Handbook:

Landscaping Tips

• http://www.mass.gov/eea/agencies/czm/program-areas/stormsmart-coasts/coastal-landscaping/tips.html
• http://ag.umass.edu/landscape/fact-sheets

BMP Coastal Siting in Massachusetts

• MA CZM Sea Level Rise Guidance Document:
• MA CZM Sea Level Rise Viewer:
  http://www.mass.gov/eea/agencies/czm/program-areas/stormsmart-coasts/flooding-impacts-viewer/
• MACZM’s Online Mapping Tool:
• NOAA’s Digital Coast: https://coast.noaa.gov/digitalcoast/topics/coastal-storms.html
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Questions?

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Report available at:
References


