Sustainable Stormwater BMPs from the Municipal Perspective

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• Professional Engineer licensed in CT, MA, NH, NY and RI
• 20+ years of experience in civil engineering and construction administration
• Bachelor’s Degree in civil and environmental engineering
• Specializes in Stormwater Management
• Committee Member for 2013 Rhode Island Soil Erosion and Sediment Control Handbook update
• USDA/NRCS Technical Service Provider in CT, MA, and RI
• Extensive experience with design and improvement of Stormwater drainage and treatment
• Served as the Consulting Engineer and Town Engineer for municipalities throughout Southern New England
Goals for Sustainability

• Simple and consistent BMP design
• Efficient and cost effective maintenance of stormwater BMPs by DPWs
• Continued effectiveness of BMPs
Overview

- Need for BMPs and how they affect public works departments
- Development and construction of BMPs
- Strategies to reduce maintenance costs
- Costs associated with maintenance
- Design ordinance
- Retrofit of existing BMPs
- Tips for successful construction
- Interactive BMP Design
Why We Need Stormwater BMPs
Before: Most precipitation is absorbed by vegetation, evaporates, or infiltrates through the ground.

After: Vegetative absorption and ground infiltration is reduced; surface runoff is increased.

Image courtesy of Puget Sound Partnership
Why Do We **Need** Stormwater BMPs?

Prevent and Mitigate Stormwater Impacts

- Quality
- Quantity
- Recharge
Stormwater Quality

Basin – Swale – Rain Garden

• Typically Treat 1” of Rainfall from Impervious Areas
• Water Quality Volume
Hydrodynamic Separator

- Typically Treat 1” of Rainfall from Impervious Areas
- Water Quality Flow
- Avoid Mixing of Additional Stormwater
Detention – Retention

• Typically Reduce Proposed Peak Flows to Existing Peak Flows
  (2 through 100 year storm events)
### Stormwater Recharge

#### Function of Proposed Impervious Area

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>A</td>
<td>0.4 inches</td>
<td>0.6 inches</td>
</tr>
<tr>
<td>B</td>
<td>0.25 inches</td>
<td>0.35 inches</td>
</tr>
<tr>
<td>C</td>
<td>0.10 inches</td>
<td>0.25 inches</td>
</tr>
<tr>
<td>D</td>
<td>0 inches</td>
<td>0.1 inches</td>
</tr>
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</table>
Typical Types of BMPs
Typical *Types of BMPs*

Wide Variety:
- Catch Basins
- Hydrodynamic Separators
- Forebays
- Basins
- Rain Gardens
- Swales
- Infiltration Systems
- Filters
- Permeable Pavements
Why They Become Ineffective
Why Do BMPs Stop Working?

Lack of Maintenance – Some causes are:

Access
- Physical
- Legal
Design

Why Do BMPs Stop Working?
Why Do BMPs Stop Working?

Cost
Why Do BMPs Stop Working?

Site Constraints

- Requires specialized tools / training
- Overly time consuming

Result: deferred maintenance
Why Do BMPs Stop Working?

Construction Practices
Case Study I
Why Do BMPs Stop Working: Case Study I

Sedimentation and Erosion Control
Sedimentation and Erosion Control
Construction – Summer 2005
Why Do BMPs Stop Working: Case Study I

Sedimentation and Erosion Control
Sedimentation and Erosion Control
Sedimentation and Erosion Control
Sedimentation and Erosion Control
Fall 2013
Case Study II
Why Do BMPs Stop Working: Case Study II

Construction & Access
Why Do BMPs Stop Working: Case Study II

Construction & Access

Basin
Easement
Why Do BMPs Stop Working: Case Study II

Construction & Access
Why Do BMPs Stop Working: Case Study II

Construction & Access

Initial Review

Retrofit Complete
Case Study III
Why Do BMPs Stop Working: Case Study III

No Maintenance
Constructed – Approximately 1996
No Maintenance
Why Do BMPs Stop Working: Case Study III

No Maintenance
Why Do BMPs Stop Working: Case Study III

No Maintenance
Why Do BMPs Stop Working: Case Study III

No Maintenance: Downstream results
Development and Construction of BMPs
How BMPs are *Developed & Constructed*

**Design**

- Minimum standards and performance criteria for stormwater provided by local or state regulations
How BMPs are *Developed & Constructed*

**Local Review and Approval**
- Town / City Engineer Review
- Peer Review
- Local Board / Commission Review
- Public Works?
How BMPs are Developed & Constructed

Consider Owners Ability to Maintain the BMP

- Equipment
- Manpower
- Knowledge & Skill

Specify the Correct BMP for the Ability of the DPW
How BMPs are Developed & Constructed

Majority of Construction done by Developer/Contractor

DPW may have little to no control over construction
  • Proper E&S Control and Plan
  • Inspection Parameters
  • DO NOT USE DURING CONSTRUCTION
Required Maintenance
Typical Maintenance Requirements

- Sediment Removal
- Light Oils
- Mowing

- Erosion Repair
- Compaction
Suggestions for Typical Practices
Design Strategies to *Reduce Maintenance Costs*

**Forebays**

*First Means of Collecting Sediment*

- Limit Riprap
- Provide Easy Access
- Concrete Bottom
- Size for Sediment Load
Design Strategies to *Reduce Maintenance Costs*

**Swales & Basins**

- Limit Riprap
- Provide Access to Bottom of Basin and to Outlet
- Proper Side Slope
- Proper Bottom Width
- Proper Berm Width
- Design of Sand / Loam Mix
- Design of Underdrain
- Removal of Invasive Plants
- Aesthetics
Design Strategies to *Reduce Maintenance Costs*

**Hydrodynamic Separators**

- Depth
- Access Covers
- Confined Space Issues

- Internal Mechanics may block ability to maintain or may break
- Alternate means of maintenance if equipment is unavailable
Design Strategies to Reduce Maintenance Costs

Rain Gardens

- Plantings
- Mulch
- Aesthetics - Free Maintenance?
Design Strategies to *Reduce Maintenance Costs*

Separation of Public and Private Watersheds

- Employ LID
Sampling Structure prior to Connection with Public System

- MS4
Costs Associated with Maintenance
## Costs Associated with Maintenance

<table>
<thead>
<tr>
<th>Task</th>
<th>Designed with no input from DPW (maintained once in 10 years)</th>
<th>Designed with DPW in mind (maintained yearly)</th>
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</thead>
<tbody>
<tr>
<td>Repair Lawn</td>
<td>4 hours</td>
<td>N/A</td>
</tr>
<tr>
<td>Construct Access into Basin</td>
<td>2 hour</td>
<td>N/A</td>
</tr>
<tr>
<td>Remove Trees &amp; Brush</td>
<td>8 hours</td>
<td>N/A</td>
</tr>
<tr>
<td>Mowing</td>
<td>2 hours</td>
<td>30 minutes</td>
</tr>
<tr>
<td>Remove Sediment</td>
<td>4 hours</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Loam, Seed, E &amp; S</td>
<td>4 hours</td>
<td>N/A</td>
</tr>
</tbody>
</table>
## Costs Associated with Maintenance

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>Typical Cost Savings over 10 years</td>
<td>2 employees for 24 hours</td>
<td>2 employees for 45 minutes each year</td>
</tr>
<tr>
<td>(manhours only)</td>
<td>48 manhours</td>
<td>15 manhours</td>
</tr>
</tbody>
</table>

**70% Reduction in Man Power**
Design Ordinance
Public Works Design Ordinance

- Overall Design Theory
  - LID/Stormwater Layout, Public vs Private Systems

- Structural Conveyance
  - Catch Basins, Manholes, Pipe, etc.

- Pretreatment (10 to 25% WQV) for Swales / Basins
  - Forebays, Hydrodynamic Separators, Grass Swales, etc.

- Primary Treatment Practices
  - Swales, Basins, etc.

- Maintenance Access
  - Min. 12’ wide, Max. 15% slope

- Special Provisions
  - Infiltration, Erosion Controls, Inspection, Connections, Maintenance, Reporting, Digital Mapping, As-Built/Closeout

- Details
Concrete Forebay Bottom Detail

- **Wood Float or Broom Finish**
- **4 @ 12” Each Way**
- **2 #5 Continuous Top & Bottom Lap 24”**
- **Provide Corner Bars**
- **2”-0”**
- **3”**
- **1”-0” Min. Rolled 3/4” Crushed Stone Under Entire Slab**
- **6” Concrete Slab on Grade**
- **Compacted Granular Fill**
Typical Basin Cross Section Detail
NOTE:
IMPERMEABLE EMBANKMENT MATERIAL SHALL CONTAIN AT LEAST 15% PASSING THE NO. 200 SIEVE AND NOT MORE THAN 50% PASSING THE NO. 200 SIEVE. NO STONES LARGER THAN 6 INCHES SHALL BE ALLOWED WITHIN THE COMPACTED EMBANKMENT. WITHIN TWO FEET OF ANY STRUCTURE, THE MAXIMUM SIZE SHALL BE 3 INCHES. CONSTRUCTION SHALL NOT TAKE PLACE DURING COLD PERIODS WHERE TEMPERATURES ARE CONSISTENTLY LOWER THAN 40 DEGREES FAHRENHEIT. EMBANKMENT MATERIAL TO BE COMPACTED IN 6” MAXIMUM LIFTS TO 95% MAXIMUM DRY DENSITY.
Gravel Access Way Detail

NOTES:
1. MAINTENANCE ACCESS WAYS SHALL BE A MINIMUM OF 12’ WIDE & SHALL HAVE A MAXIMUM SLOPE OF 15% AND A MAXIMUM CROSS SLOPE OF 4%.
2. ACCESS WAYS SHALL BE PROVIDED TO ALL MAJOR SYSTEM COMPONENTS.
Retrofitting Existing BMPs
• Ensure no downstream harm
  • Flooding & Erosion
• Preserve WQV
• Ensure easy & cost effective maintenance
Retrofit of Existing Practices: Case Study 1

Town Hall Swale
Retrofit of Existing Practices: Case Study I

Town Hall Swale
Retrofit of Existing Practices: Case Study I

Town Hall Swale
Tips for Successful Construction
Tips for Successful BMP Installation

- Implement Design Ordinance
- Proper Design, Coordination and Review
- Proper Construction
  - Install BMP after up gradient watershed is stabilized
  - Ensure proper E & S
  - Inspections
  - Maintenance by Contractor Prior to Acceptance of Ownership
- Training
- Preparation and Filing of As Built Plan
Interactive BMP Design
Interactive BMP Design: Case Study I

Public Works Facility
Interactive BMP Design: Case Study I

Public Works Facility
Public Works Facility

Improper Install and E&S over Winter
Public Works Facility

Restoration of Basin
Interactive BMP Design: Case Study I

Public Works Facility
Interactive BMP Design: Case Study I

Public Works Facility
Interactive BMP Design: Case Study II

Parking Lot

Parking Lot Expansion
Parking Lot
Interactive BMP Design: Case Study II

Parking Lot
Parking Lot
Additional Case Study: Case Study III

Highway Swale
Additional Case Study: Case Study III

Highway Swale
Additional Case Study: Case Study III

Highway Swale
Additional Case Study: Case Study III

Highway Swale
Questions?

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