Making the Invisible Visible: Seattle’s Green Stormwater Infrastructure

Presented by:
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Green Stormwater Infrastructure (GSI)

- GSI toolbox overview
- GSI projects in the separated system
- GSI standardization
- GSI for CSO reduction
City Sewer System

- Combined and Partially Separated (2/3 of City)
- Separated (1/3 of City)
infiltration | bioretention cells without underdrain
infiltration | permeable pavement facilities
reduce | trees + compost-amended soils
reduce | green roofs
slow+clean | bioretention cells with underdrain
<table>
<thead>
<tr>
<th>GSI for CSO Reduction</th>
<th>Stormwater Goals via Stormwater Code</th>
<th>CSO Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bioretention/ Rain Garden</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Permeable Pavement</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Rainwater Harvesting/ Detention Cistern</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Trees</td>
<td>✓</td>
<td></td>
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<tr>
<td>Greenroofs</td>
<td>✓</td>
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<tr>
<td>Bioretention with Underdrain</td>
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<td></td>
</tr>
</tbody>
</table>
GSI for Creeks
Natural Drainage Systems

- Initiated 1999 for creek restoration
- Pilot blocks
- Pilot catchments
- Pilot partnering
- National leaders
## Natural Drainage Systems

*Building GSI Experience and Knowledge*

<table>
<thead>
<tr>
<th>Project</th>
<th>Project Drainage Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEA Street #1</td>
<td>2.3 acres</td>
</tr>
<tr>
<td>NW 110&lt;sup&gt;th&lt;/sup&gt; Cascade</td>
<td>28 acres</td>
</tr>
<tr>
<td>Broadview Green Grid</td>
<td>32 acres</td>
</tr>
<tr>
<td>Pinehurst Green Grid</td>
<td>49 acres</td>
</tr>
<tr>
<td>High Point</td>
<td>129 acres</td>
</tr>
</tbody>
</table>
SEA Street

- Constructed in 2000
- 660 linear feet
- 2.3-acre drainage
- 99-percent reduction in runoff volume
NW 110th Cascade

- Constructed 2003
- 1400 linear feet
- 28-acre drainage
- 48-74 percent reduction in runoff volume
- Released water in only 49 of 235 storms
NW 110th Monitoring

- Water quality monitoring, removal rates based on mass loading (and no ‘biofiltration plants’):
  - total suspended solids (TSS), 84%;
  - total nitrogen, 63%;
  - total phosphorus, 63%;
  - total copper, 83%; dissolved copper, 67%;
  - total zinc, 76%; dissolved zinc, 55%;
  - total lead, 90%; and
  - motor oil, 92%.
Broadview Natural Drainage System
- Constructed 2004
- 4,500 linear feet
- 32-acre drainage
Pinehurst Natural Drainage System

- Constructed 2005
- 3,800 linear feet
- 49-acre drainage
- Infiltrate 82 percent average annual volume (9.7 million gallons)
High Point

- Constructed 2005-2009
- Seattle Housing Authority project
- 120 acres of compact mixed-income development
Citywide Natural Drainage Systems

232 acres
GSI Standardization

seattle.gov/util/greeninfrastructure
GSI for CSO Reduction
Combined vs. Partially Separated

Figure 5-7. Typical Combined (left) and Separated (right) Sewer Systems
Green Stormwater Infrastructure

Fully Combined Area

- Private Property
  - RainWise to manage flows
- Public Property
  - Permeable Pavement Alleys
  - Roadside Raingardens
  - Natural Drainage Systems (only if no existing curb and gutter)

Partially Separated Area

- Private Property Only
- RainWise – primarily to disconnect flows and direct to street
Public Rights-of-Ways

- Roadside Rain gardens
- Permeable Pavement
- Alleys
Roadside Raingarden Planting Strip Concept Street

Before

After

Images courtesy King County
Roadside Raingarden Curb Bulbs
Roadside Raingardens

*planting strip vs. curb bulbs*

- **Existing Planting Strip**
  - No parking Impact
  - Applicable with 9.5-feet minimum width

- **Curb Bulb**
  - Use when need larger raingarden footprint
Public Sensitivities to Roadside Raingardens

• Resistance to any changes
• Standing water
• Loss of parking
• Change in aesthetics
• Signs are intrusive
Loyal Way NW & 30th Ave NW (Ballard)

Raingarden Types
- Raingarden with the existing curb line and planting strip
- Raingarden with modified curb and planting strip
- No parking area

Prepared November 2009
NW 75th St & 31st Ave NW in Ballard

Raingarden Types

- Raingarden with the existing curb line and planting strip
- Raingarden with modified curb and planting strip
- No parking area

Prepared November 2009
Roadside Raingardens Effectiveness Estimates

- Step 1: Roadway connected to combined sewer
- Step 2: Technically feasible
  - Infiltration restrictions
  - Site restrictions (slope less than 7 percent, existing large trees)
- Step 3: Participation estimates
Roadside Raingardens
Participation: Voluntary vs. Mandatory
Permeable Pavement Alleys Effectiveness Estimates

- Step 1: Alley connected to combined sewer
- Step 2: Technically feasible
- Step 3: Participation estimates: not applicable
Permeable Pavement: Step #2 Technical Feasibility

- Slope
- Debris loading
- Structural conflicts, retaining walls
- Dense utilities
- Alley width
GSI on Private Property

RainWise – Rebates for Property Owners
RainWise: Rainwise.seattle.gov

Be RainWise
Rain that falls on our roofs, driveways and other hard surfaces can carry pollutants to our creeks, Lake Washington, and Puget Sound. During big storms, the sheer volume of this “storm water” can flood homes, cause sewer overflows, and erode hillsides and streambanks.

We can all help to slow and clean the rain runoff from our homes with simple projects that are useful and attractive additions to our yards.

Explore
Explore useful solutions for controlling stormwater around your home.

Find
Locate RainWise projects and share your own.

Get Started
Select a contractor to install your project.

Do you live in Ballard?
Find out about financial incentives for stormwater actions.

Contractor Workshops
Business opportunities for Seattle licensed contractors and design professionals.

Contractors and Vendors
Want to register as a Rainwise Contractor? Find out more here.

Find your home on a map and calculate your stormwater impact.
RainWise Effectiveness Estimates

- **Step 1:** Roof connected to combined sewer
- **Step 2:** Technically feasible
- **Step 3:** Participation estimates
RainWise: Step #2 Technical Feasibility

- Roof area that can be directed to a GSI ‘tool’
- Infiltration restrictions
- Site restrictions /Space
RainWise Feasibility: Site Restrictions
RainWise Participation Estimates

- Low = 1 percent
- High = 30 percent
- Why not 100%?
  - Volunteer program
  - Landscape choices, aesthetics
  - Concern that will cause wet basements
  - Rebate level and turnaround time
  - Awareness
RainWise Promotion

- Variety of tools to maximize participation
  - Direct mail to all eligible households (4x/year)
  - Listserv messages via e-mail
  - Demonstration projects (Sunset Hill Community Club, Loyal Heights Elementary)
  - Local media (Ballard News-Tribune, local blogs)
  - Point-of-sale promotions at local businesses
  - Presence at Ballard Sunday Market
  - Trusted advocates (Groundswell, Sustainable Ballard)
  - November 6 – Ballard RainWise Roadshow
Ballard

- Step 1: Connectivity to combined sewer
Ballard

- Step 2: Technical Feasibility
  - Step 2a: Infiltration Restrictions
Step 2: Technical Feasibility

- Step 2b: GSI practice specific feasibility
Ballard

- **Step 3: Participation Estimates**
  - **Step 3a: Roadside Raingardens**
    - High: 60%
    - Low: 30%
  - **Step 3b: RainWise**
    - High: 35%
    - Low: 15%
Step 1: Connectivity to combined sewer
Fremont/Wallingford

- Step 2: Technical Feasibility
  - Step 2a: Infiltration Restrictions
Fremont/Wallingford Participation Estimates

- Roadside raingardens participation estimate 5%
- Planting strips too narrow
- Parking evaluation not yet conducted but anticipate majority of streets would NOT meet the criteria for parking policy memo
GSI Potential for CSO Control Planning Areas

- **Area 1**
  - Ballard
  - Fremont/Wallingford
  - Interbay

- **Area 2**
  - North Union Bay
  - Portage Bay
  - Madison Park/Union Bay
  - Montlake
  - Leschi

- **Area 3**
  - Duwamish
Planning Area 1: GSI Potential for CSO Control

Legend

- Basins with Potential to Fully Control CSOs – Maximum Potential
- Basins with Potential to Fully Control CSOs – Most Practical
- Basins with Moderate Potential to Reduce Control Volumes
- Basins with Low Potential to Reduce Control Volumes
Planning Area 2: GSI Potential for CSO Control

Legend:
- **Green**: Basins with Potential to Fully Control CSOs – *Maximum Potential*
- **Blue**: Basins with Potential to Fully Control CSOs – *Most Practical*
- **Yellow**: Basins with *Moderate Potential* to Reduce Control Volumes
- **Red**: Basins with *Low Potential* to Reduce Control Volumes
Planning Area 3: GSI Potential for CSO Control

Legend
- Basins with Potential to Fully Control CSOs – Maximum Potential
- Basins with Potential to Fully Control CSOs – Most Practical
- Basins with Moderate Potential to Reduce Control Volumes
- Basins with Low Potential to Reduce Control Volumes
Other benefits of GSI

• Significant reduction in total volume of combined stormwater flows
  – Water quality benefit
  – Energy savings from decreased pumping and Wastewater Treatment costs

• Increased awareness about stormwater and impacts

• Increased green space (increased walkability, increased habitat)
GSI Roll Out: Leading with Green

2010
- Ballard Roadside Raingardens, Phase 1
- Ballard RainWise

2011
- Ballard Permeable Pavement Alleys, Phase 1
- Windermere RainWise
- Montlake RainWise, Roadside Raingardens and Perm Pvmt Alley
- North Union Bay RainWise

2012
- Ballard Roadside Raingardens, Phases 2-5
- Interbay RainWise
- Genesee RainWise
- Henderson RainWise
- Fremont/Wallingford RainWise

2014
- Ballard Permeable Pavement Alleys, Phase 2