Green Infrastructure for Stormwater Management in Portland

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Stormwater Systems Division, Watershed Services
City of Portland, Oregon
140 sq. miles; Population = 603,000
Green Infrastructure

Interconnected engineered systems or natural areas that use plants and soil to slow, filter, and infiltrate runoff close to its source.
Your System’s Assets
July 2013

1,000 Miles
Sanitary Sewers

885 Miles
Combined Sewers

454 Miles
Storm Sewers

8,587
Stormwater Sumps (UICs)

97
Active Pumping Stations

56 Miles
Force Mains

47,779
Manholes

885,312
Feet of Culverts and Ditches

50,615
Stormwater Inlets

1,913
Green Streets and Other Stormwater Facilities

Estimated replacement value is $12.5 billion. Population served is approximately 600,000.
Why Green Infrastructure for Stormwater Management?

- Manage stormwater runoff at the source, on the surface
- Mimic natural hydrology
- Integrate into the built environment
- Provide multiple benefits
Green Infrastructure | Multiple Benefits

**Economic**
- lower life cycle costs
- preserves capacity
- more flexibility
- cost effective alternative to pipe replacement

**Public Infrastructure**
- peak flow and volume reduction
- reduction of CSO events
- basement sewer backup relief

**Environmental**
- urban heat island
- groundwater recharge
- reduced pollutants
- climate change
- air quality
- habitat

**Community**
- neighborhood livability
- increased property values
- engaged community
- pedestrian and bike safety
Portland Watersheds

- Willamette River
- Columbia Slough
- Johnson Creek
- Fanno Creek
- Tryon Creek
Portland | Monthly Rainfall

Average = 37 in / yr

Rainfall (mm)
Portland | Rainfall Events (1983-2012)

66% are < 0.5 in
Portland | Snow

SW 4th & College

average 8 cm / year
Bureau of Environmental Services

- Infrastructure
  - Two treatment plants
  - 100 pump stations
  - 2,500 miles of pipe (42% combo sewer)
- Rivers and streams BES protects: 300 miles
- Budgets
  - Operating budget of $895 million/year
  - 5-yr capital budget of $530 million
- Employees: > 500 full time employees
Portland | Regulations

Key Laws / Regulations

- Clean Water Act (1972)
- Endangered Species Act (1973)
- Safe Drinking Water Act (1974)
- State & Local Req.

- Combined Sewer Overflow (CSO)
- NPDES / Municipal Separated Stormwater Sewer System (MS4)
- salmon
- other fish
- amphibians
- birds
- Underground Injection Control (UIC)
- Drinking water wellhead protection area
- sewer capacity
- flooding
- development
- land use
Watershed Health Goals

- Stream flow and hydrology
- Physical habitat
- Water quality
- Biological communities
Green Infrastructure | Key Milestones

Pioneering Projects and Policies

1990
OMSI Parking lot retrofit

1991
SFO to control CSOs

1993
Downspout Disconnection Program

1994
AFSO that required 96% CSO reduction

1999
Stormwater Management Manual

1999
First commercial ecoroof
Green Infrastructure | Key Milestones

Pioneering Projects and Policies

2000
Clean River Plan

2002
Demonstration projects for private property

2003
First Green Street at NE Siskiyou and first partnership with Portland Public Schools

2005
Watershed Management Plan

2006
Clean River Rewards incentive

2007
Tabor to the River Program

2008
Grey to Green Initiative
Portland’s CSO Program

• Completed in 2011
• Cost: $1.4 Billion
• All of it funded by BES rate payers
Grey & Green: T2R Project
T2R | 2006 Pre-Design

2006 Recommended Plan

Legend
- Taggart D Boundary
- Parking Lots with Sustainable Stormwater Controls
- Roofs with Sustainable Stormwater Controls
- Streets with Sustainable Stormwater Controls
- New Combined Sewer Pipes
- Pipes in Poor Condition
- Other Pipes

Pipes + Green
T2R | Overview

• 500 green street facilities
• 81,000 feet of poor condition pipe replaced
• 3,500 street trees
• Private Property Retrofit Program (~2,2 hectares)
• Invasives removal & native planting
• Community partnerships, public outreach / education / involvement
Going from pipes only to pipes + green will save $58 million
Green Roofs and Walls
Green Roofs
Facilities | Green Roofs

~ 370 Ecoroofs, 8 hectares
~150 Roof Gardens, 7 hectares
Facilities | Green Roofs

~ 420 Ecoroofs
9.3 hectares

Acres of Extensive Ecoroof

Facilities | Ecoroofs

Multnomah County Building (retrofit, 2004)
Hotel Modera Green Walls
Green Streets
4' WIDE CURB EXTENSION FACILITY
Green Streets | Curb Extensions

Multnomah Village (SW Troy & 35th)
Green Streets | Curb Extensions

NE Everett & 16th
Bike Boulevards, SE Spokane & 13th
SE Clay Street
South Waterfront planters
Green Streets | Swales

Swan Island (N Channel Ave)
On-site Facilities
Facilities | Private Property

~3,000 facilities total

- ecoroofs
- swales
- planters
- basins
- ponds
Stormwater Planters

Infiltration Planter

Flow-Through Planter
SW Montgomery, Urban Plaza
SW Montgomery, Urban Plaza
SW Montgomery & 12th
Mt Tabor School Rain Garden
Vegetated Infiltration Basins

- Rain Gardens
- Bioretention Facilities
Rain Harvesting

Youth Hostel – SE Hawthorne
Green Streets | Integration

Holman Pocket Park
Tree Program
Meet the Tree Program
Planting Trees for Clean Rivers

The Grey to Green mandate

GOAL: Plant 83,000 trees
(50,000 street, 33,000 yard)

ACTUAL: 32,200 trees planted

Increase capacity for the urban forest via sustainable, partnership-focused, education-based planting programs
Planting Trees for Clean Rivers

The Grey to Green Tree Program

5 years (minus three months)

$14 million (ramp up to ~$4 million/year)

2 full-time staff

10,000 seasonal staff hours/year

2 computers/work stations

6-month planting season

(~Nov-Apr)
Growing a Planting Program for the Urban Forest

Inspiration, Collaboration, Perspiration

**Partnership Building**

**NGOs:** Friends of Trees will plant 21,000 street trees and a large chunk of the yard trees.

**Public Agencies:** Portland Parks and state and city transportation groups are key partners.

**Community:** Residents and community groups plant street trees and residential yard trees.
How Many Trees?

Grey to Green

Number of Trees

FY09  FY10  FY11  FY12  FY13  FY14

FOT  BES on-call  Treebate
East Lents Floodplain

East Lents Floodplain Restoration Project

EXISTING FEATURES:
- Johnson Creek
- Buildings
- Roads
- Bypass Culvert

PROPOSED IMPROVEMENTS:
- Project Boundary
- Streambank Restoration
- Floodplain/Wetland/Grading
- New Road
- New Sidewalk
- Stormwater Treatment
- Removed Road/Bridge/Utilities
- Floodplain Storage Berm
- Berm culvert

Simplified map - not to scale  WS 1111/
East Lents Floodplain Project
East Lents Floodplain Project
East Lents Floodplain Project
Tryon Creek Headwaters Project

- Raingarden
- Creek Restoration
- Ecoroof
- Wetland Improvement
- Street Removed
- Daylit Creek
Tryon Creek Headwaters Project

Daylit creek through the complex
Tryon Creek Headwaters Project

Solar hot Water and photovoltaics on Village Ecoroof
Modeling and Monitoring
Modeling
Modeling | Directly Connected Subcatchments
Modeling | Raingages
Monitoring | Results

Summary Report

– Peak Flow Reduction
– Flow Volume Reduction
– Groundwater
– Facility Soils
Monitoring
Testing and Monitoring
Glencoe Rain Garden / Peak Flow Reduction

Monitoring | Green Streets

Peak Flow (m³/s)

Design Standard = .5 ft³/s

5-min Rainfall Intensity (mm/hr).

construction no outflow meter

Nov 02, May 03, Nov 03, May 04, Nov 04, May 05, Nov 05, May 06, Nov 06, May 07, Nov 07, May 08, Nov 08, May 09, Nov 09, May 10, Nov 10, May 11, Nov 11, May 12, Nov 12
Monitoring | Green Streets

Glencoe Rain Garden / Flow Volume Reduction

Volume Reduction = 86%
Monitoring | Ecoroofs

Potential Runoff: 458 l/min

Ecoroof Peak Flow: 10 l/min

Hamilton Ecoroof / Peak Flow Reduction
Monitoring | Ecoroofs

Volume Reduction = 50%

Rainfall
Metered Runoff

Hamilton Ecoroof / Flow Volume Reduction
Stormwater Operations & Maintenance

Green Street

Regional Stormwater Facility
Regional Stormwater Facilities

• Maintenance Activities
  – Inspection (2 times/year, roughly spring & fall)
  – Maintenance (1-3 times/year)
    • Vegetation Management (control invasive plants & keep access roads and driveways clear)
    • Forebay/Inlet Cleaning and Sediment Removal
    • Trash and Debris Removal
    • Address Erosion Issues

• Repair Activities
  – Structural Damage (fences, gates, forebays, control structures and valves)
Regional Stormwater Facilities

- Approximately 135 sites, ranging in size from 0.01 acre to 19 acres
- Total of 130 acres
- Maintenance cost $1,960/acre (Source: BES Wastewater Collection Systems Division, February 2015)
- Maintenance performed by Contractors and BES staff
Green Streets, Regional Facilities in O&M and Budget by FY

Source: Bureau of Environmental Services Wastewater Collection Systems Division February 2015
Green Streets

- Integration of Green Street into the Collection System Maintenance Management System (CMMS)
  - Asset Information
  - Inspections
  - Maintenance Work Order Information

- Created an Inspection and Condition Assessment Program
  - Based on Observation and Severity Codes
  - Field inspections performed on laptops
<table>
<thead>
<tr>
<th>Service Delivery</th>
<th>Category</th>
<th>LOS B</th>
<th>(Good Effort)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetation</td>
<td></td>
<td>Plants are mostly healthy</td>
<td>Small quantities of weeds</td>
</tr>
<tr>
<td>Litter</td>
<td></td>
<td>Small quantities of litter present</td>
<td>Occasional bare spots</td>
</tr>
<tr>
<td>Soils</td>
<td></td>
<td>Checkdam condition?</td>
<td>Inlets are open no less than 50% of time</td>
</tr>
<tr>
<td>Function</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance Effort</td>
<td></td>
<td>WRP staff inspect 4 times/year</td>
<td>Maintenance crews visit sites 3-4 times/year</td>
</tr>
<tr>
<td></td>
<td></td>
<td>are selectively replaced</td>
<td></td>
</tr>
</tbody>
</table>

- Key: Program budgeted based on LOS B
Green Streets: Maintenance Approach

• Current Maintenance Approach
  – City Staff
    • Perform inspections and write maintenance work orders in CMMS
    • Provide random quality control inspections of contractor work
    • Record Contractor maintenance costs in CMMS
    • Perform select number of maintenance treatments
    • Respond to customer inquiries and complaints
  – Contractors
    • Perform majority of maintenance and repair treatments
Green Streets: Establishment Maintenance

• Maintenance Activities
  – Routine Maintenance
    • Inlet Cleaning and Sediment Removal
    • Leaf and Trash Removal
    • Weeding
    • Tree and Shrub Pruning
    • Irrigation

• Repair Activities
  – Replanting: plant coverage or health below service level
Green Streets: Long-Term Maintenance

• Maintenance Activities
  – Routine Maintenance (3-4 times/year)
    • Inlet Cleaning and Sediment Removal
    • Leaf and Trash Removal
    • Weeding
  – Periodic Maintenance (as needed)
    • Tree and Shrub Pruning
    • Irrigation

• Repair Activities
  – Replanting: plant coverage or health below service level
  – Structural Damage
Green Streets Maintenance Costs

• Establishment Maintenance (post planting maintenance and irrigation)
  • Approximately $3.00- $4.00 per square foot facility area

• Long-Term Maintenance
  • $1.55 per square foot facility area

Source: Bureau of Environmental Services Wastewater Collection Systems Division February 2015
Green Street Steward Program

Goal:
Recruit residents, businesses and organizations to care for Green Streets and supplement BES maintenance activities.

Objectives:
Build civic infrastructure to protect and maintain BES investment in GI through education, training, and support.

Cultivate sense of ownership and responsibility for GI assets that advance watershed health, stormwater management, and livability.
Green Street Steward Program

2010 – Roll out as 6-month pilot in targeted area
• Created maintenance guide
• Developed web page and registration process
• Sent letters to adjacent residents resulting in 5% participation

2012 – Began citywide effort
• AmeriCorps contract for 1.5 years; now hired under 2 year civilian contract

Up to Present - Still citywide pilot
• 271 Green Streets adopted; (19% of total Green Streets)
• 131 Registered Green Street Stewards

Yearly Summary of stewards and GS adopted since the beginning of the program (Nov. 2010)
Green Street Steward Program

Ask that they first register as a steward
adopt a green street safety disclaimer
Report activities (on-line or email)
BES Tracking which ones adopted

Simple activities that ensure Green Streets continue to function and look good

• Clear curb openings of leaves and debris so water can flow – most important!
• Pick up trash
• Pull weeds

Do Not:
• Prune/trim
• Replace or interplant with
• Remove sediment
Inspiring Partnerships – Building Capacity

- Neighborhood Residents
- Business Owners and Green Teams
- Community Watershed Councils
- Garden Club members
- Non-profits and Affinity groups – Surfriders, Sierra Club, Audubon Society, Alternative youth programs, etc.
- Neighborhood & Business Associations
- Non-profit groups with environmental mission
- Partner with volunteer coordinators of local watersheds councils
- University student volunteer and engagement center
- Business Association Chairs
Statistics

Total
- 217 Green Streets adopted
- 103 registered Green Street Stewards

Since May 2012
- 2062 adults reached
- 888 youth reached
- 216 homes and 41 businesses canvassed

Once was asked to be a babysitter and twice to come over for a cup of tea
Into the Future
Into the Future

• Green infrastructure integrated into City wide planning:
  – City Greenways, Green Connectors (The Portland Plan)
    • multi-modal streets that connect schools, parks, and natural features
Into the Future

- Green infrastructure integrated into City wide planning:
  - System Plan
    - long-term facilities plan for stormwater & combined
Into the Future | Clay Street

• Green Connector
• integrate needs of:
  » pedestrians, cyclists, freight, business owners, stormwater management
Into the Future | Clay Street
Into the Future | Clay Street

SE 12th & Clay
Into the Future | Clay Street
Into the Future

• Green infrastructure integrated into City wide planning:
  – Climate Action Plan
Into the Future

• Green infrastructure integrated into City wide planning discussions:

  – Eco Districts
    • neighborhood scale, smart growth and urban design
• In the beginning, there were just a few design issues to address …

   Planting Design

   Inlet Location

   Infiltration Rates

   Fire Access

   Water Lines
... but many more were added over the years

- On Street Parking
- Infiltration Rates
- Pavement Type
- Steep Slopes
- Inlet Location
- Street Trees
- Water Lines
- ADA requirements
- Gas Lines
- Power Poles
- Fire Access
- Groundwater
- Modeling
- Basements
A Little Humor
Why Does the Specification Matter?