Statewide LID Training Program
INSTRUCTORS

REBECCA DUGOPOLSKI, PE
Senior Engineer

Key project experience: Stormwater monitoring, design, and NPDES Permit compliance

KATE FORESTER
Environmental Designer

Key project experience: Stormwater design, maintenance, and manual development
• 2012: Public and private partners engage state legislature to fund program

• June 2012: LID Training Steering Committee convened

• 2012-2013: Washington State LID Training Plan developed: www.wastormwatercenter.org/lid-background

• 2014: Training program built from state LID Training Plan
• 49 trainings in western and eastern WA in 2014-2015
• 42 trainings in western and eastern WA in 2015-2016
• 39 trainings offered in western and eastern WA in 2017
• Three levels: Introductory, Intermediate, and Advanced
• Statewide LID Certificate now available
Statewide LID Training Program

OVERVIEW OF PROGRAM

PROJECT LEAD

HERRERA

CORE TEAM

CASCADIA CONSULTING GROUP

WASHINGTON STORMWATER CENTER

ADDITIONAL TRAINING SUPPORT

CH2M

CITY OF PUYALLUP

MUTUAL MATERIALS

ASSOCIATED EARTH SCIENCES INCORPORATED

KINDRED

MITHŪN

LEAPING FROG FILMS
Statewide LID Training Program

OVERVIEW OF PROGRAM

INTRODUCTORY

2.1 Introduction to LID for Inspection & Maintenance Staff

INTERMEDIATE

3.1 Intermediate LID Topics: NPDES Phase I & II Requirements

3.2 Intermediate LID Design: Bioretention

3.3 Intermediate LID Design: Permeable Pavement

3.4 Intermediate LID Design: Site Assessment, Planning & Layout

3.5 Intermediate LID Design: Rainwater Collection Systems & Vegetated Roofs

3.6 Intermediate LID Design: Hydrologic Modeling

ADVANCED

5.0 Advanced Topics for Long-term LID Operations: Bioretention

5.1 Advanced Topics for Long-term LID Operations: Permeable Pavement

5.2 Advanced Topics in LID Design: Bioretention

5.3 Advanced Topics in LID Design: Permeable Pavement

5.4 Advanced Topics in LID Design: Site Assessment, Planning & Layout

5.5 Advanced Topics in LID Design: Rainwater Collection Systems & Vegetated Roofs

5.6 Advanced Topics in LID Design: Hydrologic Modeling

6.2 Advanced Topics in LID Design: Bioretention Media and Compost Amended Soils

Advanced Topics for Long-term LID Operations: Bioretention

Advanced Topics in LID Design: Bioretention

Advanced Topics in LID Design: Permeable Pavement

Advanced Topics in LID Design: Site Assessment, Planning & Layout

Advanced Topics in LID Design: Rainwater Collection Systems & Vegetated Roofs

Advanced Topics in LID Design: Hydrologic Modeling

Advanced Topics in LID Design: Bioretention Media and Compost Amended Soils
# Statewide LID Training Program

## TODAY’S TRAINING

<table>
<thead>
<tr>
<th>INTRODUCTORY</th>
<th>INTERMEDIATE</th>
<th>ADVANCED</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Introduction to LID for Inspection &amp; Maintenance Staff</td>
<td>3.1 Intermediate LID Topics: NPDES Phase I &amp; II Requirements</td>
<td>5.0 Advanced Topics for Long-term LID Operations: Bioretention</td>
</tr>
<tr>
<td></td>
<td>3.2 Intermediate LID Design: Bioretention</td>
<td>5.1 Advanced Topics for Long-term LID Operations: Permeable Pavement</td>
</tr>
<tr>
<td></td>
<td>3.3 Intermediate LID Design: Permeable Pavement</td>
<td>5.2 Advanced Topics in LID Design: Bioretention</td>
</tr>
<tr>
<td></td>
<td>3.4 Intermediate LID Design: Site Assessment, Planning &amp; Layout</td>
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</tr>
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<td>3.5 Intermediate LID Design: Rainwater Collection Systems &amp; Vegetated Roofs</td>
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<td>5.6 Advanced Topics in Hydrologic Modeling</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.2 Advanced Topics in LID Design: Bioretention Media and Compost Amended Soils</td>
</tr>
</tbody>
</table>
INTRODUCTION TO LID
INSPECTION & MAINTENANCE STAFF
introduction

LID O&M overview

BMP specifics

administrative tools

wrap up
introduction

LID O&M overview

BMP specifics

administrative tools

wrap up
LEARNING OBJECTIVES

1. Participants will gain a basic understanding of inspection and maintenance activities associated with LID BMPs.

2. Identify priority elements when conducting inspections for LID facilities

3. Identify and understand the most common problems and associated solutions related to maintaining LID BMPs
INTRODUCTION TO LID

Intro to LID

NPDES Permit

Western Washington Phase II Municipal Stormwater Permit

Statewide LID Training Program

2.1 INSPECTION & MAINTENANCE STAFF
INTRODUCTION

LOW IMPACT DEVELOPMENT (LID): Stormwater Management Strategy

- Site design & planning techniques emphasizing conservation
- Use of small-scale engineered and non-engineered controls to closely mimic pre-development hydrologic processes
INTRODUCTION

LID Principles: Pre-developed Forest

2012 LID Technical Guidance Manual for Puget Sound
INTRODUCTION
LID Principles: Developed Condition

2012 LID Technical Guidance Manual for Puget Sound
INTRODUCTION

LID Principles: Site Design And Planning

• Minimize disturbance
• Reduce impervious surface
• Protect and restore native soils and vegetation
• Manage stormwater close to the source

Traditio
nal  LID
INTRODUCTION

LID BMPs: Small-Scale Engineering Controls

- Infiltration
- Filtration
- Storage
- Evaporation
- Transpiration

Synonyms for LID BMPs:
- Green Stormwater Infrastructure (GSI), Integrated Management Practices (IMPs), and On-Site Stormwater Management BMPs

Conserve or regain pre-developed hydrologic functions
INTRODUCTION

TOPICS

Intro to LID

NPDES Permit
National Pollutant Discharge Elimination System (NPDES) Municipal Stormwater Permits

<table>
<thead>
<tr>
<th>Municipal Stormwater Permittees in Washington State</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Phase 1 Permittees</strong></td>
</tr>
<tr>
<td>Seattle</td>
</tr>
<tr>
<td>Tacoma</td>
</tr>
<tr>
<td>Clark County</td>
</tr>
<tr>
<td>King County</td>
</tr>
<tr>
<td>Pierce County</td>
</tr>
<tr>
<td>Snohomish County</td>
</tr>
<tr>
<td><strong>Western Washington Phase II Permittees</strong></td>
</tr>
<tr>
<td>82 Cities</td>
</tr>
<tr>
<td>5 Counties</td>
</tr>
<tr>
<td><strong>Eastern Washington Phase II Permittees</strong></td>
</tr>
<tr>
<td>18 Cities</td>
</tr>
<tr>
<td>5 Counties</td>
</tr>
</tbody>
</table>

**Secondary Permittees:** Approximately 45; such as ports and universities

To see a listing of permittees visit [http://www.ecy.wa.gov/programs/wq/stormwater/municipal/MuniStrmWtrPermList.html](http://www.ecy.wa.gov/programs/wq/stormwater/municipal/MuniStrmWtrPermList.html)
INTRODUCTION

NPDES PERMIT REQUIREMENTS:
Requirements Vary By Permittee

- Phase II requirements are somewhat less extensive
- Secondary permittee requirements vary

Timeline for updating maintenance standards

**Phase I**

Per Section S5.C.9.a of the Phase I Permit

- June 30, 2015

**Phase II**

Per Section S5.C.5.a of the Phase I Permit

- Most Permittees
- Lewis Co.
- City of Aberdeen

- June 30, 2016
- June 30, 2017
- June 30, 2018
NPDES PERMIT REQUIREMENTS: Requirements Vary By BMP Classification

- On-site Stormwater Management BMPs
- Stormwater Treatment and Flow Control BMPs/Facilities
INTRODUCTION

NPDES PERMIT REQUIREMENTS: Minimum Requirements (MRs)

1. Preparation of Stormwater Site Plans
2. Construction SWPPP
3. Source Control
4. Preserve natural Drainage
5. On-Site Stormwater management
6. Run-off Treatment
7. Flow Control
8. Wetlands Protection
9. O&M
NPDES PERMIT LID O&M REQUIREMENTS: Minimum Requirements (MRs)

• MR #2 – Construction Stormwater Pollution Prevention Plan (SWPPP)
  • Protect LID BMPs from sediment and compaction

• MR #5 – On-site Stormwater Management
  • Infiltrate, disperse, and retain runoff on-site to the extent feasible
INTRODUCTION

NPDES PERMIT REQUIREMENTS: Minimum Requirements (MRs)

• **MR #6 – Runoff Treatment**
  • Water quality treatment for pollution-generating areas

• **MR #7 – Flow Control**
  • Control of flow peaks and flow durations
INTRODUCTION

NPDES PERMIT REQUIREMENTS: On-site Stormwater Management BMPs

• Used to help meet MR #5

• May be used to help meet MR #6 and/or MR #7

• “On-site Stormwater Management BMPs” = LID BMPs
INTRODUCTION

NPDES PERMIT REQUIREMENTS: On-site Stormwater Management BMPs

Includes the following LID BMPs:

- Rain Gardens (BMP T5.14A)
- Bioretention (BMP T5.14B)
- Permeable Pavement (BMP T5.15)
- Vegetated Roofs (BMP T5.17)
- Full Dispersion (BMP T5.30)

- Downspout Full Infiltration (BMP T5.10A)
- Downspout Dispersion (BMP T5.10B)
- Concentrated Flow Dispersion (BMP T5.11)
- Sheet Flow Dispersion (BMP T5.12)
- Compost-amended soils (BMP T5.13)
INTRODUCTION

NPDES PERMIT REQUIREMENTS: Treatment and Flow Control BMPs/Facilities

• Subset of On-site Stormwater Management BMPs
• Used to meet MR #6 or MR #7
• May also be used to meet MR #5
• Includes the following BMPs:
  • Bioretention (BMP T5.14B)
  • Permeable Pavement (BMP T5.15)
  • Vegetated Roofs (BMP T5.17)
  • Detention facilities
  • Standard infiltration facilities
  • Treatment BMPs/facilities
### LID O&M OVERVIEW

#### NPDES PERMIT LID O&M REQUIREMENTS: O&M Standards

<table>
<thead>
<tr>
<th>Requirement</th>
<th>On-site SW Management BMPs</th>
<th>SW Treatment &amp; Flow Control BMPs/Facilities (MR #6 and/or MR #7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implement maintenance standards</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Adopt or update ordinance or other enforceable documents</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Implement practices, policies, &amp; procedures to reduce SW impacts associated with runoff</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
## NPDES PERMIT LID O&M REQUIREMENTS:

### Plan Review

<table>
<thead>
<tr>
<th>Requirement</th>
<th>On-site SW Management BMPs</th>
<th>SW Treatment &amp; Flow Control BMPs/Facilities (MR #6 and/or MR #7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verify maintenance plan completed &amp; O&amp;M responsibility assigned</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Verify submission of maintenance instructions</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Verify that O&amp;M manual is complete</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Review and approve declaration of covenant (including design details,</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>figures and maintenance instructions) and grant of easement</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
NPDES PERMIT LID O&M REQUIREMENTS:

**Inspection**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>On-site SW Management BMPs</th>
<th>SW Treatment &amp; Flow Control BMPs/Facilities (MR #6 and/or MR #7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Legal authority to inspect private stormwater facilities and enforce maintenance standards</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Conduct post-construction inspections to ensure proper installation</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
LID O&M OVERVIEW

NPDES PERMIT LID O&M REQUIREMENTS: Inspection (continued)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>On-site SW Management BMPs</th>
<th>SW Treatment &amp; Flow Control BMPs/Facilities (MR #6 and/or MR #7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conduct inspections during construction in new residential developments*</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Conduct ongoing annual inspections</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Perform spot checks for potentially damaged BMPs owned/operated by Permittee after major storm events</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

*Every 6 months until 90% of the lots are constructed or when construction is stopped and the site is fully stabilized
NPDES PERMIT LID O&M REQUIREMENTS:

Enforcement

<table>
<thead>
<tr>
<th>Requirement</th>
<th>On-site SW Management BMPs</th>
<th>SW Treatment &amp; Flow Control BMPs/Facilities (MR #6 and/or MR #7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enforce compliance with maintenance standards, as needed, based on inspection</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
# LID O&M Overview

## NPDES Permit LID O&M Requirements: Training

<table>
<thead>
<tr>
<th>Requirement</th>
<th>On-site SW Management BMPs</th>
<th>SW Treatment &amp; Flow Control BMPs/Facilities (MR #6 and/or MR #7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Train staff involved in plan review, permitting, construction site inspections, &amp; enforcement</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Implement an ongoing training program for employees who have primary O&amp;M job functions that may impact SW quality</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
## LID O&M OVERVIEW

### NPDES PERMIT LID O&M REQUIREMENTS:

#### Record Keeping

<table>
<thead>
<tr>
<th>Requirement</th>
<th>On-site SW Management BMPs</th>
<th>SW Treatment &amp; Flow Control BMPs/Facilities (MR #6 and/or MR #7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keep records of inspections and enforcement actions (e.g., inspection reports, notices of violations)</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
### NPDES PERMIT LID O&M REQUIREMENTS: Mapping

<table>
<thead>
<tr>
<th>Requirement</th>
<th>On-site SW Management BMPs</th>
<th>SW Treatment &amp; Flow Control BMPs/Facilities (MR #6 and/or MR #7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scale drawing of the lot(s) and public ROW that show BMP locations</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Map BMPs owned/operated by Permittee</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Map connections between BMPs and tributary conveyances*</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

*Phase I Only
LID O&M GUIDANCE DOCUMENT: Objective

• Support permittees in implementing LID maintenance programs

• Provide specific O&M guidance so permittees can create maintenance standards that preserve facility function

• Note: Jurisdictions may want to tailor the tables in the O&M guidance document to address varying levels-of-service
LID O&M OVERVIEW

LID O&M GUIDANCE DOCUMENT: Development

- Two advisory committees
  - LID Maintenance Advisory Committee
  - LID Maintenance Administrative Issues Advisory Committee

- Best available information
  - Advisory committee input
  - Literature review
  - Targeted surveys sent to jurisdictions, contractors/landscapers, and vendors

- Guidance will evolve over time
LID O&M GUIDANCE DOCUMENT: Overview

- **Summary of NPDES Permit Requirements**
- **Maintaining LID BMPs**
  - Bioretention facilities
  - Rain gardens
  - Permeable pavement
  - Vegetated roofs
  - Downspout infiltration systems
  - Downspout, sheet flow, and concentrated dispersion systems
  - Compost-amended soils
- **Programmatic & Administrative Guidance**
LID O&M OVERVIEW

LID O&M GUIDANCE DOCUMENT: Overview

• BMP description
  • How water moves through facility

• Key maintenance considerations to ensure facility function
  • Function by BMP component
  • Key maintenance by BMP component

• Key operations to preserve facility function

Photo courtesy of Seattle Public Utilities
## LID O&M GUIDANCE: Overview

- Maintenance standards and procedures

<table>
<thead>
<tr>
<th>Component</th>
<th>Recommended Frequency</th>
<th>Condition when Maintenance is Needed (Standards)</th>
<th>Action Needed (Procedures)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Splash block inlet</td>
<td>A</td>
<td>Water is not being directed properly to the facility and away from the inlet structure</td>
<td>Reconfigure/repair blocks to direct water to facility and away from structure</td>
</tr>
<tr>
<td>Curb cut inlet/outlet</td>
<td>Weekly during fall leaf drop</td>
<td>Accumulated leaves at curb cuts</td>
<td>Clear leaves (particularly important for key inlets and low points along long, linear facilities)</td>
</tr>
<tr>
<td>Pipe inlet/outlet</td>
<td>A, W, A, S</td>
<td>Pipe is damaged</td>
<td>Repair/replace</td>
</tr>
<tr>
<td></td>
<td>Weekly during fall leaf drop</td>
<td>Pipe is clogged</td>
<td>Remove roots or debris</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sediment, debris, or trash reducing capacity of inlet/outlet</td>
<td>Clear the blockage</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Identify the source of the blockage and take actions to prevent future blockages</td>
</tr>
<tr>
<td></td>
<td>Weekly during fall leaf drop</td>
<td>Accumulated leaves at inlets/outlets</td>
<td>Clear leaves (particularly important for key inlets and low points along long, linear facilities)</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>Maintain access for inspections</td>
<td>Clear vegetation within 1 foot of inlets and outlets, maintain access pathways</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Transplant vegetation when possible</td>
</tr>
<tr>
<td>Erosion control at inlet</td>
<td>A</td>
<td>Concentrated flows are contacting soil and causing erosion</td>
<td>Maintain a cover of round rock or cobbles or other erosion protection measure (e.g., matting) to protect the ground where concentrated water enters the facility (e.g., a pipe, curb cut or swale)</td>
</tr>
<tr>
<td>Trash rack</td>
<td>S</td>
<td>Trash or other debris present on trash rack.</td>
<td>Remove/dispose</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>Bar screen damaged or missing</td>
<td>Repair/replace</td>
</tr>
</tbody>
</table>
LID O&M GUIDANCE: Overview

- Equipment and material list

---

Table 4. Bioretention Equipment and Materials List.

<table>
<thead>
<tr>
<th>Landscaping equipment</th>
<th>Landscaping materials*</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Gloves</td>
<td>□ Plants</td>
</tr>
<tr>
<td>□ Weeding tool</td>
<td>□ Stakes and ties</td>
</tr>
<tr>
<td>□ Soil knife</td>
<td></td>
</tr>
<tr>
<td>□ Pruners</td>
<td></td>
</tr>
<tr>
<td>□ Loppers</td>
<td></td>
</tr>
<tr>
<td>□ Stakes and guys</td>
<td></td>
</tr>
<tr>
<td>□ Manual edger</td>
<td></td>
</tr>
<tr>
<td>□ Line trimmer (also known as a string trimmer, weed eater, or weed whacker)</td>
<td>□ Rock or cobbles for rock pad</td>
</tr>
<tr>
<td>□ Rototiller</td>
<td>□ Erosion control matting</td>
</tr>
<tr>
<td>□ Hoe</td>
<td></td>
</tr>
<tr>
<td>□ Rake</td>
<td></td>
</tr>
<tr>
<td>□ Wheelbarrow</td>
<td>□ Arborist wood chip mulch</td>
</tr>
<tr>
<td>□ Shovel</td>
<td>□ Coarse compost mulch</td>
</tr>
<tr>
<td>□ Push broom</td>
<td>□ Rock mulch</td>
</tr>
<tr>
<td>□ Hand tamper</td>
<td></td>
</tr>
<tr>
<td>□ Blade sharpeners</td>
<td></td>
</tr>
<tr>
<td>□ Tarp/ Buckets (to remove leaf litter/debris)</td>
<td>□ Hand tools</td>
</tr>
<tr>
<td>□ Garbage bags (for disposal of trash/noxious weeds)</td>
<td>□ Wrench or manhole lifter (for opening manhole lids, grates, etc.)</td>
</tr>
</tbody>
</table>

- Erosion control material*:
  - □ Rock or cobbles for rock pad
  - □ Erosion control matting

- Mulch:
  - □ Arborist wood chip mulch
  - □ Coarse compost mulch
  - □ Rock mulch

- Pipe/structure inspection and maintenance equipment:
  - □ Hand tools
  - □ Wrench or manhole lifter (for opening manhole lids, grates, etc.)
  - □ Flashlight
  - □ Mirror (for viewing pipes without entering structure)
  - □ Garden hose
  - □ Plumbing snake
  - □ Measuring tape or ruler
LID O&M OVERVIEW

LID O&M GUIDANCE: Overview

- **Skills and Staffing**
  - List of general skills required
  - List of additional specialized skills
  - Staffing survey estimates (e.g., crew hours per facility, per linear foot, or per square foot)

---

Skills Needed for Maintenance of Bioretention Facilities

- Landscaping skills (e.g., general plant care)
- Plant identification skills (weeds vs. planted species, invasive vs. common weeds, how to dispose of invasive weeds, timing of weed seed dispersal)
- Erosion control knowledge
- General drainage system maintenance skills (e.g., inlet/pipe/underdrain cleaning experience)
DISPERSION

INfiltration

COMPOST-AMENDED SOILS

BIORETENTION

TREES

PERMEABLE PAVEMENT

VEGETATED ROOFS
• Vegetated areas that collect runoff from impervious surfaces

• Restores the natural drainage patterns of sheet flow and infiltration

• Types:
  • Downspout dispersion
  • Concentrated flow dispersion
  • Sheet flow dispersion
COMPONENTS: Downspout Dispersion

- Splash block
- Dispersal area

Source: City of Seattle
COMPONENTS: Downspout Dispersion

- Dispersion trench
- Dispersal area
BMP SPECIFICS – DISPERSION AND INFILTRATION

COMPONENTS: Sheet Flow and Concentrated Flow Dispersion

Sheet Flow Dispersion

• Transition zone
• Dispersal area

Concentrated Flow Dispersion

• Rock pad at discharge point
• Dispersal area
BMP SPECIFICS – DISPERSION AND INFILTRATION

MAINTENANCE PROCEDURES: Dispersion

Splash Block

• Reconfigure/repair blocks to direct water away from building structure
• Reconfigure/repair blocks to prevent water from disrupting soil media

Dispersal Area

• Investigate cause of erosion (gullies/rills) greater than 2 inches deep
• Remove accumulated sediment or debris blocking or channelizing flow path
• Investigate cause of standing water (e.g., grade depressions, compacted soil) that persists for more than 3 days after the end of a storm event
MAINTENANCE PROCEDURES: Dispersion

Dispersion Trench

• Remove/dispose of accumulated trash, debris, or sediment on drain rock
• Remove/dispose of vegetation/moss present on drain rock
• Repair/seal/replace cracked, collapsed, broken, or misaligned drain pipes
• Remove/dispose of sediment in the sump
• Repair/replace stuck, buried, or missing access lid cover

Rock Pad

• Add additional rock if only one layer of rock exists, exposed soil is present, or soil erosion is occurring
1. Dispersion
2. Infiltration
3. Compost-Amended Soils
4. Bioretention
5. Trees
6. Permeable Pavement
7. Vegetated Roofs
DEFINITION AND TYPES

- Trench or drywell designs intended only for use in infiltrating runoff from roof downspout drains

- Types:
  - Downspout full infiltration (infiltration trenches or drywells)
COMPONENTS: Downspout Full Infiltration

- Rock trench/well
- Inlet
- Storage sump

Source: King County
MAINTENANCE PROCEDURES: Infiltration

**Rock Trench/Well**

- Remove/dispose of accumulated trash, debris, or sediment on drain rock
- Remove/dispose of vegetation/moss present on drain rock

**Inlet/Outlet Pipe(s)**

- Remove/dispose of accumulated trash, debris, or sediment
- Clear accumulated sediment from inlet/outlet pipe and screen
- Repair/seal/replace cracked, collapsed, broken, or misaligned drain pipes
BMP SPECIFICS – INFILTRATION

MAINTENANCE PROCEDURES: Infiltration

Roof Downspout

• Repair/replace missing or damaged splash pad
• Remove/dispose of leaves or debris plugging downspout

Storage Sump

• Remove/dispose of sediment in the sump
• Repair/replace stuck, buried, or missing access lid cover
DEFINITION

- Soil/landscape system with adequate depth, permeability, and organic matter
- Retains native soil functionality in a post-development landscape

www.buildingsoil.org
MAINTENANCE PROCEDURES

Soil Media (maintain high organic soil content)

• Maintain 2 to 3 inches of mulch over bare areas
• Return leaf fall and shredded woody materials when possible
• “Grasscycle” (mulch mow or leave clippings) to build turf health

Soil Media (maintain infiltration)

• Aerate soil
• Aerate compacted areas and top-dress with ¼ to ½ inch of compost (turf)
Erosion/Scouring

- Identify and address cause of erosion and stabilize damaged area

Grass/Vegetation

- Remove/replace unhealthy plants

Weeds

- Remove weeds manually (pincer-type weeding tools, flame weeders, or hot water weeders)
- Remove and dispose of noxious weeds properly
OVERVIEW: Definition and Types

• Shallow landscaped depressions that receive stormwater from small contributing areas

• Small scale, dispersed facilities

• Types:
  • Bioretention cells
  • Bioretention swales
  • Infiltration planters
  • Flow-through planters

Photo from Drena Donofrio
COMPONENTS

- Flow Entrance
- Pre-Settling
- Ponding Area
- Bioretention Soil
- Mulch/Compost
- Vegetation
- Filter Fabric (?)
- Liner (optional)
- Underdrain (optional)
- Overflow
HOW THE FACILITY WORKS

Bioretention cell

• Water enters facility
• Ponds
• Infiltrates through bioretention soil/gravel bed
• Infiltrates into underlying soil
• Ponded water exceeding max. depth overflows

2009 Clean Water Services LIDA Handbook
HOW THE FACILITY WORKS

Bioretention Planter

- Water enters facility
- Ponds
- Infiltrates through bioretention soil/ gravel bed
- Infiltrates into underlying soil
- Ponded water exceeding max. depth overflows

2009 Clean Water Services LIDA Handbook
BMP SPECIFICS - BIORETENTION

HOW THE FACILITY WORKS

Bioretention Planter

- Water enters facility
- Ponds
- Infiltrates through bioretention soil/ gravel bed
- Infiltrates into underlying soil
- Ponded water exceeding max. depth overflows
- Underdrain collects water in gravel layer and routes to overflow

2009 Clean Water Services LIDA Handbook
BMP SPECIFICS - BIORETENTION

BIORETENTION VS RAIN GARDENS

Bioretention

Structures/
Underdrains

Yes

No

Rain Garden

Soil mixes

Designed

Less restrictive

Statewide LID Training Program

2.1 INSPECTION & MAINTENANCE STAFF

INTRODUCTION TO LID

68
BMP SPECIFICS – BIORETENTION

MAINTENANCE STANDARDS & PROCEDURES
BY COMPONENT

- Inlets
- Ponding area
- Check dams/weirs
- Bioretention soil
- Outlets
- Underdrains
- Mulch

Siskyou Street, Portland
INLETS: Types

Sheet flow from sidewalk and roadway

Sheet flow from parking lot
INLETS: Types

Curb cut

Curb cut with grate
INLETs: Types

- **Trench drain from upslope BMP**
- **Trench drain from roadway**
INLETS: Types

Piped inlet from upslope BMP

Piped inlet from roadway/parking lot
Stormwater must freely enter facility (no obstructions)

Water entering facility should not cause erosion
BMP SPECIFICS - BIORETENTION

INLETS: Maintenance

• Maintain erosion control at concentrated flow inlets (e.g., rock pad)
• Ensure pipe is not damaged or clogged
INLETS: Maintenance

- Remove accumulated sediment, debris, leaves
- Clear/move vegetation inhibiting flow into facility
BMP SPECIFICS - BIORETENTION

PONDING AREA: Types

Earthen depression

Rockery walls

SPU

Statewide LID Training Program
PONDING AREA: Types

- In ground concrete planter
- Aboveground metal planter
BMP SPECIFICS - BIORETENTION

PONDING AREA: Maintenance Considerations

• Ponding area provides temporary surface storage before infiltration

• Must infiltrate within 48 hour “drawdown” time after the end of a storm
  • Restores hydraulic capacity of system
  • Prevent mosquito breeding conditions
Integrity

- Concrete or metal planter: ensure integrity (e.g., cracks, leaks)
- Rockery: ensure rockery sidewalls are secure
- Earthen side slopes/berms:
  - Erosion: stabilize and address cause of erosion, if feasible
  - Settlement: restore to design height
  - Leaks/seeps on face of berm: repair/compact
PONDING AREA: Maintenance

Material Accumulation

- Remove trash and debris
- Remove leaves if impacting facility function
- Accumulated sediment to extent that infiltration rate is reduced (see “excessive ponded water”) or storage capacity reduced
  - Remove excess sediment
  - Replace any vegetation damaged or destroyed by sediment accumulation and removal
  - Identify and control the sediment source, if feasible
Excessive Ponded Water

• Overflows during small storms or

• Does not fully infiltrate within 48 hours of end of storm
  • Determine cause:
    • Leaves/debris in bottom impeding infiltration?
    • Underdrain, if present, is clogged?
    • Water inputs (e.g., groundwater, illicit connections)
    • Verify sized for contributing area (and area has not increased)
  • If Steps 1-4 do not solve problem: bioretention soil is likely clogged
    • Consult with an engineer or facility designer (May need to remove/replace bioretention soil)
CHECK DAMS/WEIRS: Purpose

- Provides ponding on sloped facilities
- Provides detention/some water quality (settling)
CHECK DAMS/WEIRS: Types

Portland (2012 LID Manual)  Meadow dr10th Street Cascade, the Hylebos, Seattle, WA
CHECK DAMS/WEIRS: Types

- Log/Wooden
- Gravel
- Earthen

SPU
Puget Sound LID Manual
High Point, Seattle WA

Puget Sound LID Manual

BMP SPECIFICS - BIORETENTION

Statewide LID Training Program

2.1 INSPECTION & MAINTENANCE STAFF
BMP SPECIFICS - BIORETENTION

CHECK DAMS/WEIRS: Maintenance

- Remove accumulated sediment, debris, leaves blocking/or with potential to block flow
- Repair any erosion/undercutting and take preventative measures
BMP SPECIFICS - BIORETENTION

BIORETENTION SOIL: Maintenance

- Infiltration through soil mix provides water quality treatment
- Stormwater must infiltrate freely into bioretention soil
- Infiltration rate may be reduced by compaction or clogging with fine sediment
BIORETENTION SOIL: Maintenance

• Remove and replace if clogged (see “excessive ponded water”)

• Minimize loading in cell to protect bioretention soil from compaction during maintenance
  • Never drive equipment or apply heavy loads in facility footprint
  • Minimize any loading to cell during wet conditions
  • Consider measures to distribute loading if heavy foot traffic is required or equipment must be placed in facility (e.g., boards to distribute loads)
OUTLETS: Types and Maintenance Considerations

- Stormwater must freely exit facility once capacity exceeded (above maximum ponding depth)
- Overflows must be conveyed to safe discharge point (e.g., storm drain system)
OUTLETS: Maintenance

- Remove accumulated sediment, debris, leaves at outlet/grate/trash rack
- Clear/move vegetation within 1 foot of outlet to maintain access
- Clear pipes of accumulated material
UNDERDRAINS: Types

- Perforated or slotted pipe wrapped in an aggregate blanket (or filter fabric)
- May have flow restrictor (e.g., orifice) to detain flow
- Can be included to collect treated water under the bioretention soil (e.g., where infiltration to native soil is not feasible)
UNDERDRAINS: Maintenance

- Prolonged surface ponding
  - Jet clean or rotary cut debris/roots from underdrain
  - If equipped with flow restrictor (orifice), clean regularly
VEGETATION: Maintenance Considerations

- Grasses, shrubs and trees:
  - Intercepts rain before it hits the soil and facilitates evaporation
  - Uptakes water from the soil and transpires it to the atmosphere
- Improve soil structure and increases infiltration capacity
- Promotes water quality treatment
VEGETATION: General Maintenance

- Determine cause of poor vegetation growth and establishment and replant as necessary to obtain 75% or greater survival rate.

- Identify issues and if necessary, remove and dispose of diseased plants or plant parts.

- Replace dead vegetation within 30 days of reported dead and dying plants (as practical depending on weather and planting season).
VEGETATION: Emergent Vegetation & Grasses

Hand rake with small rake or fingers to remove dead foliage in spring or earlier only if foliage is blocking water flow

- **Emergent vegetation**: Sedges and rushes do not like continuous pruning.

- **Perennial ornamental grasses**: Leave dry foliage for winter interest (e.g. switchgrass (*Panicum*) and Karl Forester grass (*Calamagrostis acutiflora* ‘Karl Forester’))

- **Evergreen ornamental grasses**: Clean, rake, and comb grasses when they become too tall. Cut back to the ground or thin every 2 to 3 years.
VEGETATION: Weeds

• Follow IPM protocols for weed management

• Remove weeds manually, with pincer-type weeding tools, flame weeders, or by other non-chemical means, as appropriate

• By law, State listed Class A noxious weeds must be removed, bagged and disposed as garbage immediately

• Requirements for removal of State listed Class B and C weeds varies by County

*Rubus laciniatus*, Evergreen blackberry, *Centaurea stoebe*, Spotted knapweed
VEGETATION: Excessive Vegetation

• Edge or trim groundcovers that grow beyond the facility edge onto sidewalks, paths, or street edges when they create pedestrian safety hazards or clog adjacent permeable pavement surfaces

• Prune, trim, or if necessary, replace plants when vegetation density inhibits stormwater flow beyond design ponding or becomes a hazard for pedestrian and vehicular circulation and safety
### BMP SPECIFICS - BIORETENTION

**VEGETATION: Watering**

#### 3 Year Establishment Period

<table>
<thead>
<tr>
<th>Year</th>
<th>Irrigation Frequency</th>
<th>Trees</th>
<th>Shrubs</th>
<th>Groundcovers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer – Year 1</td>
<td>Once every 1-2 weeks or as needed during dry periods</td>
<td>10-15 gal</td>
<td>3-5 gal</td>
<td>2 gal/sf</td>
</tr>
<tr>
<td>Summer – Year 2 &amp; 3</td>
<td>Once every 2-4 weeks or as needed during dry periods</td>
<td>10-15 gal</td>
<td>3-5 gal</td>
<td>2 gal/sf</td>
</tr>
</tbody>
</table>
BMP SPECIFICS - BIORETENTION

VEGETATION: Watering

- Irrigation after 3 year establishment period:
  - Trees may take up to 5 years to become fully established
  - Identify trigger mechanisms for drought-stress of different species and water immediately after initial signs of stress appear
    - e.g., leaf wilt, flower and leaf drop, plants falling or leaning, sun scald, etc.
  - Water during drought conditions
BMP SPECIFICS - BIORETENTION

MULCH: Maintenance Considerations

Layer of mulch covers bioretention soil to:

- Reduce weed establishment
- Regulate soil temperatures and moisture
- Add organic matter to the soil
MULCH: Maintenance Considerations

- Supplement mulch with hand tools to a depth of 2 to 3 inches
- Replenish mulch per O&M guidance: Often coarse compost used in facility bottom and arborist wood chips on side slopes above typical water levels

No mulch and undefined edge

Hand apply mulch to avoid covering base of trees and shrubs
BMP SPECIFICS - TREES
HOW THEY WORK

Eastern WA LID Manual

- Trees
- Planting Soil
- Structural Soil
- Drainage (Sand Base)
- Aeration Zone
- Sidewalk/Street
- Planter
- Compacted Subgrade
MAINTENANCE PROCEDURES: Pruning

- Prune trees at the right time of year
  - Deciduous trees: November–February
  - **Hazardous** trees should be pruned any time of the year to avoid risk or injury
  - Do not prune trees with thin bark in the summer to reduce sun scald injury (e.g. birch (*Betula spp.*), cherry (*Prunus spp.*) and crabapple (*Malus spp.*))
  - Pine (*Pinus spp.*) or Elm (*Ulmus spp.*): Do not prune May – October to reduce possible exposure to bark beetle (pine) or Dutch Elm Disease (elm)
  - Avoid pruning during spring growth flush

Refer to *Seattle Street Tree Manual* or ISA website for more information.
### BMP SPECIFICS - TREES

MAINTENANCE PROCEDURES: Watering

#### 3- to 5-year Establishment Period

<table>
<thead>
<tr>
<th>Year</th>
<th>Irrigation Frequency</th>
<th>Trees</th>
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</tr>
</tbody>
</table>

Trees may take up to 5 years to become fully established
Hand apply mulch to avoid covering base of trees
BMP SPECIFICS - PERMEABLE PAVEMENT

TOPICS

• Types
• How the system works
• Maintenance considerations for facility function
• Routine maintenance activities
• Corrective maintenance activities
TYPES: Porous Asphalt

- Flexible
- Similar to conventional asphalt, but fines < No. 30 sieve reduced
- Typically used for parking and light traffic loads; however, has been used for medium and heavy applications
- ~16% voids typical (2-3% for conventional)
TYPES: Pervious Concrete

- Rigid
- 1/4 to 5/8 round or crushed aggregate typical, portland cement, and admixtures (optional) to increase workability and strength
- 15 to 20% voids typical
TYPES: Pavers

- Flexible
- Capable of high vehicle loads. Used for lower speeds
- High-density concrete that interlock and transfer vertical loads to surrounding pavers
- 12% voids typical
BMP SPECIFICS - PERMEABLE PAVEMENT

**TYPES:** Plastic Grids

- Flexible
- Plastic grid filled with gravel or soil and planted with grass
- Capable of high vehicle loads. Used for lower speeds
- Highest percent voids
BMP SPECIFICS - PERMEABLE PAVEMENT

HOW THE FACILITY WORKS

figure 6.3.9

The aggregate median provides a connection and overflow protection from the pavement surface to the aggregate base.
Source: Adopted from Cahill

AGGREGATE
OPEN INTO
RECHARGE BED

UNIFORMLY GRADED
WASHED AGGREGATE
WITH 30 TO 40% VOID
SPACE FOR STORMWATER
STORAGE AND RECHARGE

UNCOMPACTED SUBGRADE
IS CRITICAL FOR
PROPER INFILTRATION

FILTER FABRIC RECOMMENDED
ON SIDE WALLS AND OPTIONAL
FOR BOTTOM OF SUBGRADE

Source: LID Technical Guidance Manual for Puget Sound
HOW THE FACILITY WORKS

- Inlets
- Outlets
- Slopes
MAINTENANCE CONSIDERATIONS FOR FACILITY FUNCTION

- Protect subgrade, aggregate base and wearing course from construction sediment
- Stabilize adjacent landscape areas
- Protect surface from material stockpiles
MAINTENANCE CONSIDERATIONS FOR FACILITY FUNCTION

• Modify snow management procedures
  • Skids and rollers
  • Sand minimally and remove ASAP
  • If possible, avoid sanding adjacent streets since tires will track it onto the permeable pavement
  • Avoid stockpiling snow on permeable pavement
BMP SPECIFICS - PERMEABLE PAVEMENT

ROUTINE AND CORRECTIVE MAINTENANCE BY COMPONENT

- Pavement surface
  - Asphalt and concrete
  - PICP and pavers
  - Gravel grid
  - Grass grid
- Adjacent landscaped areas
- Drains
• Routine maintenance (cleaning surface debris)

  • **Large areas:** vacuum sweep (regenerative air or high efficiency vacuum)

  • **Small areas:** walk behind vacuums, shop vacs, hand held pressure washer or power washer with rotating brushes

  • **Frequency:** 1-2 times annually or as determined by site conditions

  • Consult with equipment manufacturer/rep for optimum operation
BMP SPECIFICS - PERMEABLE PAVEMENT

PAVEMENT SURFACE: Asphalt & Concrete

• Corrective maintenance (clogged wearing course)
  • Review overall performance of the facility
  • If water ponds or flows off pavement surface during rain event, corrective maintenance or testing is needed
  • Test the surface infiltration rate using ASTM C1701 (perform 1 test/installation but not < 1 test/2,500 sf)
Corrective maintenance (clogged wearing course)

- ASTM C1701 results indicate an infiltration rate of 10 inches per hour or less
- Corrective maintenance options include:
  - Pressure wash and vacuum system
  - Hand held pressure wash or power wash with rotating brushes
  - Pure vacuum sweeper (calibrated to not dislodge wearing course aggregate)
Moss (inhibits infiltration or presents slip safety hazard)

- **Sidewalks**: broom to remove moss in the summer when it is dry

- **Parking lots and roadways**:
  - Pressure wash (hand held pressure washer or power washer with rotating brushes)
  - Vacuum sweep with brush
  - Combination of pressure washing and vacuum sweeping
BMP SPECIFICS - PERMEABLE PAVEMENT

PAVEMENT SURFACE: Asphalt & Concrete

- Major cracks or trip hazards and concrete spalling and raveling
  - Fill potholes or small cracks with patching mixes
  - Replace in-kind where feasible
  - Large cracks and settlement may require cutting and replacing the pavement section
  - Replacing porous asphalt with conventional asphalt is acceptable if it is a small percentage of the total facility area and does not impact the overall facility function
• Routine maintenance (cleaning surface debris)
  • **Large areas**: vacuum sweep (regenerative air or high efficiency vacuum)
  • **Small areas**: walk behind vacuums, shop vacs
  • **Frequency**: 1-2 times annually or as determined by site conditions
  • Consult with equipment manufacturer/rep for optimum operation
  • Vacuum settings may have to be adjusted to prevent excess uptake of aggregate from paver openings or joints
  • Vacuum surface openings in dry weather to remove dry, encrusted sediment
BMP SPECIFICS - PERMEABLE PAVEMENT

PAVEMENT SURFACE: PICP & Pavers

- Corrective maintenance (clogged wearing course)
  - Review overall performance of the facility
  - If water ponds or flows off pavement surface during rain event, corrective maintenance or testing is needed
  - Test the surface infiltration rate using ASTM C1701 (perform 1 test/installation but not < 1 test/2,500 sf)
BMP SPECIFICS - PERMEABLE PAVEMENT

PAVEMENT SURFACE: PICP & Pavers

- Corrective maintenance (clogged wearing course)
  - ASTM C1701 results indicate an infiltration rate of 10 inches per hour or less
  - Corrective maintenance options include:
    - Pure vacuum sweeper
    - Pressure wash and vacuum system calibrated to remove all visible sediment in the joints or infiltration cells
  - Replace aggregate in joints or infiltration cells per manufacturer specifications
BMP SPECIFICS - PERMEABLE PAVEMENT

PAVEMENT SURFACE: PICP & Pavers

• Structural integrity
  • Loss of aggregate material between paver blocks: Refill per manufacturer's recommendations
  • Paver block missing or damaged: Remove individual damaged paver blocks by hand and replace or repair per manufacturer’s recommendations
  • Surface settling: May require resetting
BMP SPECIFICS - PERMEABLE PAVEMENT

PAVEMENT SURFACE: PICP & Pavers

• Moss
  • **Sidewalks**: broom to remove moss in the summer when it is dry
  • **Parking lots and roadways**:
    • Vacuum sweep
    • Stiff broom/power brush
BMP SPECIFICS - PERMEABLE PAVEMENT

PAVEMENT SURFACE: Gravel Grid

- Routine maintenance (cleaning surface debris)
  - **Large areas:** vacuum sweep (regenerative air or high efficiency vacuum)
  - **Small areas:** walk behind vacuums, shop vacs, rake, leaf blower
  - **Frequency:** 1-2 times annually or as determined by site conditions
  - Consult with equipment manufacturer/rep for optimum operation
  - Vacuum settings may have to be adjusted to prevent excess uptake of aggregate from paver openings or joints
  - Vacuum surface openings in dry weather to remove dry, encrusted sediment
  - Maintain aggregate 0.25 inches above grid structure
PAVEMENT SURFACE: Gravel Grid

- Corrective maintenance (clogged wearing course)
  - Observe the pavement system after a rain event (testing infiltration rate using ASTM C1701 likely not applicable)
  - Corrective action needed, if ponding on surface or water flows off aggregate surface during rain event
BMP SPECIFICS - PERMEABLE PAVEMENT

PAVEMENT SURFACE: Gravel Grid

- Corrective maintenance (clogged wearing course)
  - Use vacuum system calibrated to remove all visible sediment (likely 2-3 cm of aggregate)
  - Replace aggregate per manufacturer specifications (usually 0.25 inches above grid structure)
**BMP SPECIFICS - PERMEABLE PAVEMENT**

**PAVEMENT SURFACE: Gravel Grid**

- **Structural integrity**
  - **Grid damaged:**
    - Remove pins (if present), pry up grid segments, and replace grid, pins and gravel
    - Replace grid segments where three or more adjacent rings are broken or damaged
  - **Loss of aggregate material:** Refill per manufacturer's recommendations (usually 0.25 inches above grid structure)
BMP SPECIFICS - PERMEABLE PAVEMENT

PAVEMENT SURFACE: Grass Grid

- Routine maintenance (cleaning surface debris)
  - **Large and small areas:** rakes, leaf blowers
  - Consult manufacturer guidelines
  - **Frequency:** 1-2 times annually or as determined by site conditions
  - Maintain soil/sand slightly below grid structure
**BMP SPECIFICS - PERMEABLE PAVEMENT**

**PAVEMENT SURFACE: Grass Grid**

- **Corrective maintenance (clogged wearing course)**
  - Observe the pavement system after a rain event (testing infiltration rate using ASTM C1701 likely not applicable)
  - Corrective action needed if ponding on surface or water flows off aggregate surface during rain event
  - Follow manufacturer’s guidelines for repairing surface
BMP SPECIFICS - PERMEABLE PAVEMENT

PAVEMENT SURFACE: Grass Grid

- Structural integrity
  - Grid damaged:
    - Remove pins (if present), pry up grid segments, and replace grid, pins and grass.
    - Replace grid segments where 3 or more adjacent rings are broken or damaged
  - Grass growth:
    - Mulch mower
    - Top dress with 0.5 inches of compost if nutrient deficient (do not use fertilizer)
- Surface settling: May require resetting
BMP SPECIFICS - PERMEABLE PAVEMENT

PAVEMENT SURFACE: Grass Grid

• Structural integrity
  
  • Poor grass coverage:
    • Restore growing medium, reseed or plant and/or amend vegetated area as needed
    • Traffic loading may be inhibiting grass growth; reconsider traffic loading if feasible
    • Growing media elevation should be maintained slightly below grid structure
    • Consult manufacturer/sales representative
ROUTINE AND CORRECTIVE MAINTENANCE BY COMPONENT

- Pavement surface
  - Asphalt and concrete
  - PICP and pavers
  - Gravel grid
  - Grass grid
- Adjacent landscaped areas
- Drains
ADJACENT LANDSCAPED AREAS

• Runoff depositing sediment, mulch, or other material

  • Check the following:
    • Surface elevation of planted area is too high
    • Planted area slopes towards pavement
BMP SPECIFICS - PERMEABLE PAVEMENT

ADJACENT LANDSCAPED AREAS

• Runoff depositing sediment, mulch, or other material
  • Address the source if possible:
    • Re-grading
    • Mulching/planting exposed soils
  • Prior to re-grading, protect porous pavement by covering with temporary plastic and secure covering in place
  • Clean
PERMEABLE PAVEMENT O&M

ADJACENT LANDSCAPED AREAS

- **Groundcover migration**
  - Protect if seeding adjacent areas
  - Modify planting plan and remove invasive plants
  - Maintain adjacent landscaping
  - Weed burners

Groundcover migration happens even with conventional pavement
BMP SPECIFICS - PERMEABLE PAVEMENT

DRAINS: Under- And Elevated- Drains

- Drain clogged:
  - Jet clean or rotary cut debris/roots from under-drain
  - Clean flow restrictor/orifice
  - Identify the source of the blockage and take actions to prevent future blockages

- Soil exposed or erosion damage at discharge point:
  - Identify source of problem
  - Repair erosion and stabilize surface
DRAINS: Under- And Elevated- Drains

- Water remains in storage aggregate longer than anticipated:
  - Determine if problem
  - Inspect drains
  - If structural problems possible schedule investigation of subsurface materials or other potential causes of extended ponding
1. Dispersion
2. Infiltration
3. Compost-Amended Soils
4. Bioretention
5. Trees
6. Permeable Pavement
7. Vegetated Roofs
DEFINITION AND TYPES

- Thin layers of engineered soil and vegetation constructed on top of conventional flat or sloped roofs

- Other names
  - Green roofs
  - Living roofs
  - Eco-roofs
  - Roof gardens

- Types:
  - Intensive (≥ 6” of growth medium)
  - Semi-intensive
  - Extensive (< 6” growth medium)
BMP SPECIFICS – VEGETATED ROOFS

HOW THE FACILITY WORKS

Clean Water Services LIDA Handbook

Statewide LID Training Program

2.1 INSPECTION & MAINTENANCE STAFF

INTRODUCTION TO LID 144
BMP SPECIFICS – VEGETATED ROOFS

MAINTENANCE CONSIDERATIONS

• Stormwater must infiltrate freely through soil
• Stormwater must freely exit facility
• Vegetation should be healthy and cover majority of soil surface
MAINTENANCE STANDARDS & PROCEDURES BY COMPONENT

- Growth Medium
- Roof Drain
- Flashing, Gravel Stops, or Other System Components
- Vegetation
- Weeds
- Watering
MAINTENANCE PROCEDURES:

Growth Medium

- Scarify if crusted or spot replace medium if failing to infiltrate
- Supplement growth medium to design thickness
- For visible erosion or scour, prevent further damage and repair media
- Repair or replace damaged erosion control material until 90% vegetation cover
MAINTENANCE PROCEDURES:

Roof Drain

- Clear blockage and debris to prevent or repair clogging
- Repair/replace damaged inlet pipes

Flashing, Gravel Stops, or Other System Components

- Repair (e.g., recoat) or replace deteriorating elements to eliminate potential pollutant source
MAINTENANCE PROCEDURES:

Vegetation

- Plant areas below 90% cover and install erosion control measures, if necessary, until 90% cover is achieved.
- Mulch mow sedums to encourage establishment.
- Recycle or remove dead vegetation and replace, if necessary.

Stressed vegetation

Moss

Vegetation growing over path
MAINTENANCE PROCEDURES:

Weeds

- Remove weeds manually, with pincer-type weeding tools, flame weeders, or hot water weeders as appropriate
- Follow IPM protocols for weed management

Watering

- Once every 1-2 weeks as needed during prolonged dry periods during establishment periods
- As needed during prolonged dry periods after establishment
introduction

LID O&M overview

BMP specifics

administrative tools

wrap up
ADMINISTRATIVE TOOLS

RECORD KEEPING & TRACKING

• Parcel information
• City/County permit (ROW and/or building permit)
• Relevant sections of the Stormwater Site Plan
• “As-builds” or “record drawings” (individual lots and public ROW)
• Legal agreements (covenants, easements)
ADMINISTRATIVE TOOLS

RECORD KEEPING & TRACKING

- Location information (GPS data, digital maps)
- Project O&M manual (where applicable)
- Maintenance logs (typically included in a Project O&M Manual)
- Inspection forms
- Enforcement documents
• **Immediately post-construction** for all LID BMPs - installed per plan and functioning properly

• **Every 6 months** (until 90% of lots are constructed) for permanent Stormwater Treatment and Flow Control BMPs/Facilities in new residential developments - identify maintenance needs and enforce maintenance standards

• **Ongoing annual** inspections for all Stormwater Treatment and Flow Control BMPs/Facilities (MR #6 and/or MR #7)
ADMINISTRATIVE TOOLS

RESOURCE LIST

• Western WA LID O&M Guidance Document

• Northwest Plant Disease Management Handbook: http://pnwhandbooks.org/plantdisease

• Pacific Northwest Weed Management Handbook: http://pnwhandbooks.org/weed
1. Introduction

2. LID O&M overview

3. BMP specifics

4. Administrative tools

5. Wrap up
## Statewide LID Training Program

### Introduction to LID for Inspection & Maintenance Staff

- **2.1** Introduction to LID for Inspection & Maintenance Staff

### Intermediate LID Design:

- **3.1** Intermediate LID Topics: NPDES Phase I & II Requirements
- **3.2** Intermediate LID Design: Bioretention
- **3.3** Intermediate LID Design: Permeable Pavement
- **3.4** Intermediate LID Design: Site Assessment, Planning & Layout
- **3.5** Intermediate LID Design: Rainwater Collection Systems & Vegetated Roofs
- **3.6** Intermediate LID Design: Hydrologic Modeling

### Advanced Topics for Long-term LID Operations:

- **5.0** Advanced Topics: Bioretention
- **5.1** Advanced Topics: Permeable Pavement
- **5.2** Advanced Topics: Bioretention
- **5.3** Advanced Topics: Permeable Pavement
- **5.4** Advanced Topics: Site Assessment, Planning & Layout
- **5.5** Advanced Topics: Rainwater Collection Systems & Vegetated Roofs
- **5.6** Advanced Topics: Hydrologic Modeling

### Advanced Topics in LID Design:

- **6.2** Advanced Topics in LID Design: Bioretention Media and Compost Amended Soils
Statewide LID Training Program

ONLINE EVALUATION

• An on-line evaluation will be sent to you within 5 days following this training
Two certificates:

- LID Design certificate
- LID Operations and Maintenance certificate

You will receive an e-mail with login information following relevant courses


Remember to sign in and sign out!
For information on training and other resources, visit the Washington Stormwater Center website:

http://www.wastormwatercenter.org

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