• 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/statewide-lid-training-program-plan

• 2014: Training program built from state LID Training Plan.
## OVERVIEW OF PROGRAM

### PROJECT LEAD

| Herrera |

### CORE TEAM

| Cascadia Consulting Group | Veda Environmental |

### ADDITIONAL TRAINING SUPPORT

| CH2M HILL | Aspect Consulting | Leaping Frog Films | SvR Design Company | Washington Stormwater Foundation | StormwaterONE.com |
• Implement first phase of trainings (September 2014 through May 2015)
• 64 trainings offered in first phase
• Three levels: Introductory, Intermediate, and Advanced
• Train the Trainer program for service providers and LID topic experts
# Statewide LID Training Program

## Overview of Program

### Introductory

| 1.0 | Introduction to LID for Eastern Washington |
| 2.1 | Introduction to LID for Inspection & Maintenance Staff |
| 2.2 | Introduction to LID for Developers & Contractors: Make Money be Green |

### 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 |
| 4.1 | Intermediate LID Design: Rainwater Collection Systems & Vegetated Roofs |
| 4.2 | Intermediate LID Design: Hydrologic Modelling |

### Advanced

| 5.1 | Advanced Topics in LID Design: Bioretention |
| 5.2 | Advanced Topics in LID Design: Permeable Pavement |
| 5.3 | Advanced Topics for LID Operations: Bioretention |
| 5.4 | Advanced Topics for LID Operations: Permeable Pavement |
| 6.0 | Advanced Topics in LID Design: Hydrologic Modeling |
| 7.0 | Advanced Topics in LID Design: Site Assessment, Planning & Layout |
| 8.1 | Advanced Topics in LID Design: Rainwater Collection Systems & Vegetated Roofs |
| 8.2 | Advanced Topics in LID Design: Bioretention Media |

### Train the Trainers

| 9.1 | Service Providers |
| 9.2 | LID Topic Experts |
# Statewide LID Training Program

## Today’s Training

<table>
<thead>
<tr>
<th>INTRODUCTORY</th>
<th>INTERMEDIATE</th>
<th>ADVANCED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>3.1</td>
<td>5.1</td>
</tr>
<tr>
<td></td>
<td>Intermediate LID Topics: NPDES Phase I &amp; II Requirements</td>
<td>Advanced Topics in LID Design: Bioretention</td>
</tr>
<tr>
<td>2.1</td>
<td>3.2</td>
<td>5.2</td>
</tr>
<tr>
<td></td>
<td>Intermediate LID Design: Bioretention</td>
<td>Advanced Topics in LID Design: Permeable Pavement</td>
</tr>
<tr>
<td>2.2</td>
<td>3.3</td>
<td>5.3</td>
</tr>
<tr>
<td></td>
<td>Intermediate LID Design: Permeable Pavement</td>
<td>Advanced Topics for LID Operations: Bioretention</td>
</tr>
<tr>
<td></td>
<td>3.4</td>
<td>5.4</td>
</tr>
<tr>
<td></td>
<td>Intermediate LID Design: Site Assessment, Planning &amp; Layout</td>
<td>Advanced Topics for LID Operations: Permeable Pavement</td>
</tr>
<tr>
<td></td>
<td>4.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intermediate LID Design: Rainwater Collection Systems &amp; Vegetated Roofs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intermediate LID Design: Hydrologic Modelling</td>
<td></td>
</tr>
<tr>
<td>9.1 Service Providers</td>
<td>9.2 LID Topic Experts</td>
<td>6.0 Advanced Topics in LID Design: Hydrologic Modeling</td>
</tr>
</tbody>
</table>

## Train the Trainers

- Introduction to LID for Eastern Washington
- Introduction to LID for Inspection & Maintenance Staff
- Introduction to LID for Developers & Contractors: Make Money be Green

---

**DEPARTMENT OF ECOLOGY**

State of Washington
INTRODUCTION TO LID
LID FOR DEVELOPERS & CONTRACTORS
MAKE MONEY, BE GREEN
INSTRUCTORS

CHRIS WEBB, PE
LEED FELLOW
Associate Engineer
Key project experience: permeable pavement, bioretention, rainwater harvesting

CURTIS HINMAN
Senior Scientist
Key project experience: Research specialist in the performance and design of LID applications
1. Introduction & regulations
2. Site assessment, planning, layout
3. BMP specifics
4. Cost comparisons & resources
5. Wrap up
LOGISTICS

SCHEDULE
• 4-hour classroom training with one break

OTHER LOGISTICS
• Restroom location
• Food
• Turn off cell phones
• Sign in and sign out
LEARNING OBJECTIVES

1. Efficient application of LID BMPs.
2. New LID regulatory requirements.
3. How LID development process and cost compares with conventional stormwater practices.
4. The basic principles of site assessment, site layout and construction sequencing to improve the design and long-term, effective operation of LID best management practices (BMPs) and projects.
5. How to minimize construction impacts.
6. Minimum requirements for construction and protection of LID BMPs during construction.

Why LID?
INTRODUCTION & REGULATIONS

LOW IMPACT DEVELOPMENT (LID): Stormwater Management Strategy

• **Site design & planning techniques** emphasizing conservation

• Use of **small-scale & distributed** engineered controls to closely mimic pre-development hydrologic processes

• Minimizing the concentration of stormwater

• Careful assessment of site soils and strategic site planning to best use those soils for stormwater management
INTRODUCTION & REGULATIONS

LID Principles: Pre-developed forest

2012 LID Technical Guidance Manual for Puget Sound
LID Principles: Developed condition

2012 LID Technical Guidance Manual for Puget Sound
LID Principles: Site Design And Planning

• Minimize disturbance
• Reduce impervious surface
• Protect and restore native soils and vegetation
• Manage stormwater close to the source in a system of distributed practices
• Disconnect impervious surfaces
INTRODUCTION & REGULATIONS

LID BMPs: Small-Scale Engineering Controls

- Infiltration
- Filtration
- Storage
- Evaporation
- Transpiration

Conserve or regain pre-developed hydrologic functions

Synonyms for LID BMPs:

*Green Stormwater Infrastructure (GSI), Integrated Management Practices (IMPs), and On-Site Stormwater Management BMPs*
INTRODUCTION & REGULATIONS

Washington Municipal Stormwater Permits

National Pollutant Discharge Elimination System (NPDES) Municipal Stormwater Permits (2013-2018 permit cycle)

<table>
<thead>
<tr>
<th>Phase 1 Permittees</th>
<th>Western Washington Phase II Permittees</th>
<th>Eastern Washington Phase II Permittees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seattle</td>
<td>82 Cities</td>
<td>18 Cities</td>
</tr>
<tr>
<td>Tacoma</td>
<td>5 Counties</td>
<td>5 Counties</td>
</tr>
<tr>
<td>Clark County</td>
<td></td>
<td></td>
</tr>
<tr>
<td>King County</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pierce County</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Snohomish County</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Secondary Permittees</strong>: Approximately 45; such as ports and universities</td>
<td>To see a listing of permittees visit <a href="http://www.ecy.wa.gov/programs/wq/stormwater/municipal/MuniStrmWtrPermList.html">http://www.ecy.wa.gov/programs/wq/stormwater/municipal/MuniStrmWtrPermList.html</a></td>
<td></td>
</tr>
</tbody>
</table>
Review and revise development related codes, rules & standards (i.e. adopt the 2012 Stormwater Manual)

**Western WA Phase I and II timeline for updating local codes**

<table>
<thead>
<tr>
<th>Phase I</th>
<th>Phase II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per Section S5.C.5.b of the Phase I Permit</td>
<td>Per Section S5.C.4 of the Phase II Permit</td>
</tr>
<tr>
<td><strong>June</strong> 2014</td>
<td>Most Permittees</td>
</tr>
<tr>
<td><strong>June 30, 2015</strong></td>
<td>Lewis Co. and Cowlitz Co.</td>
</tr>
<tr>
<td></td>
<td>City of Aberdeen</td>
</tr>
<tr>
<td></td>
<td>Dec. 31, 2016*</td>
</tr>
<tr>
<td></td>
<td>June 30, 2017</td>
</tr>
<tr>
<td></td>
<td>June 30, 2018</td>
</tr>
</tbody>
</table>

* = Or GMA update deadline
INTRODUCTION & REGULATIONS

NPDES PERMIT LID REQUIREMENTS:

Minimum Requirements

1. Preparation of Stormwater Site Plans
2. Construction SWPP
3. Source Control of Pollution
4. Preservation of Natural Drainage Systems and Outfalls
5. On-Site Stormwater management
6. Runoff Treatment
7. Flow Control
8. Wetlands Protection
9. O&M
INTRODUCTION & REGULATIONS

NPDES PERMIT LID 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

Lotus Springs. Photo: Curtis Hinman
INTRODUCTION & REGULATIONS

NPDES PERMIT LID 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
NPDES PERMIT LID REQUIREMENTS: List #1 & 2 vs. LID Performance Standard

• List #1 (MR 1-5) and List #2 (MR 1-9)
• For each surface, consider the BMP’s in the order listed for that type of surface. Use the first BMP that is considered feasible
• Example: Hard surfaces other than roof
  1. Full dispersion
  2. Permeable Pavement
  3. Bioretention
  4. Sheet Flow Dispersion

• Achieve the LID Performance Standard (Duration Flow Control)

Note: achieving LID Performance Standard will require very large ponds that may significantly reduce buildable area without incorporating LID practices.
INTRODUCTION & REGULATIONS

NPDES PERMIT LID REQUIREMENTS:

On-Site Stormwater Management BMPs

• Used to help meet MR #5

• May be used to help meet MR #6 (Treatment) and/or MR #7 (Flow Control)

• “On-site Stormwater Management BMPs” = LID BMPs
NPDES PERMIT LID 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)  
  - 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)  

- Not “Engineered”
- “Engineered”
Subset of On-site Stormwater Management BMPs used to meet MR #6 or MR #7 (may also be used to meet MR #5)

<table>
<thead>
<tr>
<th>BMP</th>
<th>Flow Control</th>
<th>Treatment¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compost Amended Soils (BMP T5.13)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Dispersion (BMP T5.30, T5.12, T5.11, T5.10B)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Retaining &amp; Planting Trees (BMP T5.16)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Bioretention (BMP T5.14B)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Bioretention (underdrain)</td>
<td>X²</td>
<td>X</td>
</tr>
<tr>
<td>Permeable Pavement (BMP T5.15)</td>
<td>X</td>
<td>X³</td>
</tr>
<tr>
<td>Green Roofs (BMP T5.17)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Rainwater Harvesting (BMP T5.20)</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

1. Meets basic, enhanced and phosphorus treatment when infiltrating through soil meeting Ecology treatment requirements
2. Bioretention (underdrain) systems where the underdrain is elevated within the underlying base course can have some peak flow reduction benefit.
3. Where permeable pavement is over soils meeting the suitability criteria or a treatment layer (sand or soil meeting criteria) is included, then permeable pavement can provide treatment.
TRADITIONAL V. LID DEVELOPMENT

- Minimize disturbance
- Reduce impervious surface
- Protect and restore native soils and vegetation
- Manage stormwater close to the source in a system of distributed practices
- Disconnect impervious surfaces

Traditional  LID
SITE ASSESSMENT, PLANNING & LAYOUT

TRADITIONAL V. LID DEVELOPMENT

Statewide LID Training Program

DEPARTMENT OF
ECOLOGY
State of Washington

DEVELOPERS & CONTRACTORS

INTRODUCTION TO LID
Typical grid road layout

- Impervious coverage: 27-36%
- Less adaptive to site features.
- Promotes transit and connectivity with more direct access to services.
Typical curvilinear road layout

- Impervious coverage: 15-29%
- More adaptive to site features.
- Generally discourages transit with longer, less connected system.
Hybrid or LID road layout

- Impervious coverage: similar percentage to other layouts.
- Adaptive to site features and uses site features (particularly water as an organizing theme).
- Can provide good connectivity and fire and safety access.
SITE ASSESSMENT, PLANNING & LAYOUT

TRADITIONAL V. LID DEVELOPMENT

Traditional

LID
### Hydrologic modeling comparing a conventional development and the flow reduction benefits from individual practices for a low impact development design.

The 24-acre till-mantled site in southern Puget Sound has 103 lots and was modeled with Western Washington Hydrologic Model (adopted from AHBL, 2000).

<table>
<thead>
<tr>
<th></th>
<th>Detention storage reduced (ft³)</th>
<th>Detention storage required (ft³)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conventional development</strong></td>
<td>270,000</td>
<td></td>
</tr>
<tr>
<td><strong>Low impact development</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• reduce development envelope</td>
<td>-149,019</td>
<td></td>
</tr>
<tr>
<td>• and use bioretention</td>
<td>-40,061</td>
<td></td>
</tr>
<tr>
<td>• and use minimal excavation foundation</td>
<td>-7,432</td>
<td></td>
</tr>
<tr>
<td>• and use 20’ wide permeable road</td>
<td>-29,988</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>-226,500</td>
<td>43,500</td>
</tr>
</tbody>
</table>
Site Layout: New Suburban Development

General Layout Strategies

• Cluster development to preserve vegetation and protect soils
• Grade to create small basins
• Maximize infiltration potential by locating BMPS on best soils

Kensington Loop Road, 2012 LID Technical Manual
SITE ASSESSMENT, PLANNING & LAYOUT

TRADITIONAL V. LID DEVELOPMENT

Conventional Plat

1. 150' Wetland Buffer Line
2. Commercial Unit & Associated Wetlands
3. Hylebos Creek & Associated Wetlands

50' Wetland Buffer
1. Tree Retention Area
2. Flow Paths
3. Bio-Retention Area
4. Bio-Swales
5. Bio-Retention Area
6. Dispersion Sloped Biodetention
7. Creek & Associated Wetlands
8. 150' Wetland Buffer Line

Statewide LID Training Program

DEPARTMENT OF ECOLOGY
State of Washington

DEVELOPERS & CONTRACTORS

INTRODUCTION TO LID
Site Layout: New Suburban Development
SITE ASSESSMENT, PLANNING & LAYOUT

Site Layout: New Suburban Development

Roads, Driveways and Parking

• Reduce TIA by reducing overall road network cover and minimize or eliminate EIA
• Use stormwater BMPs to infiltrate, slow, and filter storm flows
• Minimize overall site disturbance
• Create connected walking, biking, vehicular, and transit services
• Create and use open space as a community amenity and stormwater management area

Preliminary Site Analysis

- Collect information from existing analyses, inventories, and historic information
- Conduct site reconnaissance and characterization
  - Info needed varies depending on which Minimum Requirements are triggered

Potential Existing Site Conditions to Inventory
Minimum Requirements for 1-5

- A survey prepared by a registered land surveyor
  - Include features from existing site conditions table
- Contour map
  - Intervals are dependent on site slopes and elevations
- Soils report
- Survey of native soil and vegetation areas
- Drainage report / Stormwater Site Plan
Minimum Requirements for 1-9 (Larger projects)

• More in-depth Geotechnical assessment than conventional project

• Ideally in 2 phases
  1. Infiltration soils reconnaissance (similar to septic reconnaissance) for planning level design information across entire site
  2. Infiltration soils testing for design level design information at the location of the BMP

• Geotechnical Report or Soils Report need to include infiltration feasibility and design discussion

© Associated Earth Sciences, Inc.

LID Site Reconnaissance with a Hand Auger
SITE ASSESSMENT, PLANNING & LAYOUT

SITE ASSESSMENT

Critical sub-surface assessment for BMPs

• Bioretention
  • Infiltration test at proper depth

• Permeable Pavement
  • Staging and access
  • Subgrade protection and remediation
  • Infiltration test at proper depth

• Additional testing for Design
  • PIT tests
  • Depth to groundwater
  • Mounding Analysis (if required)

Pilot Scale Infiltration Test (PIT)
ECOLOGY SMALL-SCALE PIT METHOD

• PIT Timing
  • Test between December 1 and April 1

• Number of PITs
  • Recommend one PIT at each bioretention site
  • For larger site, one PIT every 5,000 sf
  • For long narrow facilities, one PIT every 200 lineal feet (unless borings indicate consistent soil characteristics)
SITE ASSESSMENT, PLANNING & LAYOUT

SITING CONSIDERATIONS: Native Soils

- Important for Infiltrating facilities ONLY
- Infiltrating facilities sized based on infiltration rates
- Minimum “feasible” initial infiltration rate of 0.3 in/hr
- Locate infiltrating BMPs in areas with best soils
SITING CONSIDERATIONS: Soil Variability

Broadview Green Grid, Seattle, WA
SITE ASSESSMENT, PLANNING & LAYOUT

SITING CONSIDERATIONS: Soil Variability

Site 1: Loam

Broadview Green Grid, Seattle, WA
SITE ASSESSMENT, PLANNING & LAYOUT

SITING CONSIDERATIONS: Soil Variability

Site 2: Sand

Broadview Green Grid, Seattle, WA
Site 3: Glacial till (highly compacted with high clay content)

Broadview Green Grid, Seattle, WA
SITE ASSESSMENT, PLANNING & LAYOUT

SITING CONSIDERATIONS

- Tree and vegetation preservation
- Site Slopes
  - Cross & Longitudinal Slopes
  - Positive Drainage from drainage area to overflow
- Setbacks (e.g., utilities & other infrastructure)
- May require pre-settling
- Public acceptance/participation (retrofits)

SITE ASSESSMENT, PLANNING & LAYOUT

Site Layout: Urban Redevelopment & Infill

Roads, Driveways and Parking

- Reduce total impervious area (TIA) and minimize effective impervious areas (EIA)
- Use stormwater BMPs to infiltrate, slow, and filter storm flows
- Incorporate trees and adequate soil into planting galleries and streetscapes
- Connect walking, biking, and vehicular access to transit services
- Create and use open space as a community amenity and stormwater management area
SITE ASSESSMENT, PLANNING & LAYOUT

SINGLE FAMILY: Rain Gardens
SITE ASSESSMENT, PLANNING & LAYOUT

SINGLE FAMILY: Stormwater Planters

- Inflow
- Conveyance
- Overflow
RIGHT OF WAY: Seattle SEAstreets
SITE ASSESSMENT, PLANNING & LAYOUT

RIGHT OF WAY: Seattle SEAstreets
SITE ASSESSMENT, PLANNING & LAYOUT

RIGHT OF WAY: Curb Bulbs

NE Siskiyou Green Street
Portland, OR

23rd Ave SE & 171st Pl SE

Statewide LID Training Program
SITE ASSESSMENT, PLANNING & LAYOUT

MULTI-FAMILY DEVELOPMENTS

High Point, Seattle, WA
BIORETENTION SITING, DESIGN & CONSTRUCTION
MULTI-FAMILY DEVELOPMENTS: Block Level Design

High Point, Seattle, WA
SITE ASSESSMENT, PLANNING & LAYOUT

MULTI-FAMILY DEVELOPMENTS: Block Level Design

High Point, Seattle, WA
Site Layout: Commercial Development

Parking
- Conduct parking studies to establish min. and max. demand ratios
- Design parking to reduce impervious surface area
  - Diagonal parking stalls with one-way traffic lanes
  - Place parking under buildings or create multi-story parking structures
  - Use permeable surface materials
  - Utilize BMPs to capture, treat, and infiltrate stormwater
  - Design parking lots to be multi-use and serve different users at different times

Site Layout: Commercial Development

Rooftops
• Create vegetated roofs to reduce EIA
Downtown CSO Demand Management, Seattle, WA
COMMERCIAL PARCELS: Parking Lots

Northgate Mall, Seattle, WA
SITE ASSESSMENT, PLANNING & LAYOUT

COMMERCIAL PARCELS: Parking Lots

Northgate Mall, Seattle, WA
COMMERCIAL PARCELS: Parking Lots

Northgate Mall, Seattle, WA

- Curb Cut Inflow
- Beehive Structure
- Overflow
SITE ASSESSMENT, PLANNING & LAYOUT

COMMERCIAL PARCELS: Parking Lots

Lewis Creek Park, Bellevue, WA

Combining landscape requirements with bioretention
Combining conveyance with bioretention

Bagley Elementary, Seattle, WA
COMMERCIAL PARCELS: Bioretention and Rain Gardens

YMCA Silverdale, WA

Villanova Campus
SITE ASSESSMENT, PLANNING & LAYOUT

SITE LAYOUT EXAMPLE 1: Using List #2

• Forested 0.8 ac. Parcel

• 2012 Manual adopted by local jurisdiction
  • 7,000 sf building
  • 7,000 sf parking
  • 1,750 sf walks
  • 12,000sf landscaping

• Till & perched groundwater at 1-2’ depth
SITE ASSESSMENT, PLANNING & LAYOUT

SITE LAYOUT EXAMPLE 1: Lawn and Roofs

List #2 (Project triggers Minimum Requirements #1-9)

- Post-Construction Soil Quality and Depth in accordance with BMP T5.13 in Chapter 5 of Volume V of the SWMMWW

Feasible (SELECTED)

<table>
<thead>
<tr>
<th>Lawn</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Full Dispersion in accordance with BMP T5.30 in Chapter 5 of Volume V of the SWMMWW, or Downspout Full Infiltration Systems in accordance with BMP T5.10A in Section 3.1.1 of Volume III of the SWMMWW.</td>
</tr>
<tr>
<td>Infeasible</td>
</tr>
<tr>
<td>2. Bioretention (See Chapter 7 of Volume V of the SWMMWW) facilities that have a minimum horizontally projected surface area below the overflow which is at least 5% of the of the total surface area draining to it</td>
</tr>
<tr>
<td>Infeasible</td>
</tr>
<tr>
<td>3. Downspout Dispersion Systems in accordance with BMP T5.10B in Section 3.1.2 of Volume III of the SWMMWW.</td>
</tr>
<tr>
<td>Infeasible</td>
</tr>
<tr>
<td>4. Perforated Stub-out Connections in accordance with BMP T5.10C in Section 3.1.3 of Volume III of the SWMMWW.</td>
</tr>
<tr>
<td>Infeasible</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Roof</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infeasible</td>
</tr>
<tr>
<td>Infeasible</td>
</tr>
<tr>
<td>Infeasible</td>
</tr>
<tr>
<td>Infeasible</td>
</tr>
</tbody>
</table>
### Site Layout Example 1: Other Hard Surfaces

<table>
<thead>
<tr>
<th>Other Hard Surfaces</th>
<th>Infeasible</th>
<th>Feasible (selected for sidewalks*)</th>
<th>Infeasible for PGIS</th>
<th>Infeasible</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Full Dispersion in accordance with BMP T5.30 in Chapter 5 of Volume V of the SWMMWW.</td>
<td>Infeasible</td>
<td>Feasible (selected for sidewalks*)</td>
<td>Infeasible for PGIS</td>
<td>Infeasible</td>
</tr>
<tr>
<td>2. Permeable pavement* in accordance with BMP T5.15 in Chapter 5 of Volume V of the SWMMWW</td>
<td>Infeasible</td>
<td>Feasible (selected for sidewalks*)</td>
<td>Infeasible for PGIS</td>
<td>Infeasible</td>
</tr>
<tr>
<td>3. Bioretention (See Chapter 7, Volume V of the SWMMWW) facilities that have a minimum horizontally projected surface area below the overflow which is at least 5% of the of the total surface area draining to it.</td>
<td>Infeasible</td>
<td>Feasible (selected for sidewalks*)</td>
<td>Infeasible for PGIS</td>
<td>Infeasible</td>
</tr>
<tr>
<td>4. Sheet Flow Dispersion in accordance with BMP T5.12, or Concentrated Flow Dispersion in accordance with BMP T5.11 in Chapter 5 of Volume V of the SWMMWW.</td>
<td>Infeasible</td>
<td>Feasible (selected for sidewalks*)</td>
<td>Infeasible for PGIS</td>
<td>Infeasible</td>
</tr>
</tbody>
</table>

* Groundwater/saturated conditions must be no more than 12” from bottom of aggregate base.
SITE ASSESSMENT, PLANNING & LAYOUT

SITE LAYOUT EXAMPLE 1: Resulting Site Plan

- Bioretention for Treatment
- Detention
- Permeable Sidewalks
SITE LAYOUT EXAMPLE 2: Using List #2

- Forested 0.7 ac. Parcel
- 2012 Manual adopted by local jurisdiction
  - 12,000 sf building
  - 22 parking stalls
- Outwash soils (4” per hour long term)
- Groundwater at 15’ +
SITE LAYOUT EXAMPLE 2: Lawn and Roofs

Lawn

Feasible (SELECTED)

Roof

Infeasible due to lack of downstream flow path and site land coverages

Feasible (SELECTED)

Feasible

Feasible
## SITE LAYOUT EXAMPLE 2: Other hard Surfaces

<table>
<thead>
<tr>
<th>1. Full Dispersion in accordance with BMP T5.30 in Chapter 5 of Volume V of the SWMMWW.</th>
<th>Infeasible</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Permeable pavement¹ in accordance with BMP T5.15 in Chapter 5 of Volume V of the SWMMWW</td>
<td>Feasible (SELECTED)</td>
</tr>
<tr>
<td>3. Bioretention (See Chapter 7, Volume V of the SWMMWW) facilities that have a minimum horizontally projected surface area below the overflow which is at least 5% of the of the total surface area draining to it.</td>
<td>Feasible</td>
</tr>
<tr>
<td>4. Sheet Flow Dispersion in accordance with BMP T5.12, or Concentrated Flow Dispersion in accordance with BMP T5.11 in Chapter 5 of Volume V of the SWMMWW.</td>
<td>Infeasible</td>
</tr>
</tbody>
</table>
SITE ASSESSMENT, PLANNING & LAYOUT

SITE LAYOUT EXAMPLE 2: Resulting Site Plan

- PERMEABLE DRIVEWAY
- BIORETENTION
COMMERCIAL PARCELS: Stormwater Planters

Downtown CSO Demand Management, Seattle, WA
CONSTRUCTION CONSIDERATIONS: Access & Staging

- Staging Areas
- Temporary Access
- Subgrade protection and restoration procedures
- Element #13 of the SWPPP
STATEWIDE LID TRAINING PROGRAM

2.2 DEVELOPERS & CONTRACTORS

INTRODUCTION TO LID

LID SWPPP, Chris Webb & Associates, Inc.
Site during construction, Google/Chris Webb & Associates, Inc.
CONSTRUCTION CONSIDERATIONS: Erosion & Sediment Control

- Protect adjacent properties
- Protect public waterways and storm systems
- Protect installed work
- Protect infiltration systems including swales, soils and permeable pavement
CONSTRUCTION CONSIDERATIONS: Erosion & Sediment Control

• Inadequate protection of BMPs during construction can result in expensive mitigation
CONSTRUCTION CONSIDERATIONS: Over-compaction

- Prevent over compaction (CRITICAL FOR PERFORMANCE)
- No excavation, soil placement, or soil amendment during wet or saturated conditions
- Operate equipment adjacent to (not in) the facility
- If machinery must operate in the facility, use light weight, low ground-contact pressure equipment
CONSTRUCTION CONSIDERATIONS: Over-compaction

Vehicular loading prism – some compaction is necessary

For road or parking lot stability, need heavy compaction from road prism-2H:1V from edge

High Point, Seattle, WA
Scarify subgrade to re-fracture soil and till in BSM at interface

Smeared and sealed by bucket
1. introduction & regulations
2. site assessment, planning, layout
3. BMP specifics
4. cost comparisons & resources
5. wrap up
BMP specifics

1. **BIORETENTION**

2. **PERMEABLE PAVEMENT**

3. **DISPERSION AND INFILTRATION**

4. **NEWLY PLANTED & RETAINED TREES**

Statewide LID Training Program
BMP specifics

1. BIORETENTION

2. PERMEABLE PAVEMENT

3. DISPERSION AND INFILTRATION

4. NEWLY PLANTED & RETAINED TREES
• Bioretention and Rain Gardens (30 minutes)
  • Anatomy of bioretention and rain gardens
  • NPDES protection requirements for bioretention and rain gardens (MR #2 and MR #5-7)
  • Setbacks
  • Construction sequencing and protection during construction for bioretention and rain gardens
  • Case Study with lessons learned
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 courtesy of Seattle Public Utilities
BMP SPECIFICs – BIORETENTION

COMPONENTS

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

2012 LID Technical Guidance Manual for Puget Sound

For footnotes refer to LID Manual
HOW THE FACILITY WORKS

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

Bioretention Cell

2009 Clean Water Services LiDA Handbook
BMP SPECIFICS – BIORETENTION

HOW THE FACILITY WORKS

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

Bioretention Planter

2009 Clean Water Services LIDA Handbook
HOW THE FACILITY WORKS

- 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

Bioretention Planter

2009 Clean Water Services LIDA Handbook

Statewide LID Training Program

DEVELOPERS & CONTRACTORS
BMP SPECIFICS – BIORETENTION

BIORETENTION VS RAIN GARDENS

- **Bioretention**
  - Structures/Underdrains: Yes
  - Designed: Designed
  - Soil mixes: Less restrictive

- **Rain Garden**
  - Structures/Underdrains: Usually no
  - Designed: Designed
  - Soil mixes: Usually no
BMP specifics

1. Bioretention
2. Permeable pavement
3. Dispersion and infiltration
4. Newly planted & retained trees
PERMEABLE PAVEMENT

- Anatomy of a facility
- NPDES protection requirements for permeable pavement (MR #2 and MR #5-7)
- Construction sequencing and protection guidelines for permeable pavement
- Case Studies with lessons learned
FACILITY ANATOMY: 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)
• 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
FACILITY ANATOMY: Permeable 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

FACILITY ANATOMY: 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
The aggregate median provides a connection and overflow protection from the pavement surface to the aggregate base. 
Source: Adopted from Cahill
BMP SPECIFICS - PERMEABLE PAVEMENT

HOW THE FACILITY WORKS

- Inlets
- Outlets
- Slopes
BMP specifics

1. BIORETENTION
2. PERMEABLE PAVEMENT
3. DISPERSION AND INFILTRATION
4. NEWLY PLANTED & RETAINED TREES
 Dispersion and Infiltration (20 minutes)
  • Downspout infiltration and dispersion
  • Concentrated and sheet flow dispersion
  • Soil quality and depth (composted amended soils)
  • Local jurisdiction and homeowner requirements
  • Q&A
COMPONENTS: Downspout Dispersion

- Splash block
- Dispersal area

Source: City of Seattle
COMPONENTS:
Downspout Dispersion

- Dispersion trench
- Dispersal area
COMPONENTS: Sheet Flow and Concentrated Flow Dispersion

Sheet Flow Dispersion
- Transition zone
- Dispersal area

Concentrated Flow Dispersion
- Rock pad at discharge point
- Dispersal area
COMPONENTS: Downspout Full Infiltration

- Rock trench/well
- Inlet
- Storage sump

Source: King County
COMPONENTS: Compost Amended Soils

- **Mulch**
- **Loose Soil** with visible dark organic matter
- **Loose or Fractured Subsoil**

[Diagram showing details of compost amended soils]
BMP specifics

1. Bioretention
2. Permeable pavement
3. Dispersion and infiltration
4. Newly planted & retained trees
CONSTRUCTION CONSIDERATIONS: Tree Protection

• Trees are valuable!
• Arborist evaluation
• Valuation posted on each significant tree
• Vegetation protection in TESC
CONSTRUCTION CONSIDERATIONS: Tree Protection

• Critical Root Zone (CRZ)
  • No disturbance
  • Arborist present for construction in CRZ

• Dripline
  • Fence during construction
CONSTRUCTION CONSIDERATIONS: Tree Protection

- **Feeder Root Zone**
  - Limit heavy equipment/stockpiling
  - Limit Trenching

- **Utility Boring**
  - Tunnel/bore under trees to avoid open cut trench through CRZ and dripline
# BMP Specifics – Newly Planted and Retained Trees

## Impervious Surface Reduction Credits

### Retained Trees

<table>
<thead>
<tr>
<th>Tree Type</th>
<th>Flow Control Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evergreen</td>
<td>20% of canopy area (min of 100 sf/tree)</td>
</tr>
<tr>
<td>Deciduous</td>
<td>10% of canopy area (min of 50 sf/tree)</td>
</tr>
</tbody>
</table>

### Newly Planted Trees

<table>
<thead>
<tr>
<th>Tree Type</th>
<th>Flow Control Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evergreen</td>
<td>50 sf/tree</td>
</tr>
<tr>
<td>Deciduous</td>
<td>20 sf/tree</td>
</tr>
</tbody>
</table>
introduction & regulations

site assessment, planning, layout

BMP specifics

cost comparisons & resources

wrap up
COST COMPARISONS & RESOURCES

CONSTRUCTION COST: Bioretention

- Cost Comparison – bioretention vs. filters for treatment only

**Assumptions:**
- Double loaded parking lot with perpendicular stalls & landscape strip
- 22’ travel lane / 9’x18’ parking stalls
- Exclude reduced detention benefits
### Cost Comparison – bioretention vs. filters for treatment only

#### CONVENTIONAL:
1. 4’ wide landscape island between rows of stalls
2. Catch basins @ 150’o/c
3. 8” CPEP storm pipe continuous
4. Stormwater treatment provided by filter vaults sized @ 10 cartridges per acre

#### LID:
1. 4’ wide bioretention cell between rows of stalls, bioretention cells sized @ +/- 5% of tributary area for treatment only)
2. Standpipe overflow with beehive grate in each bioretention cell 1 @ 150’

<table>
<thead>
<tr>
<th>CONVENTIONAL</th>
<th>LID</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. $5/ SF x 4’ = $20/LF</td>
<td>1. $30/SF x 4’ = $120/LF</td>
</tr>
<tr>
<td>2. $1,000 / 150’ = $6.67/LF</td>
<td>2. $1,000/150’ = $6.67/LF</td>
</tr>
<tr>
<td>3. $50/LF</td>
<td></td>
</tr>
<tr>
<td>4. $1.25/SF x (18’x2 +22’)= $72.50</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL: ~ $149.17 / LF</strong></td>
<td><strong>TOTAL: ~ $126.67 / LF</strong></td>
</tr>
</tbody>
</table>

**Notes**
- Reduced detention benefit in addition to the 15% savings shown for treatment only
## CONSTRUCTION COST: Rain Gardens

<table>
<thead>
<tr>
<th>Location</th>
<th>Self Installation (cost per SF)</th>
<th>Professional Installation (cost per SF)</th>
<th>Average Size (SF)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wisconsin</td>
<td>$2.90 - 4.60</td>
<td>$12.70 - 15.00</td>
<td>NA</td>
<td>Edgewood College (2003)</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>$3.50 - 5.80</td>
<td>$11.50 - 13.90</td>
<td>300</td>
<td>Kassulke (2003)</td>
</tr>
<tr>
<td>General</td>
<td>$3.00 - 4.00</td>
<td>$10.00 - 40.00</td>
<td>NA</td>
<td>EPA (2008)</td>
</tr>
<tr>
<td>Virginia</td>
<td>$0.50 - 0.75</td>
<td>$10.00</td>
<td>150</td>
<td>James City County (2008)</td>
</tr>
<tr>
<td>Lincoln, NE</td>
<td>$2.00 - 8.00</td>
<td>$8.00 - 14.00</td>
<td>NA</td>
<td>Lincoln (2008)</td>
</tr>
<tr>
<td>Salt Lake City, UT</td>
<td>$8.83</td>
<td>$16.63</td>
<td>NA</td>
<td>RS Means 100 Estimate of Elaborate Garden</td>
</tr>
</tbody>
</table>

WERF LID Cost Calculator
CONSTRUCTION COST: Rain Gardens

- Average cost for self installation = $5.15 per SF
- Average cost for professional installation = $16.05 per SF
PERMEABLE PAVEMENT

Pervious Hot Mix Asphalt Per WSDOT Bid Tabs:

Pervious HMA: $105-$135/TON (2014)
Pervious Base: $25/TON (2014)

Conventional Pavement:

Dense Graded HMA Class ½”: $85-$100/TON (2014)
Crushed Surfacing Base Course: $20-$25/TON (2014)

Note: In many instances using pervious HMA is considered cost neutral. If soils infiltrate, permeable is much less costly than conventional.
Pervious Concrete Sidewalk Per Three City of Bellingham Bid Tabs:

Say $5-6/sf with base

Note: The 2013 values included some 8” thick bike lanes, bids from each same contractor basically same as solid sidewalk.
COST COMPARISONS & RESOURCES

OTHER LID BMPS: Cisterns

• Approximate cistern costs per gallon stored by tank type
### COST COMPARISON & RESOURCES

#### OTHER LID BMPS: Vegetated Roof

<table>
<thead>
<tr>
<th>Project Type</th>
<th>Green Roof Cost (s.f.)</th>
<th>Roofing Cost (s.f.)</th>
<th>Total Cost w/ Roofing (s.f.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extensive Green Roof (3-4” soil with sedums)</td>
<td>$5-8</td>
<td>$15-20</td>
<td>$20-28</td>
</tr>
<tr>
<td>Semi-Intensive Green Roof (4-8” soil with sedums/wildflowers, perennials)</td>
<td>$10-15</td>
<td>$15-20</td>
<td>$25-35</td>
</tr>
<tr>
<td>Intensive Green Roof (8-12” with groundcover, small shrubs)</td>
<td>$18-25</td>
<td>$15-20</td>
<td>$33-45</td>
</tr>
<tr>
<td>Roof Terrace (intensive with pavers, trees, planters, shrubs)</td>
<td>$50-80+</td>
<td>$15-20</td>
<td>$65-100+</td>
</tr>
</tbody>
</table>
## MAINTENANCE

<table>
<thead>
<tr>
<th>Conventional (Biofiltration swale/pond)</th>
<th>LID (Bioretention/Rain gardens)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mowing</td>
<td>Weeding &amp; vegetation management</td>
</tr>
<tr>
<td>Inlet/outlet protection</td>
<td>Inlet/outlet protection</td>
</tr>
<tr>
<td>Sediment removal</td>
<td>Ponding area maintenance</td>
</tr>
<tr>
<td>Check dam/weir sediment management and erosion repair</td>
<td>Check dam/weir sediment management and erosion repair</td>
</tr>
<tr>
<td>Maintain vegetation cover</td>
<td>Protect bioretention soil from compaction</td>
</tr>
<tr>
<td>Ponding area maintenance</td>
<td>Mulching</td>
</tr>
<tr>
<td>Flow spreader</td>
<td>Underdrain clog removal</td>
</tr>
<tr>
<td>Watering</td>
<td>Watering</td>
</tr>
</tbody>
</table>
## MAINTENANCE: Bioretention

WERF LID Cost Calculator (last updated 5/9/2009)

<table>
<thead>
<tr>
<th>Item</th>
<th>Maintenance Frequency</th>
<th>Annual O&amp;M Cost for 400 SF (Medium)</th>
<th>Cost/SF</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maintenance Frequency</strong></td>
<td><strong>Low</strong></td>
<td><strong>Medium</strong></td>
<td><strong>High</strong></td>
</tr>
<tr>
<td>Vegetation management</td>
<td>Every 3 years</td>
<td>1/year</td>
<td>12/year</td>
</tr>
<tr>
<td>Replace mulch</td>
<td>Every 5 years</td>
<td>Every 3 years</td>
<td>1/year</td>
</tr>
<tr>
<td>Till soil</td>
<td>Every 10 years</td>
<td>Every 5 years</td>
<td>Every 4 years</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Puget Sound Stormwater BMP Cost Database Technical Memorandum (Herrera 2013)

<table>
<thead>
<tr>
<th>O&amp;M Activities</th>
<th>Unit</th>
<th>n</th>
<th>Low</th>
<th>Average</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watering, weeding, and mulching</td>
<td>SF</td>
<td>7</td>
<td>$0.19</td>
<td>$1.27</td>
<td>$2.78</td>
</tr>
</tbody>
</table>
## 30-Year Cost Comparison

<table>
<thead>
<tr>
<th>BMP</th>
<th>30-year O&amp;M Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bioretention</td>
<td>$21.84 / SF</td>
</tr>
<tr>
<td>Wet Pond</td>
<td>$9.01 / SF</td>
</tr>
<tr>
<td>Combined Detention and Wetpool</td>
<td>$9.01 / SF</td>
</tr>
<tr>
<td>Stormwater Treatment Planter Vault</td>
<td>$27,903 / PV</td>
</tr>
<tr>
<td>Infiltration Basin</td>
<td>$3.36 / SF</td>
</tr>
<tr>
<td>Catch Basin</td>
<td>$1,331 / CB</td>
</tr>
</tbody>
</table>

## MAINTENANCE: Permeable Pavement

WERF LID Cost Calculator (Last updated 5/9/2009)

<table>
<thead>
<tr>
<th>Item</th>
<th>Maintenance Frequency</th>
<th>Annual O&amp;M Cost for 5,000 SF (Medium)</th>
<th>Cost/SF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspection, reporting, and data management</td>
<td>Every 3 years</td>
<td>1/year</td>
<td>$47</td>
</tr>
<tr>
<td>Litter &amp; minor debris removal</td>
<td>Every 3 years</td>
<td>12/year</td>
<td>$120</td>
</tr>
<tr>
<td>Sweeping</td>
<td>Every 3 years</td>
<td>12/year</td>
<td>$80</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>$247</strong></td>
<td></td>
</tr>
</tbody>
</table>
COST COMPARISONS & RESOURCES

MAINTENANCE: Permeable Pavement

Puget Sound Stormwater BMP Cost Database Technical Memorandum (Herrera 2013)

<table>
<thead>
<tr>
<th>O&amp;M Activities</th>
<th>Unit</th>
<th>n</th>
<th>Low</th>
<th>Average</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Routine sweeping (2X per year)</td>
<td>SF</td>
<td>1</td>
<td>$0.02</td>
<td>$0.02</td>
<td>$0.02</td>
</tr>
</tbody>
</table>

- Restorative maintenance (power washing followed by vactoring to unclog the upper layer and restore porosity) is estimated at $1/SF
### MAINTENANCE: Permeable Pavement

<table>
<thead>
<tr>
<th>BMP</th>
<th>30-year Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permeable Sidewalk</td>
<td>$15.30 / SF</td>
</tr>
<tr>
<td>Permeable Pavement</td>
<td>$1.16 / SF</td>
</tr>
<tr>
<td>Conventional Pavement</td>
<td>$1.16 / SF</td>
</tr>
</tbody>
</table>

Source: Herrera - Cost Analysis for Western Washington LID Requirements and Best Management Practices
1. Efficient application of LID BMPs.
2. New LID regulatory requirements.
3. How LID development process and cost compares with conventional stormwater practices.
4. The basic principles of site assessment, site layout and construction sequencing to improve the design and long-term, effective operation of LID best management practices (BMPs) and projects.
5. How to minimize construction impacts.
6. Minimum requirements for construction and protection of LID BMPs during construction.
### COST COMPARISONS & RESOURCES

**RESOURCES**

- **2012 Stormwater Management Manual for Western Washington**

- **Low Impact Development Technical Guidance Manual for Puget Sound**

- **Western Washington Low Impact Development (LID) Operations and Maintenance (O&M) Guidance Document,**

(Click on the “Maintain LID” tab)
COST COMPARISONS & RESOURCES

RESOURCES

Ecology Webinar - Low Impact Development – Rain Gardens and Bioretention


WWHM 2012 Training Documents

www.ecy.wa.gov/programs/wq/stormwater/municipal/PrevWS.html

Rain Garden Handbook for Western Washington


Statewide LID Training Program

DEVELOPERS & CONTRACTORS

INTRODUCTION TO LID

136
PROGRAMS

• 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)

Q&A
Statewide LID Training Program

http://www.wastormwatercenter.org/lidswtrainingprogram/
### INTRODUCTORY

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Introduction to LID for Eastern Washington</td>
</tr>
<tr>
<td>2.1</td>
<td>Introduction to LID for Inspection &amp; Maintenance Staff</td>
</tr>
<tr>
<td>2.2</td>
<td>Introduction to LID for Developers &amp; Contractors: Make Money be Green</td>
</tr>
</tbody>
</table>

### INTERMEDIATE

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Intermediate LID Topics: NPDES Phase I &amp; II Requirements</td>
</tr>
<tr>
<td>3.2</td>
<td>Intermediate LID Design: Bioretention</td>
</tr>
<tr>
<td>3.3</td>
<td>Intermediate LID Design: Permeable Pavement</td>
</tr>
<tr>
<td>3.4</td>
<td>Intermediate LID Design: Site Assessment, Planning &amp; Layout</td>
</tr>
<tr>
<td>4.1</td>
<td>Intermediate LID Design: Rainwater Collection Systems &amp; Vegetated Roofs</td>
</tr>
<tr>
<td>4.2</td>
<td>Intermediate LID Design: Hydrologic Modelling</td>
</tr>
</tbody>
</table>

### ADVANCED

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1</td>
<td>Advanced Topics in LID Design: Bioretention</td>
</tr>
<tr>
<td>5.2</td>
<td>Advanced Topics in LID Design: Permeable Pavement</td>
</tr>
<tr>
<td>5.3</td>
<td>Advanced Topics for LID Operations: Bioretention</td>
</tr>
<tr>
<td>5.4</td>
<td>Advanced Topics for LID Operations: Permeable Pavement</td>
</tr>
<tr>
<td>6.0</td>
<td>Advanced Topics in LID Design: Hydrologic Modeling</td>
</tr>
<tr>
<td>7.0</td>
<td>Advanced Topics in LID Design: Site Assessment, Planning &amp; Layout</td>
</tr>
<tr>
<td>8.1</td>
<td>Advanced Topics in LID Design: Rainwater Collection Systems &amp; Vegetated Roofs</td>
</tr>
<tr>
<td>8.2</td>
<td>Advanced Topics in LID Design: Bioretention Media</td>
</tr>
</tbody>
</table>

### TRAIN THE TRAINERS

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.1</td>
<td>Service Providers</td>
</tr>
<tr>
<td>9.2</td>
<td>LID Topic Experts</td>
</tr>
</tbody>
</table>
ONLINE EVALUATION

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

• Stay tuned for decisions on certificate

• LID Design certificate

• Long-term LID Operations certificate

Sign out!
For information on training and other resources, visit the Washington Stormwater Center website:

http://www.wastormwatercenter.org

Stay connected through Social Media

• Come “Like” our Page
• Sign up to follow and get Tweets
Further questions? Contact:
training@cascadiaconsulting.com
(206) 449-1163