AGENDA

1. Introduction

2. Rainwater collection systems

3. Vegetated roofs

4. Wrap up
LEARNING OBJECTIVES

1. Gain an intermediate level knowledge necessary for proper entry level design and implementation of permeable pavement systems in residential and commercial settings (new and retrofit).
2. Learn skills necessary for basic site assessment and locating permeable pavement areas in residential and commercial settings.
3. Learn practical skills necessary for preparing construction for basic permeable pavement systems.

PROGRAM OVERVIEW

• 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

<table>
<thead>
<tr>
<th>INTRODUCTORY</th>
<th>INTERMEDIATE</th>
<th>ADVANCED</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>3.1</td>
<td>5.0</td>
</tr>
<tr>
<td>3.2</td>
<td>3.3</td>
<td>5.1</td>
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<tr>
<td>3.4</td>
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<td>5.2</td>
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<tr>
<td>3.8</td>
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<tr>
<td>3.10</td>
<td>3.11</td>
<td>5.5</td>
</tr>
<tr>
<td>3.12</td>
<td>3.13</td>
<td>5.6</td>
</tr>
</tbody>
</table>

- **2.1**: Introduction to LID for Inspection & Maintenance Staff
- **3.1**: Intermediate LID for Inspection & Maintenance Staff
- **3.2**: Intermediate LID Design: Rainwater Collection Systems & Vegetated Roofs
- **3.3**: Intermediate LID Design: NPS Treatment & BMP Design
- **3.4**: Intermediate LID Design: Permeable Pavement
- **3.5**: Intermediate LID Design: Site Assessment, Planning & Layout
- **3.6**: Intermediate LID Design: Hydrologic Modeling
- **3.7**: Intermediate LID Design: Bioretention
- **5.0**: Advanced Topics in LID Design: Site Assessment, Planning & Layout
- **5.1**: Advanced Topics in LID Design: Hydrologic Modeling
- **5.2**: Advanced Topics in LID Design: Permeable Pavement
- **5.3**: Advanced Topics in LID Design: Bioretention
- **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: NPS Treatment & BMP Design

---

**Project Lead**: Herrera

**Additional Training Support**: Ch2m, MNS, Kindred Hydro, Northumbrian Water
AGENDA

1. introduction
2. rainwater collection systems
3. vegetated roofs
4. wrap up
LEARNING OBJECTIVES

- Participants gain an intermediate level knowledge necessary to coordinate activities for entry level design and implementation of rainwater collection systems and vegetated roofs in residential and commercial settings (new and retrofit).
- Participants learn basic entry level design and implementation approaches for rainwater collection systems and vegetated roofs in residential and commercial settings.
- Participants learn practical skills necessary for construction of basic rainwater collection systems and vegetated roofs.

LOGISTICS

SCHEDULE
- 4-hour training with one break
- Sign in and sign out

OTHER LOGISTICS
- Restroom location
- Snacks
- Turn off cell phones
- Q&A at end of each section
**INTRODUCTION & REGULATIONS**

**LID Principles: Developed condition**

**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

**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

*Traditional*  
*LID*
LID BMPs: Small-Scale Engineering Controls

- Infiltration
- Filtration
- Storage
- Evaporation
- Transpiration

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

INTRODUCTION & REGULATIONS

Western WA NPDES Permit

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

<table>
<thead>
<tr>
<th>Municipal Stormwater Permittees in Washington State</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>5 Counties</td>
<td></td>
</tr>
<tr>
<td>King County</td>
<td>5 Counties</td>
<td></td>
</tr>
<tr>
<td>Pierce County</td>
<td>5 Counties</td>
<td></td>
</tr>
<tr>
<td>Snohomish County</td>
<td>5 Counties</td>
<td></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

NPDES PERMIT LID REQUIREMENTS:

Implementation Timeline Varies By Permittee

Review and revise development related codes, rules & standards (i.e. adopt the 2012 Stormwater Manual)

Timeline for updating local codes

<table>
<thead>
<tr>
<th>Phase I</th>
<th>Phase II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per Section 35.E.3.b of the Phase I Permit</td>
<td>Per Section 35.E.4 of the Phase I Permit</td>
</tr>
<tr>
<td>June 2014</td>
<td>June 30, 2015</td>
</tr>
<tr>
<td>June 30, 2016 *</td>
<td>June 30, 2017</td>
</tr>
<tr>
<td>June 30, 2017</td>
<td>June 30, 2018</td>
</tr>
</tbody>
</table>

* = Or GMA update deadline

To see a listing of permittees visit http://www.ecy.wa.gov/programs/wq/stormwater/municipal/MuniStrmWtrPermList.html
INTRODUCTION & REGULATIONS
NPDES MUNICIPAL STORMWATER PERMIT:
Minimum Requirements (MRs)

1. Preparation of Stormwater Site Plans
2. Construction Stormwater Pollution Prevention Plan (SWPPP)
3. Source Control of Pollution
4. Preservation of Natural Drainage Systems and Outfalls
5. On-Site Stormwater Management
6. Run-off Treatment
7. Flow Control
8. Wetlands Protection
9. Operations and Maintenance

DEFINITIONS
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>Onsite SW Management BMP</th>
<th>Flow Control Credit</th>
<th>Treatment Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Amendment</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Dispersion</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Retaining &amp; Planting Trees</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Rainwater Harvesting</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Bioretention*</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Permeable Pavement*</td>
<td>X</td>
<td>X*</td>
</tr>
<tr>
<td>Vegetated Roofs*</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

* Meets basic, enhanced and phosphorus treatment when infiltrating through soil per Ecology treatment requirements

* Where permeable pavement is over soils meeting the suitability criteria or a treatment layer is included

* Also considered SW Treatment & Flow Control BMPs (Facilities (additional requirements in regard to long term inspection, operations, and maintenance apply))
AGENDA

1. Introduction
2. Rainwater collection systems
3. Vegetated roofs
4. Wrap up

RAINWATER COLLECTION SYSTEMS
Introduction

- What is Rainwater Collection
- History of Rainwater Collection
- Definitions
  - Reclaimed water
  - Greywater
  - Rainwater
- Benefits of Rainwater Harvesting
**System Types**

- **Non-Potable**
  - toilets
  - urinals
  - trap primers for floor drains and floor sinks
  - irrigation
  - industrial processes
  - water features
  - cooling tower makeup

- **Potable**
  - Sole Source
  - Redundant
  - Gravity or Pumped
  - Commercial / Residential
  - Single Building or Community Scale
  - Simple
  - Complex
  - Hybrid Stormwater Systems

**System Components**

**Roofing**

- For potable systems powder coated metal roofing is preferred
- Others can be considered
- Ecology water quality testing results
- Potable source control (UPC Appendix K)
  - Wood Roofing Materials
  - Lead Flashing
  - Roof paints and coatings with lead, chromium, or zinc
**System Components**

**Collection**
- Gutters
- Screens
- Wet vs. dry conveyance
- Sumps & relay pumping
- Freeze protection

**System Components**

**Pre-Filtration**
- Filter Examples
- Pre-filtration vs. roof washer
- 100 micron per UPC 1709.9.11

**System Components**

**Storage (Cistern)**
- Design requirements
  - Structural
  - Access
  - Overflow
  - Isolate and drain for maintenance
  - Screen all penetrations for vermin and insects
  - Freeze protection
RAINWATER COLLECTION SYSTEMS

System Components

Storage (Cistern) – Above Grade Metal

---

Storage (Cistern) – Recycled

---

Storage (Cistern) – Above Grade Plastic
System Components
Storage (Cistern) – Below Grade Plastic

System Components
Storage (Cistern) – Below Grade Concrete (cast in place)

System Components
Storage (Cistern) – Below Grade Concrete (Pre-Cast)
**System Components**

**Pumping & Distribution**

- Freeze protection
- Suctions
  - Floating
  - Static
- Float Switches

- Controls
  - Variable Speed vs. single speed with pressure tank
- Jet pumps
- Submersible pumps
System Components

Filtration: Non-potable

- Depends on use
- Typically 20-50µ

Filtration: SF Residential Non-Potable Filter example

Filtration: community Non-Potable Filter example
**System Components**

**Filtration: community Non-Potable Filter example**

---

**System Components**

**Filtration: community Non-Potable Filter example**

---

**System Components**

**Filtration: Potable**

- Pollutants of Concern
- Filtration
- Disinfection
RAINWATER COLLECTION SYSTEMS
System Components
Filtration: Potable Filter example

RAINWATER COLLECTION SYSTEMS
System Components
Back-up
• Direct Connection
• DCVA / RP Device
• Level Control
• Cistern top off
• Air Gap

RAINWATER COLLECTION SYSTEMS
Codes and Permitting
Plumbing Code
Governs the piping of water inside and outside of a building
Enforced by health / building departments
• Chapter 17 - Nonpotable RW Catchment Systems
• Appendix K - Potable RW Systems
• WAC 51-56-1700 WA Amendments
RAINWATER COLLECTION SYSTEMS
Codes and Permitting

**Plumbing Code – Cross Connection**

- Located on back-up line
- Most important code issue
- Necessary to protect potable supply
- Need to isolate premises or within a premises
- Covered by WAC 246-290-490
- EPA Cross Connection Control Manual (816-R-03-002)
- Local code may vary

RAINWATER COLLECTION SYSTEMS
Codes and Permitting

**Plumbing Code – Cross Connection – Air Gap**

- Diagram showing air gap

RAINWATER COLLECTION SYSTEMS
Codes and Permitting

**Plumbing Code – Cross Connection – RP Device / DCVA**

- Diagrams of RP Device and DCVA

RAINWATER COLLECTION SYSTEMS

Codes and Permitting

Plumbing Code – Pipe Labeling

• Requirements vary by jurisdiction
• Label per ASME 13.1
• Black Lettering on yellow background 4’ o/c
• Purple pipe can be allowed

Plumbing Code – Fixture Labeling

• Label all plumbing fixtures “CAUTION: NONPOTABLE WATER, DO NOT DRINK”

Plumbing Code – Equipment Room Signs

• Equipment Room Signs per code:
  “CAUTION NONPOTABLE RAINWATER, DO NOT DRINK. DO NOT CONNECT TO DRINKING WATER SYSTEM. NOTICE: CONTACT BUILDING MANAGEMENT BEFORE PERFORMING ANY WORK ON THIS WATER SYSTEM.”
**RAINWATER COLLECTION SYSTEMS**

**Codes and Permitting**

**Plumbing Code – Building Signs**

- Building Signs per code:

  "TO CONSERVE WATER, THIS BUILDING USES RAINWATER TO FLUSH TOILETS AND URINALS."

**Plumbing Code – Tank Labeling**

- Tank Signs per code:

  "NONPOTABLE RAINWATER."

  "DANGER-CONFINED SPACE."

**ANSI/NSF P151**

- NSF P151 - Health Effects from Rainwater Catchment System Components

- Plumbing Code Appendix K, 103.1
Codes and Permitting

Rainwater Collection Systems

Water Rights
• Water Law / Water Rights
• WSDOE POL 107 (Oct. 9, 2009)
• Limitations and requirements

Codes and Permitting

ARCSA/ASPE/ANSI 63-2013: Rainwater Catchment Systems

Design and Installation Requirements
• Collection Parameters
• Conveyance System
• Pre-filtration
• Cisterns / Storage
• Pump
• Filtration
• Piping
• System Inspection and Maintenance
• Potable Water Applications
• Operation and Water Quality Maintenance
• Labeling

Codes and Permitting

Local Codes & Guides
• Varies by jurisdiction
• Rainwater as sole source
• Sizing guidance
• ARCSA Accredited Professional
• Other requirements
Modeling

Stormwater (BMP T5.20: Rainwater Harvesting)

- Instances where BMP T5.20 applies is very limited
- **Recommendation**: Model daily demand as an infiltration rate in a vault
- Stacked hybrid vault or in-line cistern

---

Operations and Maintenance

- Inspect and clean filters and screens
- Inspect cisterns and clean accumulated sediment
- Inspect pump & controls
- Backflow prevention device inspection
- Water quality testing as required for potable systems
- Document and log all maintenance and testing

---

Potable Example

Chris Webb & Associates, Inc.
**Potable Example**

- Sole Source
- Retrofit
- 3 bedroom / 5 occupants (183 gpd)
- 200sf irrigated garden
- 2,500sf roof
- High rainfall site (119”/year)
- 13,500 gallon cistern meets 95% of days in the model
- Sump pumps required for collection

**NOTES:**

1. All equipment to be installed per manufacturer's instructions.
2. Tank to be vented per manufacturer's instructions.
3. All items can be used in lieu of or in addition to the system.
4. The system is designed for an average of 200 gallons per day.
5. The system is designed for a maximum of 7 days of storage.
6. Please refer to the manufacturer's instructions for installation details.

---

**RainBank Rainwater Systems**
Hybrid Rainwater / Green Roof?

- Not recommended to collect and re-use rainwater collected from Green Roof areas for potable reuse
- Toilet flushing in some cases/irrigation ok
- Aesthetic issues (i.e. discoloration / tannins)
- Some leaching of nutrients possible with some media
AGENDA

1. Introduction
2. Rainwater collection systems
3. Vegetated roofs
4. Wrap up

VEGETATED ROOFS
Types, Functions & Performance
Vegetated Roof?

A Range of Benefits
- Improved Stormwater Management
- Urban Heat Island Reduction
- Usable Green Space
- Energy Efficiency/Thermal Insulation
- Roof Longevity
- Biodiversity/Habitat
- Reduction of Noise
- Reduction of Dust & Smog Particles
- Integrated Design Opportunities
- Aesthetics/Views
VEGETATED ROOFS
Types, Functions & Performance

Extensive
Thin, lightweight soil profile for with low maintenance vegetation such as succulents, grasses and perennials for stormwater management. Access paths usually for maintenance only.

Semi-Intensive
Hybrid system with slightly more soil, capable of supporting more vegetation including small trees and shrubs. Can include small areas for seating and paths.

Intensive
Thicker soil profile with more robust vegetation including trees and shrubs. Includes paving, structures and other roof terrace elements.

VEGETATED ROOFS
Types, Functions & Performance

Extensive

VEGETATED ROOFS
Types, Functions & Performance

Extensive
Types, Functions & Performance

Intensive (Roof Terrace)

VEGETATED ROOFS

Types, Functions & Performance

Rooftop Agriculture

VEGETATED ROOFS

Types, Functions & Performance

Rooftop Agriculture
VEGETATED ROOFS
Types, Functions & Performance
Part of an Integrated System – LID Design

VEGETATED ROOFS
Types, Functions & Performance
Performance

<table>
<thead>
<tr>
<th>Project</th>
<th>Completion Date</th>
<th>GM Depth</th>
<th>Area</th>
<th>Volume Reduction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSU Broadway Building</td>
<td>2005-present</td>
<td>15 cm</td>
<td>500 m²</td>
<td>41-48%</td>
</tr>
<tr>
<td>BGIT</td>
<td>2005</td>
<td>75, 150 mm</td>
<td>33 m²</td>
<td>20%/75mm 26%/150mm</td>
</tr>
<tr>
<td>Multnomah</td>
<td>2004-2005</td>
<td>6 in</td>
<td>11,900 ft²</td>
<td>30%</td>
</tr>
<tr>
<td>Hamilton (west roof)</td>
<td>2002-2005</td>
<td>5 in (~4&quot;)</td>
<td>2,520 ft²</td>
<td>56%</td>
</tr>
<tr>
<td>Zoonazium</td>
<td>2-4/2007</td>
<td>6 in</td>
<td>8,000 ft²</td>
<td>36%</td>
</tr>
</tbody>
</table>

VEGETATED ROOFS
Types, Functions & Performance
Performance

- Peak flows reduced by up to 53.3%
- Total runoff reduction of up to 70%
- Reductions of peak flows due to increased travel time of runoff

VEGETATED ROOFS
Types, Functions & Performance
Factors Influencing Performance
- Size, shape and configuration of vegetated roof
- Soil depth
- Soil moisture conditions
- Magnitude and distribution of rainfall events
- Vegetative Conditions
- Runoff travel path

VEGETATED ROOFS
Types, Functions & Performance
Additional Performance Values
- 10% reduction in energy use
- Double lifespan of roof (50 years)
- Reduced UV degradation and fluctuation of temperatures
- Reduction of urban heat island (local and modelled cumulative benefit)
- Reduction in particulate matter

VEGETATED ROOFS
Types, Functions & Performance
Additional Performance Values
- Improved performance of solar due to cooling from vegetated roof
**Vegetated Roofs**

**Design Process**

**Base Components**
- Waterproof Membrane
- Protection Layer
- Root Barrier
- Drainage Layer
- Edging/Curbs
- Maintenance Paths
- Ballast/Gravel
- Filter Fabric
- Growth Media (soil)
- Vegetation/Plants

**Optional Components**
- Insulation
- Moisture Retention Mat
- Leak Detection System
- Rainwater Detention
- Ponds/Detention
- Railings
- Paving
- Lighting

---

**Extensive Roof – Typical Layers**

- a. existing structural roof support
- b. existing 5-ply roofing system
- c. 1/2" protection board
- d. 1/4" drainage mat with root barrier
- e. stainless steel edging
- f. 6" growth medium
- g. green roof vegetation
- h. drip irrigation system
- i. gravel ballast
- j. roof drain
- k. monitoring equipment
- l. concrete pavers
VEGETATED ROOFS

Design Process

Different Systems

Growing Media

- Standard topsoil
  - 120-160 pounds per square foot (saturated)
- Lightweight aggregate
  - 40-80 pounds per square foot (saturated)

Growing Media

- Expanded shale
- Perlite
- Paper pulp
- Pumice
- Organic matter
- Polymers
VEGETATED ROOFS

Design Process

Growing Media

- Grain Size Distribution
- Density
- Water & Air Management
- pH, Lime & Salt Content
- Organics
- Nutrients
- CEC Capacity

http://www.fli.de/

VEGETATED ROOFS

Design Process

Varying Depths of Growing Media

<table>
<thead>
<tr>
<th>Type of Vegetated Roof</th>
<th>Range of Loading (pounds per square foot)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extensive</td>
<td>12-40 p.s.f.</td>
</tr>
<tr>
<td>Semi-intensive</td>
<td>40-80 p.s.f.</td>
</tr>
<tr>
<td>Intensive (Roof Terrace)</td>
<td>80-250 p.s.f. (can be higher depending on use of larger trees)</td>
</tr>
<tr>
<td>Rooftop Agriculture</td>
<td>40-150 p.s.f.</td>
</tr>
</tbody>
</table>
Plantings: Got CAM?*

Non-Sedums breath through stomata during the day to photosynthesize, thus lose water in large amounts...

CAM plants keep stomata closed during the day and open during the night to absorb CO2, cutting down on transpiration and increasing the ability to survive arid conditions.

* Crassulacean Acidic Metabolism
Vegetated Roofs
Design Process
Plantings: Diversity

Sedum oreganum
(Oregon Stonecrop)

Sedum spathulifolium 'Coral Carpet'
(Coral Carpet Stonecrop)

Sedum acre
(Biting Stonecrop)

Sedum kamtchaticum 'Variegatum'
(Variegated Stonecrop)

Delosperma cooperi
(Hardy Iceplant)

Sempervivum spp
(Hens and Chicks)
VEGETATED ROOFS
Design Process
Plantings: Diversity

Leptosiolia columbiana
(Columbia Lewisia)

Hemerocallis spp.
(Daylilies)

Festuca glauca 'Elijah's Blue'
(Elijah's Blue Fescue)

Fragaria chiloensis
(Coast Strawberry)

Rainwater Systems & Vegetated Roofs
Statewide LID Training Program
Intermediate Topics in LID Design
**Vegetated Roofs Design Process**

**Irrigation: Precipitation - Seattle vs. European Cities**

- Graph showing precipitation data for Seattle and European cities.

**Irrigation: Precipitation - Seattle vs. Other US Cities (East)**

- Graph showing precipitation data for Seattle and East Coast US cities.

**Irrigation: Precipitation Seattle vs. Other US Cities (West)**

- Graph showing precipitation data for Seattle and West Coast US cities.
**Design Process**

**Irrigation: Seattle - Precipitation v. Evapotranspiration**

Irrigation: Seattle - Precipitation v. Evapotranspiration

**Irrigation: Demand**

- 30-40 day spans without even a trace of precipitation
- When trace precipitation (less than 0.01 inches) is factored in, the dry spells increase even greater, up to 71 days with only a trace of precipitation.
- There are a number of recorded 40-60 day spans with only a trace of precipitation, mostly occurring from mid-June to late August

**Irrigation: Spray Rotors**
VEGETATED ROOFS

Design Process

Irrigation: ET Controllers/Weather Stations

Layout

Complexity of Rooftop Equipment /Access
Views from Adjacent Spaces

Access & Interpretive Elements

Preliminary Sketches
Vegetated Roofs
Layout

Renderings

Vegetated Roofs
Layout

Design Concept

Vegetated Roofs
Layout

Construction Documents
VEGETATED ROOFS
Construction Process

Irrigation

VEGETATED ROOFS
Construction Process

Planting

Inspections
- Pre Construction
- Roofing/Waterproofing
- Plumbing/Mechanical/Electrical (as governed by permitting)
- Initial Layout/Edging (design)
- Growing Media (depth)
- Planting (correct plants/density)
- Irrigation (proper operation)
- Final Walkthrough/Punchlist
- Periodic O&M Reviews
VEGETATED ROOFS

Operations & Maintenance

O&M Planning

General Operations & Maintenance

O&M Contacts

Operations and Maintenance Requirements
• Irrigation
• Vegetation Management
• Soil Substrate/Growing Medium
• Aesthetics
• Insect Control
• Structural Components
• Debris & Litter
• Spill Prevention
• Training/Written Guidance
• Access & Safety

O&M Schedule & Documentation
• Activity Matrix
• Maintenance Calendar
• O&M Form

Vegetated Roofs O&M Planning: Detailed Specs

1. Soil Substrate/Growing Medium
   - The soil substrate is a critical component of the vegetation system and should be chosen with care. It should
     be well-drained, able to retain moisture, and provide a suitable growing medium for the vegetation.

2. Aesthetics
   - The aesthetic appearance of the vegetated roof is important, and the design should consider factors such as
     color, texture, and composition. The selection of vegetation should enhance the overall appearance of the roof.

Vegetated Roofs O&M Planning: Activity Matrix

The following table summarizes the operations and maintenance activities for vegetated roofs. Each activity is
divided into tasks, and the schedule is based on the frequency and importance of each task. The table provides
an overview of the activities required to maintain a vegetated roof system. The schedule varies depending on
the specific requirements of the roof and the maintenance plan.
Operations & Maintenance
O&M Planning: Maintenance Calendar

<table>
<thead>
<tr>
<th>Month</th>
<th>Maintenance Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>Check for Excess/Glazed Soft/Standing Water Check: Ditch, Downspout &amp; Catch Basin</td>
</tr>
<tr>
<td>April</td>
<td>Spring Cleaning/Asphalt Maintenance in Standing Water Catch Basins &amp; Storm Drain</td>
</tr>
<tr>
<td>May</td>
<td>Storm Drain Inspection/Inspection of Inlet and Outlet</td>
</tr>
<tr>
<td>June</td>
<td>Weather and Adjust Irrigation Timing (System inspection)</td>
</tr>
</tbody>
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Operations & Maintenance
O&M Planning: O&M Forms/Documentation

<table>
<thead>
<tr>
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<th>O&amp;M Form</th>
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<td>Maintenance: Record date, description, and contractor (if applicable) for all structural repairs, landscape maintenance, and facility interior activities.</td>
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Ecology Guidelines

- Vegetated Roofs in the 2013-2018 Western Washington Phase II Stormwater Permit
  - Defined as a “Hard Surface”
  - Flow control and on-site stormwater management option
  - Not an option in List #1 or List #2 for meeting Minimum Requirement #5
  - Need to use LID Performance Standard to receive on-site stormwater management (Minimum Requirement #5) or flow control (Minimum Requirement #7) credit
VEGETATED ROOFS
Codes & Permitting

Ecology Guidelines
- Vegetated Roofs in the 2012 Stormwater Management Manual for Western Washington (SWMMWW)
  - BMP TS.17 (Volume V)
  - Consist of four basic components: waterproof membrane, drainage layer, light-weight growing medium, and vegetation
  - Install on roofs with slopes between 5 and 20 degrees. Roofs with slopes greater than 10 degrees require an analysis of engineered slope stability
  - Refer to LID Technical Guidance Manual for Puget Sound (2012) for additional design guidance, and Appendix III-C of the SWMMWW for modeling guidance

Statewide LID Training Program
RAINWATER SYSTEMS & VEGETATED ROOFS
INTERMEDIATE TOPICS IN LID DESIGN

Q&A

AGENDA
1. introduction
2. rainwater collection systems
3. vegetated roofs
4. wrap up
INTRODUCTORY

INTRODUCTION to LID for Inspection & Maintenance Staff

INTERMEDIATE

Intermediate LID Design: Rainwater Collection Systems & Vegetated Roofs

Intermediate LID Design: Permeable Pavement

Intermediate LID Design: Hydrologic Modeling

ADVANCED

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

Advanced Topics in LID Design: Permeable Pavement

Advanced Topics in LID Design: Hydrologic Modeling

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

Advanced Topics for Long-Term LID Operations: Rainwater Collection Systems & Vegetated Roofs

Advanced Topics for Long-Term LID Operations: Permeable Pavement

Advanced Topics for Long-Term LID Operations: Hydrologic Modeling

Advanced Topics for Long-Term LID Operations: Bioretention Media and Compost-Amended Soils

OVERVIEW OF PROGRAM

COURSE CATALOG

www.wastormwatercenter.org/lidswtrainingprogram/

ONLINE EVALUATION

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

• Feedback will help to refine future trainings.
Statewide LID Training Program

CERTIFICATE

Two certificates:
• LID Design certificate.
• LID Operations and Maintenance certificate.

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

LID Certificate Program Policies Page:
www.wastormwatercenter.org/lid-certificate-policies

Remember to sign in and sign out!

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ONLINE RESOURCES

For information on training and other resources, visit the Washington Stormwater Center website:
http://www.wastormwatercenter.org

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QUESTIONS

Further questions? Contact:
training@cascadiaconsulting.com
(206) 449-1163