OVERVIEW OF PROGRAM

- 2012: Public and private partners engage state legislature to fund program
- June 2012: LID Training Steering Committee
- 2012-2013: Washington State LID Training Plan developed: www.wastormwatercenter.org/statewide-lid-training-program-plan
- Training program built from state LID Training Plan

PROJECT LEAD

HERRERA

CORE TEAM

CASCADIA

ADDITIONAL TRAINING SUPPORT

- MITHÜN
- Kindred Hydro
- CH2M HILL
- Mutual Materials
- Stormwater ONE
- Learning PROS Plans
Statewide LID Training Program

PROGRAM OVERVIEW

- Implement first phase of trainings (September 2014 through May 2015)
- 49 trainings offered in western and eastern WA first year
- 45 trainings scheduled for western and eastern WA in current phase (through June 2016)
- Three levels: Introductory, Intermediate, and Advanced
- Statewide LID Certificate now available

**INSTRUCTIONAL MATERIALS**

- 2.1 Introduction to LID for Inspection & Maintenance Staff
- 2.2 Introduction to LID for Inspection & Maintenance Staff
- 2.3 Introduction to LID for Developers & Contractors: Make Money by Greening Interim

**OVERVIEW OF PROGRAM**

**INTRODUCTORY**

- Introduction to LID for Inspection & Maintenance Staff

**INTERMEDIATE**

- Intermediate LID Design: Site Assessment, Planning & Layout
- Intermediate LID Design: Rainwater Collection Systems & Vegetated Roofs
- Intermediate LID Design: Hydrologic Modelling
- Intermediate LID Design: Permeable Pavement

**ADVANCED**

- Advanced Topics for Long-term LID Operations: Bioretention
- Advanced Topics for Long-term LID Operations: Permeable Pavement
- Advanced Topics in LID Design: Hydrologic Modeling
- Advanced Topics in LID Design: Site Assessment, Planning & Layout
- Advanced Topics in LID Design: Rainwater Collection Systems & Vegetated Roofs

**REFERENCES**

- Advanced Topics in LID Design: Bioretention
- Advanced Topics in LID Design: Hydrologic Modeling
- Advanced Topics in LID Design: Site Assessment, Planning & Layout
Rainwater Collection Systems & Vegetated Roofs

WESTERN WASHINGTON

INSTRUCTORS

JASON KING, RLA
ASLA LEED AP
Senior Landscape Architect
Key project experience: Stormwater design for development, site design, green roofs, stormwater art, ecological planning

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

AGENDA

1. Introduction
2. Rainwater Collection Systems
3. Vegetated Roofs
4. Wrap Up
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.

LID Principles: Pre-developed forest
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

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

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

Conserve or regain pre-developed hydrologic functions

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 Permits in Washington State</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase I Permittees</td>
<td>Western Washington Phase II Permittees</td>
</tr>
<tr>
<td>Seattle</td>
<td>82 Cities</td>
</tr>
<tr>
<td>Tacoma</td>
<td>5 Counties</td>
</tr>
<tr>
<td>Clark County</td>
<td></td>
</tr>
<tr>
<td>King County</td>
<td></td>
</tr>
<tr>
<td>Pierce County</td>
<td></td>
</tr>
<tr>
<td>Snohomish County</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

INTRODUCTION & REGULATIONS

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 5.5.C.6 of the Phase I Permit</td>
<td>Per Section 5.5.C.8 of the Phase II Permit</td>
</tr>
<tr>
<td>June 2014</td>
<td>June 30, 2015</td>
</tr>
<tr>
<td>Dec. 31, 2016</td>
<td>June 30, 2017</td>
</tr>
<tr>
<td>June 30, 2018</td>
<td>June 30, 2019</td>
</tr>
</tbody>
</table>

City of Aberdeen

City of Timaru

City of Vancouver

City of Yakima

City of Yakima

City of Yakima
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 Credit1</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>Bioretention1</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Permeable Pavement2</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Vegetated Roofs3</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

1. Meets basic phosphorus treatment when infiltrating through soil per Ecology treatment requirements
2. Where permeable pavement is over soils meeting the suitability criteria or a treatment layer is included
3. 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
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
**System Types**

- 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

**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

System Components

Storage (Cistern) – Above Grade Metal
System Components

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

Storage (Cistern) – Below Grade Concrete (Pre-Cast)

Storage options with costs

Approximate cistern costs per gallon stored by tank type

- $0.50
- $1
- $2.00
- $4-$6

- $1.50
- $2.00
- $4-$6
- $4-$6
System Components

Pumping & Distribution

• Freeze protection
• Suctions
  • Floating
  • Static
• Float Switches

• Controls
  • Variable Speed vs. single speed with pressure tank
• Jet pumps
• Submersible pumps

Filtration: Non-potable

• Depends on use
• Typically 20-50µ
System Components

Filtration: SF Residential Non-Potable Filter example

Mithun

System Components

Filtration: community Non-Potable Filter example

Chris Webb & Associates, Inc.
System Components

Filtration: community Non-Potable Filter example

System Components

Filtration: Potable

• Pollutants of Concern
• Filtration
• Disinfection

System Components

Filtration: Potable Filter example
### System Components

**Back-up**

- Direct Connection
- DCWA / RP Device
- Level Control
- Cistern top off
- Air Gap

### 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

**Exceptions**

- A preset is not required for exterior rainwater catchment systems used for ornamental and landscaping purposes with a maximum storage capacity of 500 gallons (1,893 L).

**EPA Cross Connection Control Manual** (816-R-03-002)

Local code may vary

**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

Rainwater Collection Systems
Codes and Permitting
Plumbing Code – Cross Connection – RP Device / 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
Codes and Permitting

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.”

Plumbing Code – Building Signs

• Building Signs per code:

“TO CONSERVE WATER, THIS BUILDING USES RAINWATER TO FLUSH TOILETS AND URINALS.”
Codes and Permitting

RAINWATER COLLECTION SYSTEMS

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

Water Rights

• Water Law / Water Rights

  • WSDOE POL 107 (Oct. 9, 2009)

  • Limitations and requirements
**RAINWATER COLLECTION SYSTEMS**

**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

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

**Modelling**

**Cistern Sizing (monthly vs. daily)**

**Average Monthly Precipitation**
Seattle, WA / Lynnwood, WA
Modelling

Cistern Sizing (monthly vs. daily)

![Graph showing performance with increasing cistern sizes.]

**Performance with increasing cistern sizes:**
- Mixed Use

---

Modelling

Stormwater (BMP T5.20: Rainwater Harvesting)

**BMP T5.20: Rainwater Harvesting**

- **Purpose and Definition:** Rainwater harvesting involves the capture and storage of rainwater for beneficial use. Roof runoff may be routed to cisterns for storage and subsequently used for irrigation, toilet flushing, and cold-water laundry. Rainwater harvesting can help reduce peak stormwater flows, detention, and volumes. The amount of reduction achieved with cistern storage is a function of contributing area, storage volume, and rainwater use rate.

- **Design Criteria:**
  - 100% reuse of the annual average runoff volume (use continuous runoff model to get annual average for drainage area).
  - System designs involving interior uses must have a monthly water balance that demonstrates adequate capacity for each month and mass of all stored water annually.

- **Runoff Model Representation:** Do not enter drainage area into the runoff model.

- **Other Criteria:**
  - Restrict use to residential housing and lower densities where the captured water is solely for outdoor use.

---

Modelling

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

**Diagram showing detention and cistern components.**
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

- 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
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

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 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

Types, Functions & Performance

VEGETATED ROOFS
Types, Functions & Performance

Extensive

VEGETATED ROOFS
Types, Functions & Performance

Semi-intensive

VEGETATED ROOFS
Types, Functions & Performance

Intensive
Types, Functions & Performance

**Extensive**

Types, Functions & Performance

**Semi-Intensive**
### Types, Functions & Performance

#### Rooftop Agriculture

- **Statewide LID Training Program**
- **Western Washington**
- **Rainwater Collection Systems & Vegetated Roofs**

#### Part of an Integrated System – LID Design

- **The water system in Boro's Potsdamer Platz**

### Performance

<table>
<thead>
<tr>
<th>Project</th>
<th>Completed</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>BCIT</td>
<td>2005</td>
<td>75, 150 mm</td>
<td>33 m²</td>
<td>29%/79%/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')</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>38%</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


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

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
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

• Irrigation System

Essential for our climate!
VEGETATED ROOFS
Design Process
Extensive Roof – Typical Layers

a. existing structural roof support
b. existing 5-ply roofing system
c. 1/2" protection board
d. 1/2" 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

VEGETATED ROOFS
Design Process
Growing Media

standard topsoil
120-160 pounds per square foot (saturated)

lightweight aggregate
40-80 pounds per square foot (saturated)
VEGETATED ROOFS

Design Process

Growing Media

- Light weight (saturated)
- Maintain structure/Limited fines
- Retain moisture
- Environment for plant growth

- expanded shale
- perlite
- pumice
- paper pulp
- organic matter
- polymers

Design Process

Varying Depths of Growing Media
### Structural Considerations

<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>

---

### Design Process

#### Plantings

* Crassulacean Acidic Metabolism

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.
VEGETATED ROOFS

Design Process

Plantings: Seasonality

Plant Variety

VEGETATED ROOFS

Design Process

Plantings: Diversity

Sedum oreganum
(Oregon Stonecrop)

Sedum spathulatum ‘Coral Carpet’
(Coral Carpet Stonecrop)

Sedum acre
(Biting Stonecrop)

Sedum kamtschatcicum ‘Variegatum’
(Variegated Stonecrop)
VEGETATED ROOFS
Design Process
Plantings: Diversity

Delosperma cooperi
(Hardy Iceplant)

Sempervivum spp.
(Hens and Chicks)

Lewisia columbiana
(Columbia Lewisia)

Hemerocallis spp.
(Daylilies)

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

Fragaria chiloensis
(Coast Strawberry)
Design Process

Irrigation: Precipitation - Seattle vs. European Cities

Irrigation: Precipitation - Seattle vs. other US Cities (East)
### Design Process

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

- Graph showing precipitation comparison between Seattle and other US cities.

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

- Graph showing precipitation and evapotranspiration comparison for Seattle.

**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.
VEGETATED ROOFS
Construction Process
Soil Loading & Placement

VEGETATED ROOFS
Construction Process
Irrigation

VEGETATED ROOFS
Construction Process
Planting
VEGETATED ROOFS
Construction Process
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
Operations & Maintenance
O&M Planning: Detailed Specs
1c. Soil Substrate/Growing Medium
   - Inspection should be conducted to evidence of erosion from wind or water:
     a. Any erosion should be detected with additional substrate and growing medium similar in nature to the original material not to exceed 1” soil depth
     b. Areas should be tested immediately with appropriate material to fill voids in places where erosion control materials allow areas to become rainwater consuming. Vegetation control should be completed immediately.

1d. Aesthetics
   - The desired aesthetic of the green roof is to maintain a healthy mix of assorted vegetation, perennial, and annual plants, that is free of weeds and such hardscapes are not detrimental for a single species.
   - To minimize the maintenance of plant health, avoid adding for seasonal variation of plants, not to maintain a soft surface year-round.
   - Mowing and fertilization should be done to maintain real appearance of vegetation and common areas, and to avoid oversaturation by non-essential species.

Statewide LD Training Program
WESTERN WASHINGTON
REINMATER COLLECTION SYSTEMS & VEGETATED ROOFS
VEGETATED ROOFS
Operations & Maintenance
O&M Planning: Activity Matrix

<table>
<thead>
<tr>
<th>No.</th>
<th>Activity</th>
<th>Scheduled Dates</th>
<th>Schedule A Note</th>
<th>Schedule B Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Install system for control system water conveyance and/or barrier lines.</td>
<td>1st season</td>
<td>As needed</td>
<td>As needed</td>
</tr>
<tr>
<td>2</td>
<td>Evaluate irrigation system water needs.</td>
<td>1st season</td>
<td>As needed</td>
<td>As needed</td>
</tr>
<tr>
<td>3</td>
<td>Check performance of irrigation system.</td>
<td>1st season</td>
<td>As needed</td>
<td>As needed</td>
</tr>
<tr>
<td>4</td>
<td>Maintain irrigation system equipment.</td>
<td>1st season</td>
<td>As needed</td>
<td>As needed</td>
</tr>
<tr>
<td>5</td>
<td>Check irrigation system for leaks.</td>
<td>1st season</td>
<td>As needed</td>
<td>As needed</td>
</tr>
<tr>
<td>6</td>
<td>Maintain irrigation system equipment.</td>
<td>1st season</td>
<td>As needed</td>
<td>As needed</td>
</tr>
<tr>
<td>7</td>
<td>Maintenance Calendar</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

VEGETATED ROOFS
Operations & Maintenance
O&M Planning: Maintenance Calendar

VEGETATED ROOFS
Operations & Maintenance
O&M Planning: O&M Forms/Documentation

O&M Forms

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<tr>
<th>Log #</th>
<th>Date</th>
<th>Work Performed By</th>
<th>Initiate</th>
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Description of Work Performed:

Required Follow-up Activities and Date:

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<th>Scheduled?</th>
<th>Y/N</th>
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Codes & Permitting

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 in the 2013-2018 Western Washington Phase II Stormwater Permit

BMP T5.17 (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

Vegetated Roofs in the 2012 Stormwater Management Manual for Western Washington (SWMMWW)

AGENDA

introduction

rainwater collection systems

vegetated roofs

wrap up
Statewide LID Training Program

OVERVIEW OF PROGRAM

INTRODUCTORY
1. Introduction to LID for Inspectors & Maintenance Staff
2. Introduction to LID for Inspectors & Maintenance Staff

INTERMEDIATE
3. Intermediate LID Design: Rainwater Collection Systems & Vegetated Roofs
4. Intermediate LID Design: Permeable Pavement
5. Intermediate LID Design: Hydrologic Modelling

ADVANCED
6. Advanced Topics in LID: Bioretention
7. Advanced Topics in LID: Permeable Pavement
8. Advanced Topics in LID: Hydrologic Modelling

COURSE CATALOG
For more information, visit: http://www.wastormwatercenter.org/lidswtrainingprogram/

ONLINE EVALUATION

- An on-line evaluation will be sent to you within 5 days following this training
Statewide LID Training Program

CERTIFICATE

Two certificates:
• LID Design certificate
• Long-term LID Operations certificate

Sign out!

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