Rain Gardens: Designing your Landscape to Protect Aquatic Resources

Curtis Hinman
WSU Extension Faculty
Watershed Ecologist
chinman@wsu.edu
Basic Design Characteristics

- Shallow landscaped depressions that receive stormwater from small contributing areas
- Soil mixes and plants selected to more closely mimic native conditions
- Small scale, dispersed facilities integrated into the design as a landscape amenity
Anatomy of a Rain Garden

Water flowing off impervious surfaces (for example a roof or driveway) can be delivered to the rain garden through a swale lined with decorative rock or plants, through a pipe, or across a landscape area.

Selected native plants or hardy cultivars

- Ponding depth (6" to 12" typical)
- Mulch layer
- Rain garden soil mix
- Gradual side slopes
- Overflow

Existing ground

Rain garden soil mix depth (12" to 24" typical)
Buckman Heights, 430 NE 16th Ave. Portland
Represent in simple language and primarily through graphics, the design and construction of rain gardens on single family lots.
Funded with a DOE DIF grant

Approximately 18 months to complete and included:
- Scoping
- Extensive modeling
- Construction of 3 demonstration rain gardens
- Handbook with design of many original graphics

Printed 15,000 copies
Guidelines

Don’t locate

- Within 10 ft of a building foundation
- Over septic drain field or tank (if uphill > 50ft between rain garden and septic)
- Over shallow utilities...locate and mark
- Near edge of steep slopes...slopes should be < 15% for conventional RG...if within 50ft of 15% slope consult with geotech)
- Where groundwater < 1ft from bottom of finished rain garden
**Guidelines**

**Do locate**
- Where overflow can direct water safely away from the home and neighboring property
- Where it enhances the appearance of the home
Soil Assessment

- Dig perk hole (1-2ft diameter x ~2ft deep)
- Look for signs of high groundwater and examine soil texture
- Conduct simple perk test
In the handbook, soil that infiltrates at 0.5 inches/hour or more is considered well-draining and less than 0.5 inches/hour poor-draining.

**Guidelines**

Using the Information From the Soil Drainage Test

- Drainage or infiltration rate is less than 0.25 inches/hour, but more than 0.1 inches/hour
- Infiltration rate is less than 0.1 inches/hour

In the handbook, soil that infiltrates at 0.5 inches/hour or more is considered well-draining and less than 0.5 inches/hour poor-draining.
Guidelines

Sizing

- Handbook does not provide equations or specific sizing guidelines
- Guidelines provide instructions to properly locate and design considering primary constraints: 1) drainage area; and 2) scale and aesthetics appropriate with lot
- Extensive modeling condensed into table with rain garden annual volume reduction (rain garden size expressed as a percent of contributing area)
Annual Stormwater Reduction (%) for Seattle Rainfall
Annual Stormwater Reduction (%) for Olympia Rainfall

Ratio of Rain Garden Area to Impervious Area

Reduction

Till
Outwash
Table 1: Annual volume of water held in a rain garden with 12 inches of rain garden soil mix and a 6-inch ponding depth (18 inches total)

<table>
<thead>
<tr>
<th>Size of rain garden (as a percent of impervious area and measured in square feet)</th>
<th>Annual volume of water held in rain garden for poor-draining soils</th>
<th>Annual volume of water held in rain garden for well-draining soils</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>70%</td>
<td>99%</td>
</tr>
<tr>
<td>20%</td>
<td>90%</td>
<td>100%</td>
</tr>
<tr>
<td>50%</td>
<td>99%</td>
<td>100%</td>
</tr>
<tr>
<td>80%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

If the depth of the rain garden is increased to 30 inches* on poor-draining soils, then you can reduce the square foot area by 5% and hold the same amount of water. On well-draining soils depth does not significantly increase how much water the rain garden can hold.

*24 inches of rain garden soil mix and a 6-inch ponding depth (30 inches total).
Guidelines

Excavation

- Minimal excavation on good quality soils
  - Excavate ~ 9” to create desired ponding depth and incorporate ~3” of compost to 4-5”

- Excavation on fairly flat ground
Excavation on slopes (>5%)

1. Place stakes at the uphill and downhill sides and about 5 feet apart along the length of the rain garden.

2. Tie a string from the ground level of the uphill stake to the downhill stake so that it’s level (a small, light weight line level works well for this).

3. Use the soil excavated from the uphill side to fill the downhill area up so that the area is flat. Compact the soil by walking over the fill after every few inches added.

4. Create a berm at the downhill side to confine water in the rain garden. For the correct height, build the berm up to the string. To keep the top level, the berm will be highest at the downhill end and then become shorter up the sides until tapering off at the uphill end. The berm should be a minimum of 24 inches wide at the base, have gently sloping sides, and be well compacted.

Important...build berm at least 6” higher than max. ponding depth, armor overflow, compact, and plant
Bioretention Soil Mix

- Current Guidelines can be difficult to apply consistently
- Seattle and WSU developing guidelines that use fairly consistent materials and are readily available, affordable and meet necessary criteria

WSU work Funded by the Puget Sound Partnership

Technical Memorandum

Bioretention Soil Mix Review and Recommendations for Western Washington

Prepared for: Puget Sound Action Team
Prepared by: Curtis Hinman WSU Extension Faculty
Date: June 25, 2007
Soil mixes for bioretention areas need to balance three primary design objectives to provide optimum performance. These are:

- Provide high enough infiltration rates to meet desired surface water drawdown and system dewatering.
- Provide infiltration rates that are not too high in order to optimize pollutant removal capability.
- Provide a growth media to support long-term plant and soil health.

Draft recommendations from Seattle and WSU similar

- Aggregate component of both are primarily sand and very little fines
- Seattle uses a type 17 aggregate (primarily sand with some gravel) with compost
- WSU guidelines will likely use a utility or screened sand (very little or no gravel) with compost
<table>
<thead>
<tr>
<th>Sample Identification</th>
<th>Organic Content (%)</th>
<th>Grain Size Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>before perm. test</td>
<td>after perm. test</td>
</tr>
<tr>
<td>Fred Hill Screen Sand + Compost</td>
<td>8.3</td>
<td>6.3</td>
</tr>
<tr>
<td>Green Earth C33 Washed Sand + Compost</td>
<td>8.8</td>
<td>6.2</td>
</tr>
<tr>
<td>Green Earth Screen Sand + Compost</td>
<td>9.6</td>
<td>--</td>
</tr>
<tr>
<td>Miles S&amp;G Utility Sand + Compost</td>
<td>8.9</td>
<td>--</td>
</tr>
</tbody>
</table>
Guidelines

Rain Garden Soil Mix

- Using excavated soils
  - ~65% excavated soil with 35% compost

- Replacing excavated soil
  - ~60% screened sand and 40% compost

Don’t add sand to soil with high clay content
Armor inflow and outflow channels

Rock lined overflow

Rock lined inlet. Rock should be free of sediment, so order "washed."
Plant Requirements

- Tolerate inundation & summer drought
- Tolerate expected pollutant loads
- Position on soil moisture gradient to tolerate ponding and water fluctuations
- Underground infrastructure and rooting depth

Some examples:
- Woody plants in wet zone: twinberry, nine bark, willow, red-twig dogwood, salmonberry
- Emergents in wet zone: rushes & sedges
- Drier zone: currants, manzanita, grasses
Bioretention
Planting Plan

Note: Vertical scale is exaggerated to show zones.
Guidelines

Mulch

- Coarse compost best for bottom of ponding area
- Shredded or chipped hardwood or softwood floats—good for perimeter
- Dense groundcover beneficial—may need access to maintain mulch if pollutant hotspot
<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Removal Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metals (Cu, Zn, Pb)</td>
<td>93-98%</td>
</tr>
<tr>
<td>TP</td>
<td>70-80%</td>
</tr>
<tr>
<td>TKN</td>
<td>60-70%</td>
</tr>
<tr>
<td>NO$_3$</td>
<td>20 to -194%</td>
</tr>
<tr>
<td>TSS</td>
<td>90%</td>
</tr>
<tr>
<td>Organics</td>
<td>90%</td>
</tr>
<tr>
<td>Hydrocarbons</td>
<td>95+%</td>
</tr>
</tbody>
</table>

Source: Davis et al. 1998 and Hong et al. 2002
Links to Bioretention Guidelines:

Puget Sound Action Team, WSU
LID Technical Guidance Manual
www.psp.wa.gov/LID

Seattle “Natural Drainage Systems” specs
www.seattle.gov/util/NaturalSystems

Rain Garden Handbook for Western Washington Homeowners
www.pierce.wsu.edu/Water_Quality/LID

Bioretention Soil Mix Review and Recommendations for Western Washington
www.pierce.wsu.edu/Water_Quality/LID