Rain Gardens 101: how they fit into LID, CSO control, and stormwater management; Key RG design and construction details

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Presentation to the Green Gardening program
“Creating a Sustainable Future” workshop 11/2/11
-- based on slides from Seattle’s “Installing Rain Gardens & Cisterns” training for contractors, 4/26/2011

www.seattle.gov/util/rainwise
The Stormwater Problem: Impacts of turning spongy forests into cities

1972-1996: Amount of land with 50% tree cover decreased by 37% in Puget Sound region (from 42% of land down to 27%).

Impervious surface (roads, buildings) increasing proportionately

More people moving into Puget Sound region and Seattle = denser development

Our climate is changing: more high rainfall events
Forest

Before development:
- Forest soils absorb rainfall – release it slowly

Urban

After development:
- Rainfall rushes off roofs, roads, and compacted soils

Development Effects

Before development: forest soils absorb rainfall – release it slowly
Development Impacts
– from lost soil infiltration
and increased impervious surface

↑runoff  = ↑peak storm flows
↑erosion of stream bank and bed
↑fine sediment choking spawning gravels
↑pollutants (from cars, landscape chemicals)
↓groundwater recharge
↓summer low flows in streams
↑summer stream & estuary temperature
↓oxygen
↓habitat and food supply for young salmon
What are the impacts?

- Salmon decline
- Pollution
- Erosion
- Flooding & property damage
- Failing landscapes:
  - more chemical use,
  - higher summer water needs
- Combined sewer overflows (CSO’s):
  - Where storm and sanitary sewers are combined, high rainfalls can cause overflows into nearest water body
What’s a Combined Sewer Overflow? (CSO)

When it rains harder than combined sanitary/storm sewers can convey to the sewage treatment plant, the excess overflows through a “combined sewer outfall” into a nearby water body, carrying untreated sewage along with rain runoff from streets, roofs, and yards.
How can we make our cities function hydrologically more like forests?

Make this…

Work like this
The solution: “Low Impact Development”
= “Green Stormwater Infrastructure”, required in new Seattle code
= “Natural Drainage Systems” in City projects
= “Rain Wise” for homeowner retrofits

Protect watersheds by managing stormwater upstream, on each site.

Try to restore pre-development site hydrology, through distributed on-site detention and infiltration.

Rainfall:
- slow it
- spread it
- filter it
- soak it in.

Manage stormwater on-site!

green roofs (on new construction)
trees
compost-amended soil
rain garden

driveway with grass center
rock-filled trench
permeable pavers
cistern
Why We Need Low Impact Development around Puget Sound

• Protect our streams, lakes, & Puget Sound
  – Fish & wildlife habitat
  – Watershed hydrology
  – Water quality

• Reduce stormwater infrastructure costs
  – CSO reduction
  – Flood protection
  – Water quality treatment

• Reduce both flooding and drought damage

• Make our communities more attractive & livable
The Rain Wise Toolbox in Seattle for homeowner stormwater retrofits

- Focus of current incentives
- Cisterns
- Rain Gardens
- Learn more: www.seattle.gov/util/rainwise
Before you build:
Locating and Planning a Rain Garden

David McDonald, Seattle Public Utilities
Installing Rain Gardens & Cisterns Trainings for contractors  www.seattle.gov/util/rainwise

Plants that fit soil conditions
Runoff from roof or driveway, flowing into yard or through ditch or pipe. Inflow higher than overflow.

- Ponding depth (6" to 12" inches)
- Mulch layer
- Rain garden soil mix
- Overflow (rock-lined to prevent erosion)
- Rain garden soil mix (12" to 24" inches deep)
  1/3 compost, 2/3 soil
Refer to Rain Garden Handbook & Seattle Flow Control Manual

- **Rain Garden Handbook for Western Washington Homeowners** has complete “how to” except sizing chart not appropriate for Seattle.
- Seattle RainWise sizing: see next slide
- Code-required bioretention project sizing: refer to Seattle Stormwater Code:
  
  **Volume 3 – Flow Control and Water Quality Treatment Technical Requirements Manual, Chapter 4 – Flow Control Design**

  **Table 4.5 “Flow Control Sizing Factors for Pre-Sized Approach”**

  Look under “Bioretention Cell” for rain gardens with 2-inch, 6-inch, or 12-inch ponding depths on soils with infiltration rates of $\frac{1}{4}$, $\frac{1}{2}$, or 1 inch per hour.

- Both linked from [www.seattle.gov/util/rainwise](http://www.seattle.gov/util/rainwise)
Sizing Factor from tables gives the **bottom area** of rain garden – add side-slope width to get top area

Example: Site with 0.25”/hr infiltration rate.
Sizing Factor from table (for 6” ponding depth) is 7.4% (.074)
500 SF roof area X .074 = **37 sf bottom rain garden area** (or about 6’x6’)

To convert to **top** rain garden area, add slope grading for 10” minimum depth (the 6-inch ponding depth plus 4” inch minimum freeboard). At 2.5H:1V side slope, add 10”x2.5 = 25” (~2 feet) around RG bottom area, = **100 sf top rain garden area**
Infiltration ("perc") on-site test

1) Dig hole 24 inches deep, add stake with ruler
2) Fill with hose, let drain completely
3) Repeat fill-&-drain (may take overnight)
4) Third time fill only to 12” from top:
   - Measure water height every hour
   - Continue until rate of fall stabilizes (same amount of fall for 2-3 hours)
   - Use that as the infiltration rate (inches/hour)

Results:
< 0.25 in/hr: use 0.25 RG size in table
> 1.0 in/hr: use 1.0 in/hr RG size in table (can’t make RG size smaller)

If you hit hardpan within 24” don’t build there!
Rain Garden Location

– Don’t locate ☑

☑ Over underground utilities – call 1-800-424-5555 for free utility location service or www.callbeforeyoudig.com

☑ Over major tree roots

☑ In soggy areas (water table at surface in winter)

☑ Within 300 feet of steep slopes or landslide-prone areas (500 ft. setback for code-required bioretention projects)
   – Enter your site on RainWise Tools website to see critical areas, or see DPD map showing steep slope & landslide areas at http://web1.seattle.gov/dpd/dpdgisv2/mapviewer.aspx
   – Consult a geotechnical engineer if in doubt

☑ Within setback limits from buildings:
   – 5 ft. minimum from all buildings
   – 10 ft. min. from buildings with basements. Add 2 ft. more setback for each foot that basement extends below 5 feet.
Rain Garden Location

- Do locate

- On a fairly level site – up to 5% slope (1ft. drop in 20 feet)
- On site big enough for required bottom area (from sizing table) plus width of side slopes (depending on depth & freeboard)
- Where roof (or driveway) runoff will flow downhill to the rain garden through a pipe, swale (shallow ditch) or overland
- Where overflow (in a big storm) will flow downhill to street drains
- Where it will look good.
Sizing to allow for side slope width (depending on ponding depth and freeboard)

- Side slopes must be max. slope of 2.5H:1V (2½ inches horizontal run per 1 inch vertical rise), and
- Require minimum 4 inches of vertical freeboard from overflow height (which determines ponding depth) to top of slope,
- So to compute top size for:
  - **6-inch ponding depth** + 4 inches of freeboard = 10 in. vertical rise, so add 10”x2.5 = 25 inches (~2 ft.) to bottom width all around
  - **12-inch ponding depth** + 4 in. freeboard = 16 in. rise, so add 3½ ft. (16” x 2.5 = 40 inches) to bottom width all around

Ponding depth is determined by height of overflow. Must have **4 inches minimum freeboard** above overflow height to top of berm
Simple layout method, to see where RG will fit in existing landscape

- Start with required bottom size (square feet) from sizing table
- Make that size into a square (take square root of bottom size)
  - Example: 100 sf bottom area as a square is 10 ft x10 ft
- Add side slopes to get top dimensions as square
  - 6 in. ponding depth + 4 in. freeboard at 2.5:1 slope
    = 25 in. (~2 ft.) side slope width all around, so
  - 10’x10’ bottom needs 14 ft x 14 ft top width
- Calculate perimeter of square (side length x 4)
  - 14 ft side length x 4 = 56 ft. perimeter
- Mark a rope or hose to that length, tie it in loop
- Use that loop to try RG layouts and shapes in different locations in yard
  (works for oval or bean shapes).
Planning the inflow

- Downhill (≥ 2% slope) from downspout or driveway contributing area
- Convey inflow by:
  - Underground pipe (connected above-ground to downspout),
  - Shallow swale (with grass or vegetation), or ditch filled with drain rock

Runoff from roof or driveway, flowing in over yard or through ditch or pipe. Inflow higher than overflow

Plants that fit soil conditions

Ponding depth (6” to 12” inches)
Mulch layer
Rain garden soil mix
Overflow (rock-lined to prevent erosion)
Rain garden soil mix (12” to 24” inches deep)
1/3 compost, 2/3 soil
Planning the overflow

• In big storms, rain garden may overflow – plan for it!
• Rock line overflow area to prevent erosion
• Should disperse onto landscape minimum of 3 ft. away from sidewalks or alleys – disperse with rock or gravel level spreader (see Detail sheet #8 on website)

Runoff from roof or driveway, flowing in over yard or through ditch or pipe. Inflow higher than overflow

Plants that fit soil conditions

Bioretention soil mix

12-24 " deep

Must have 4 inches min. freeboard above overflow height to top of berm

Disperse overflow into landscape
Excavation, Soil Work, Grading, and Planting Rain Gardens

David McDonald
Seattle Public Utilities
Installing Rain Gardens & Cisterns
Trainings for contractors, March 30, 2010

www.seattle.gov/util/rainwise
Over-excavate, to depth of amended soil

Excavate to:

- ponding depth (usually 6 in.)
- plus 4 in. minimum freeboard
- plus 12 inches min. for amended soil
- = 22 inches minimum excavation depth
Use a transit and/or level – *Your eye won’t tell you what’s level!*

- Bottom must be flat & **level**, so water spreads over whole area
- Inlet higher than overflow
- Overflow at **lowest** point on edge
- Compact berm around edges, minimum 4” inches higher than overflow
Import bioretention soil

- Haul off excavated native soil
- Backfill with “bioretention soil” mix (35% compost / 65% coarse sand per SPU specification – currently only available from Cedar Grove)
- Place in 6-inch lifts, wetting each lift to settle if possible.
Compost and bioretention soil quality

- **Compost**: ½ or ¾ inch screened
  - from WA permitted composting facility see list in Building Soil manual at www.BuildingSoil.org
  - Additional quality assurance if producer is certified by US Composting Council “STA” (Seal of Testing Assurance) program
  - Your nose can tell: should smell like forest floor, not stinky ammonia, neither sticky wet nor dusty dry

- **Bioretention soil**: 35-40% compost, 60-65% coarse sand
  - Same compost quality
  - Coarse sand, **few fines**: less that 5% passing #200 sieve
  - Bioretention soil spec at www.seattle.gov/util/GreenInfrastructure
  - Available from Cedar Grove Compost, likely other suppliers soon
Grading the rain garden soil

- Level the bottom (use 2x4 with level)
- Form side slopes at 3H:1V slope (3 inches horizontal run per 1 inch vertical rise)
- Settle RG soil by saturating with water
  - Or boot pack, but don’t machine compact!
  - Use water to find final level grade
- Use native soil to compact into a berm on down-slope edge (if needed to fit site slope)
- Haul away leftover native soil

photo from “Rain Gardens” article by Emily Bishton at www.IPMopedia.org
**Inflow** higher than overflow, options:
- vegetated swale
- ditch filled with rock
- 3 in. underground pipe

**Overflow**:
- min. 4 in. below top of berm
- determines ponding height
- rock-lined edge
- rock spreader to disperse water into landscape, min. 10 ft. from buildings, 3 ft. from sidewalks

**Piped Inflow** – higher than overflow level
- 3" diameter schedule 40 PVC pipe, see standard plan 209 for pipe bedding
- extend pipe at least 2' out of rain garden surface
- 1.5” washed gravel placed at outlet of rain garden surface

**Vegetated Swale Inflow**
- Plants that tolerate periodic inundations of water
- Plants for drier conditions
- 3” compost
- Compost amended soil in place
Plant Selection for Rain Gardens

- Two Planting Zones:
  - Zone 1 (Bottom): wet-loving plants
  - Zone 2
    - Sides: wet & dry tolerant plants
    - Top (Zone 3 in RG Handbook): dry-tolerant plants – grass, shrubs, trees
Plant Selection Criteria for Rain Gardens

- Right Plant Right Place
- Low maintenance – Plants reach a mature height with minimal pruning (fit plant size to site – plants grow bigger in compost!)
- Wildlife Habitat Potential – Berries, nuts and flowers
- Mix of evergreen and deciduous plants
- Flowers
- NW Natives
- Availability (Easy to find and/or replace)
- Tough and hardy in our climate and growing conditions
Examples

Zone 1
- Carex obnupta – slough sedge
- Cornus stolonifera ‘Isanti” – dwarf red-twig dogwood
- Juncus patens – grooved rush

Zone 2
- Arctostaphylos uva-ursi – kinnikinnik
- Erica sp. – various heaths
- Polystichum munitum – sword fern
Rain Garden Plant Lists

- City of Seattle Green Factor Plant List “Bioretention Zone”
- Rain Garden Handbook (3 Zones)
- SPU Streetside Rain Garden Plant List (2 Zones)

All linked from:
- www.seattle.gov/util/rainwise
- www.rainwise.seattle.gov
Plant Spacing, & Best Planting Times

**Space plants** according to their mature size. Plants in rain gardens grow fast!

- 3 ft. O.C. is typical for perennials and small shrubs
- 12 in. O.C. for ground covers
- Plant ground covers 1 ft. away from sidewalk edge
- Plant shrubs 2 ft. away from sidewalk & driveway edges

**Best Planting times**

- Early fall (Sept.- Oct.) needs least irrigation
- Spring once soil warms – provide summer irrigation
- Avoid planting July & Aug. or water daily
- All plantings will need water through first summer season, and hot-dry-weather watering for first 2-3 years
Finish with a Mulch Layer

- Place 2”- 4” arborist wood chips on upper zone and slopes
- If the rain garden regularly fills, use compost as the mulch in the bottom zone, because it doesn’t float

Can mulch and then plant, or plant and then mulch, but don’t mix mulch into planting hole
Learn more about rain garden details and design examples

- Rain Garden summary factsheet
- *Rain Garden Handbook*
- Design specs, photo examples, and locations for field visits to City projects on [www.seattle.gov/util/greeninfrastructure](http://www.seattle.gov/util/greeninfrastructure)
- Locations to see rain gardens on private property and more resources on RainWise Tools, [www.rainwise.seattle.gov](http://www.rainwise.seattle.gov)

All linked from [www.seattle.gov/util/rainwise](http://www.seattle.gov/util/rainwise)