Raingarden, Bioswale & Infiltration Garden Design

Design construction and maintenance

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Other sources and manuals
Bioretention (Rain Gardens)

Minimum Measure: Post-Construction Stormwater Management in New Development and Redevelopment

Subcategory: Filtration

Description

Bioretention areas, or rain gardens, are landscaping features adapted to provide on-site treatment of stormwater runoff. They are commonly located in parking lot islands or within small pockets of residential land uses. Surface runoff is directed into shallow, landscaped depressions. These depressions are designed to incorporate many of the pollutant removal mechanisms that operate in forested ecosystems. During storms, runoff ponds above the mulch and soil in the system. Runoff from larger storms is generally diverted past the facility to the storm drain system. The remaining runoff filters through the mulch and prepared soil mix. The filtered runoff can be collected in a perforated underdrain and returned to the storm drain system.

Applicability

Bioretention systems are generally applied to small sites and in a highly urbanized setting. Bioretention can be applied in many climatological and geologic situations, with some minor design modifications.
Join the Association of Watershed and Stormwater Professional (AWSPS)

For an introductory membership price of $219, members who sign up will get:

- Two issues of our journal, *The Watershed Bulletin (WSB)*, (due out Fall 2010 and Spring 2011)
What is a Rain Garden?

A rain garden is a garden which takes advantage of rainfall and stormwater runoff in its design and plant selection. Usually, it is a small garden which is designed to withstand the extremes of moisture and concentrations of nutrients, particularly Nitrogen and Phosphorus, that are found in stormwater runoff. Rain gardens are sited ideally close to the source of the runoff and serve to slow the stormwater as it travels downhill, giving the stormwater more time to infiltrate and less opportunity to gain momentum and erosive power.

On the surface, a rain garden looks like an attractive garden. It may support habitat for birds and butterflies, it may be a formal landscape amenity or it may be incorporated into a larger garden as a border or as an entry feature. What makes it a rain garden is in how it gets its water and what happens to that water once it arrives in the garden.

Below the surface of the garden, a number of processes are occurring which mimic the hydrologic action of a healthy forest. Soils are engineered and appropriate plants selected for the rain garden. The garden is a small bioretention cell in which stormwater is cleaned and reduced in volume once it enters the rain garden. Nitrogen and phosphorus levels and overall sediment loads in the stormwater are reduced by the action of the plants and...
Infiltration and Evapotranspiration, Volume and Peak Reduction BMP’s

- Infiltration basin
- Subsurface infiltration bed
- Infiltration trench
- Rain Garden / Bioretention
- Vegetated constructed filter
- Vegetated swale
- Vegetated filter strip
- Infiltration berm
Rain Garden / Bioretention bed

• Flexible in size and infiltration dynamics
• Provides medium volume reduction, medium to high recharge, low to medium peak rate control, medium to high water quality functions
• Suitable for Residential, Commercial, Urban, Industrial, Retrofit, and Highway/Road
Rain Garden / Bioinfiltration
Design and Construction

- Site analysis
- Design
- Construction
- Maintenance
Site analysis

• Design goals - disconnect impervious surfaces
  – Roof tops
  – Paved areas

Source: VA DCR STORMWATER DESIGN SPECIFICATION NO. 1
Site analysis

- Rain gardens mimic natural shallow ponding areas (Depression storage) frequently found in our landscapes.
- Ponding depth limited to 12” or less - usually 4-8”
- Should drain fully in less than 72 hours - 2-4 hours is recommended.
Site Analysis

• Aesthetic and social considerations
• Slope, erosion, ponding, wet areas
• Exposure
• Soils
• Existing landscape
• Existing hardscape and utilities
Well
Septic Tank
Downspout
Leech Field
Drywell
Driveway
Never put a rain garden too close to the building unless it is lined and under-drained
Planters or foundation planters
Never put a rain garden too close to wells, drywells or septic systems or active cisterns.
Don’t put them in large drainage ways or swales that are part of a development, these conveyance systems have been engineered and modifications will affect their capacity.
Don’t try to build them by diverting municipal owned storm drain flow without the municipality’s permission (written approval)
Well
Septic Tank
Downspout
10 ft min
Drywell
Leech Field
Driveway
Well
To reduce stormwater impact its best if you can change a downspout that goes directly to an impervious area to your rain garden.

Figure 1.3. Residential Rooftop Disconnection – Section View:

a) Simple Disconnection to downstream Rain garden
b) Disconnection – Alternative Practice: Compost Amended Flow Path to downstream Rain garden

Source: VA DCR STORMWATER DESIGN SPECIFICATION NO. 1
Summary: The siting of rain gardens should consider:

Source of water - downspouts < 30 ft – 50 ft

Soils and geology – not where ponding currently happens for extended periods (mottled/gleyed soils)

Topography – max 10% - 12% slopes, look for existing low or flat spot

No closer than 10 ft to the house, or 100 ft if located upslope of a house

Keep at least 50 ft away from septic system

Keep at least 100 ft away from well

Keep the bottom at least 2 ft above limiting zones
Soils
Type
Drainage
Depth

Planting Soil depth should be at least 18”
Site Analysis / Rain Garden Design

- Lined or unlined
- Under-drained or self contained

Source: Prince George's County Bioretention Manual
Areas that currently infiltrate well.
Limit soil disturbance
Unlined - self contained

- Underlying geology - Karst topography
  - Risk of failure
- Overflow outlet
Risk of failure
Unlined - under-drained

- Infiltration rate limited
- Depth to groundwater or compacted or impervious layer
Site Analysis / Rain Garden Design

- Unlined
- Under-drained
Site Analysis / Rain Garden Design

- Unlined
- Under-drained with added subsurface storage

Source: Prince George’s County Bioretention Manual
Site Analysis / Rain Garden Design

- Lined
- Under-drained

Source: Prince George's County Bioretention Manual
- High risk Karst
- Contamination risks
- High water table
Site Analysis - sizing a rain garden / bioretention

1. Determine a suitable place on the site and where you have a downspout - or other inputs.
2. Calculate the area of the roof or impervious surface that drains to the proposed site.
3. Assume a design standard for precipitation - 1” is probably good enough unless there are policy or code considerations.
4. Compute the design runoff volume, which is equal to the impervious area times the precipitation depth.
5. Decide on a ponding depth for the rain garden / bioinfiltration.
6. Divide the runoff volume by the depth of the garden, this equals the area needed for the garden.
7. Determine if the garden will fit where you want it. Modify as needed.
Sizing a rain garden or bioretention - why 1”?

1. We receive about 0.5” of rainfall every 2 weeks, which generates about 0.35” of runoff from impervious areas.

2. We receive about 1.0” of rainfall every 2 months, which generates about 0.8” of runoff from impervious areas. - (80-90% of events)

3. We receive about more than 2.0” of rainfall only about once a year, which generates about 1.8” of runoff from impervious areas.
• Impervious surface to Garden area - limited to 5:1
• Overall drainage area limited - epa suggests less than 5 acres
Sizing the rain garden calculations

Roof area = length x width = 50 ft x 12.5 ft = 625 sq ft

Precipitation = 1” = 1”/12 = 0.083 ft

Runoff volume = 625 sq ft x 0.083 ft = 52 cf

Using a 6” deep rain garden = 0.5 ft

Area of rain garden = 52 cf / 0.5 ft = 104 ft

Check that the size works, or determine if the assumptions can be modified
Sizing the rain garden calculations

Roof area = length x width = 50 ft x 12.5 ft = 625 sq ft

Precipitation = 5” = 5”/12 = 0.415 ft

Runoff volume = 625 sq ft x 0.415 ft = 259 cf

Using a 6” deep rain garden = 0.5 ft

Area of rain garden = 259 cf / 0.5 ft = 519 sf

Rain garden gets large very quickly when dealing with larger design storms
Rain garden / bioretention design

- Concept
- Templates - template modification or original design

Low impact development center (lowimpactdevelopment.org)
Inlets
Outlets
Construction:

- Kill the grass for ease of removal
- Excavate - limit disturbance to subsoil
- Line if desired
- Add gravel storage bed or under-drain if needed
- Amend the soils (if required)
- Plant (watering may be necessary to promote establishment)
- Install mulch
Determining slope and leveling

Slope less than 10-12% is desirable

\[ \text{Slope} = \frac{\text{Height}}{\text{Length}} \times 100 = \frac{1 \text{ ft}}{10 \text{ ft}} \times 100 = 10\% = \text{OK} \]
The bottom of the rain garden should be level.

Keep the side slopes as gentle as possible to make aesthetically pleasing with a maximum of 3:1.
Irrigation may be needed during the first year
Weeding, pruning, mulching
Salt and other road applied materials
Plant selection

★ Plants that are easy to grow, relatively low maintenance, and appropriately sized.

★ Perennials
  - Annuals that can reseed
Plant Selection

• Adapted to a range of soil conditions
• Adapted to a range of moisture conditions
• Salt and pollution tolerant
Plant Selection

- Plants that may provide other ecological services
  - Forage for birds, insects, animals
  - Shelter or habitat for birds, insects, animals
Plant selection

- Native or non-native?
- Potential for invasiveness
- Trees, shrubs, herbaceous forbs

Most rain gardens are fairly small so it is important to remember scale.
Plant lists:

- http://www.lowimpactdevelopment.org/rain
garden_design/plant_lists.htm
- http://www.rainscaping.org/index.cfm/fuse
  action/plants.main/typeID/37/index.htm
- http://www.newfs.org/grow/buy-native-
  plants/rain-garden-plant-list-
suggestions.htmldownloads/SuffolkCounty
  VAAppc6-2Plants4SW.pdf