

## Summary Fact Sheet

**Category:** 1.0 Bioretention Systems

**Practice:** 1.1 Bioretention Basins

**General Description:** Bioretention basins are used to reduce the runoff volume and peak discharge rates for small, distributed drainage areas by providing a combination of surface ponding and subsurface storage. They have a greater storage capacity than bioretention cells (see fact sheet 1.2).

Bioretention basins are small-scale, shallow vegetated depressions that provide source control of runoff by rapid filtering through bioretention soil media, biological and chemical reactions in the soil matrix and root zone, infiltration into the underlying subsoil, and retention and detention storage. Properly constructed bioretention basins replicate the ecosystem of an upland forest floor through the use of specific shrubs, trees, groundcover, mulch, and soils. By intercepting, detaining, and infiltrating runoff, bioretention basins reduce the energy of stormwater flows and reduce on-site erosion. They may be designed on-line or off-line from the primary stormwater conveyance system.

### Water Quantity Controls

Bioretention basins can be used to meet minimum retention and detention requirements for Fairfax County, e.g. control of the 2-year, 2-hour and 10-year, 2-hour storms. It is important to emphasize, however, that the drainage areas for bioretention basins should be small and distributed. Stormwater can be stored through surface ponding and through storage in the soil and gravel layers. The voids in these layers provide stormwater storage capacity. The depths of the layers are sized to meet storage requirements.

Exfiltration into the subsoil can potentially reduce the volume of stormwater that ultimately enters the conveyance system. The amount of volume reduction depends on the available storage in the gravel layer and ponding area, the maximum flow rate into the subsoil, and the flow rate into the basin, which is related to the storm intensity and drainage area size. Additional information is provided in PFM section 6-1300 and in Virginia Stormwater Management Handbook Standard and Specification 3.11.

### Water Quality Controls

Phosphorus removal efficiencies for bioretention basins are set by Fairfax County as follows:

- 50% removal for basins that capture 0.5" of runoff from the impervious area
- 65% removal for basins that capture 1.0" of runoff from the impervious area

The 50% removal rate will generally be met if the basin is sized to control the 2-year, 2-hour and/or the 10-year, 2-hour storm.

**Location:** Bioretention basins are appropriate for use in commercial, residential, and industrial areas. Potential applications include median strips, parking lots, and residential developments. Bioretention basins should not be located in areas of high sediment loads or where the site is not entirely stabilized.

**Design Construction and Materials:** Bioretention basins are excavated to a minimum depth of one (1) to three (3) feet, depending on the infiltration rate and depth to the seasonal high

groundwater table or bedrock. Deeper excavation can provide for additional storage in the soil or gravel layers, or additional surface ponding.

Underdrains are recommended in areas with low subsoil permeability (e.g. compacted or clay soils) or shallow soil profiles. Underdrains must tie into an adequate conveyance system. Observation/cleanout wells should also be installed if underdrains are used.

A gravel layer provides temporary storage of stormwater, which will exit through an underdrain (if present) and/or through exfiltration into the subsoil. If an underdrain is present, the gravel layer surrounds the underdrain pipe to minimize the chance of clogging. The excavated area is then filled with an engineered media classified as “sandy loam” or “loamy sand” that typically consists of:

- 50% sand
- 30% planting soil with minimal clay content, and
- 20% shredded hardwood mulch.

The area is then mulched and planted with shrubs, perennials, grasses, and small trees. A surface or subsurface control structure (e.g. a riser) can be used to control the basin’s discharge rate for the design storm(s). This structure must also include a high flow bypass. Bioretention basins typically consist of the following cost components.

Item	Unit	Estimated unit cost (2005 Dollars)
Excavation	C.Y.	\$8 - \$10
Bioretention media	C.Y.	\$40 - \$60
Filter fabric	S.Y.	\$1 - \$5
Gravel	C.Y.	\$30 - \$35
4" dia. perforated underdrain pipe	L.F.	\$8 - \$15
Plants	Ea.	\$5 - \$20
Mulch	C.Y.	\$30 - \$35

Depending on space constraints and drainage area characteristics, a pretreatment device, most commonly a vegetated filter strip, can be provided to intercept debris and large particles. A minimum two (2) to four (4) foot clearance must be maintained between the bottom of the basin and the seasonal high groundwater table or bedrock, dependent on the soil structure, water table, and other environmental conditions of the site.

**Cost:** The cost for a bioretention basin to treat runoff from ½ impervious acre is comprised of both the installation cost and annualized costs. These cost calculations were based upon a bioretention cell with a surface area of 900 ft<sup>2</sup>, sized to treat the first 0.5" of runoff. A 50% contingency was added to the installation and replacement costs to roughly account for the additional excavation and materials needed to provide storage for larger storm events. A bioretention basin is assumed to have a lifespan of 25 years, at which point it will be removed and replaced.

Item	Required Cost per Year (2005 Dollars)													
	0	1	2	3	4	5	6	7	8	9	10	...	25	
Installation <sup>1</sup>	15,000													
Mulching and Debris Removal		350	350	350	350	350	350	350	350	350	350			
Replace Vegetation		200	200	200	200	200	200	200	200	200	200			
Remove & Replace														15,000
<b>Total Cost</b>	<b>15,000</b>	<b>550</b>	<b>550</b>	<b>550</b>	<b>550</b>	<b>550</b>	<b>550</b>	<b>550</b>	<b>550</b>	<b>550</b>	<b>550</b>			<b>15,000</b>
Annualized Cost	\$1,125 / year (includes replacement in year 25)													

<sup>1</sup>Developer Cost. Not included in annualized cost.

**Maintenance:** The primary maintenance requirement for bioretention basins is to inspect the treatment area's components and repair or replace them if necessary. Generally, maintenance is the same as the routine periodic maintenance that is required of any landscaped area. Removal of accumulated sediment and debris, replacement of any dead or stressed plants, and replenishment of the mulch layer is recommended on an annual basis. Any eroded areas should be repaired as soon as they are detected. The control structure should be inspected regularly for clogging and structural soundness.

**Performance and Inspection:** To ensure proper performance, visually inspect that stormwater is infiltrating properly into the bioretention basin. Water ponding in a bioretention basin for more than 48 hours may indicate operational problems. Corrective measures include inspection for and removal of accumulated sediments. Backflushing the underdrain is another option. Samples of the bioretention media should be taken in the case of poor infiltration to determine the condition of the media (e.g. clay content). Full or partial replacement of the bioretention media may be required to restore the flow rate through the basin. Alternately, soil amendments can first be applied in an attempt to restore permeability. Perform this inspection:

- o annually in spring, and
- o after extreme events (e.g. after hurricanes).



**Bioretention Basin Example**  
Source: LID Center

**Potential LEED Credits**

Primary: Sustainable Sites – Credit 6 “Stormwater Management” (1-2 Points)  
Other: Sustainable Sites – Credit 7 “Landscape & Exterior Design to Reduce Heat Islands” (1-2 Points)  
Water Efficiency – Credit 1 “Water Efficient Landscaping” (1-2 Points)  
Innovation & Design Process (1-4 Points)

**Links to Additional Information:**

Fairfax County PFM:

<http://www.co.fairfax.va.us/dpwes/publications/pfm/6.htm>

Fairfax County Letters to Industry:

[http://www.co.fairfax.va.us/dpwes/publications/LTI\\_archive.htm](http://www.co.fairfax.va.us/dpwes/publications/LTI_archive.htm)

USEPA Office of Water:

<http://www.epa.gov/OW-OWM.html/mtb/biortn.pdf>

Natural Resources Defense Council, 2001: Stormwater Strategies: Community Responses to Runoff Pollution.

<http://www.nrdc.org/water/pollution/storm/stoinx.asp>

United States Environmental Protection Agency, 2000: Bioretention applications: Inglewood Demonstration Project, Largo, Maryland, and Florida Aquarium, Tampa, Florida. Office of Water, Washington, D.C., EPA-841-B-00-005A

U.S. Environmental Protection Agency, 1995: Maryland developer grows 'Rain Gardens' to control residential runoff. Nonpoint Source News-Notes, 42 (August/September)

<http://www.epa.gov/NewsNotes/issue42/urbrnf.html>

Virginia Stormwater Management Handbook

<http://www.dcr.virginia.gov/sw/stormwat.htm>