**PDHonline Course C316 (4 PDH)**

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# Designing Bioretention Facilities

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# Landscaping Integrated Management Practices

***Description:*** The IMPs presented in this chapter cover a range of practices that can be made part of the landscaping plan for a site. Through sedimentation, infiltration, filtering, and grading, these practices were developed to enhance the quality and reduce the quantity of stormwater runoff using landscaping features. Site specific conditions such as slope, soil type, drainage area, and site constraints must be considered in the selection of a suitable control option. Vegetation used for landscaping must be tolerant of the hydrologic regime. For example, some IMPs discussed in this chapter expose vegetation to conditions that are continuously or intermittently wet.

***Purpose:*** To create on-site, self-supporting management systems using native vegetation to reduce the quantity and enhance the quality of stormwater runoff. The use of these IMPs can help preserve a site's natural hydrologic features such as groundwater recharge and stormwater runoff volumes.

***Applicability:*** Landscaping IMPs can be applied in existing and newly developed sites including residential, commercial, industrial and transportation land uses.

***Benefits:***

- Improvements in water quality
- Maintenance of downstream stream stability
- Self-supporting landscapes naturally adapted to the frequency and duration of stormwater inputs and site conditions
- Reductions in the need for and size of conventional stormwater management systems

***Examples of Applicable IMPs:***

- Bioretention
- Preservation and re-vegetation of riparian buffers
- Backyard water gardens
- Wetlands restoration and enhancement

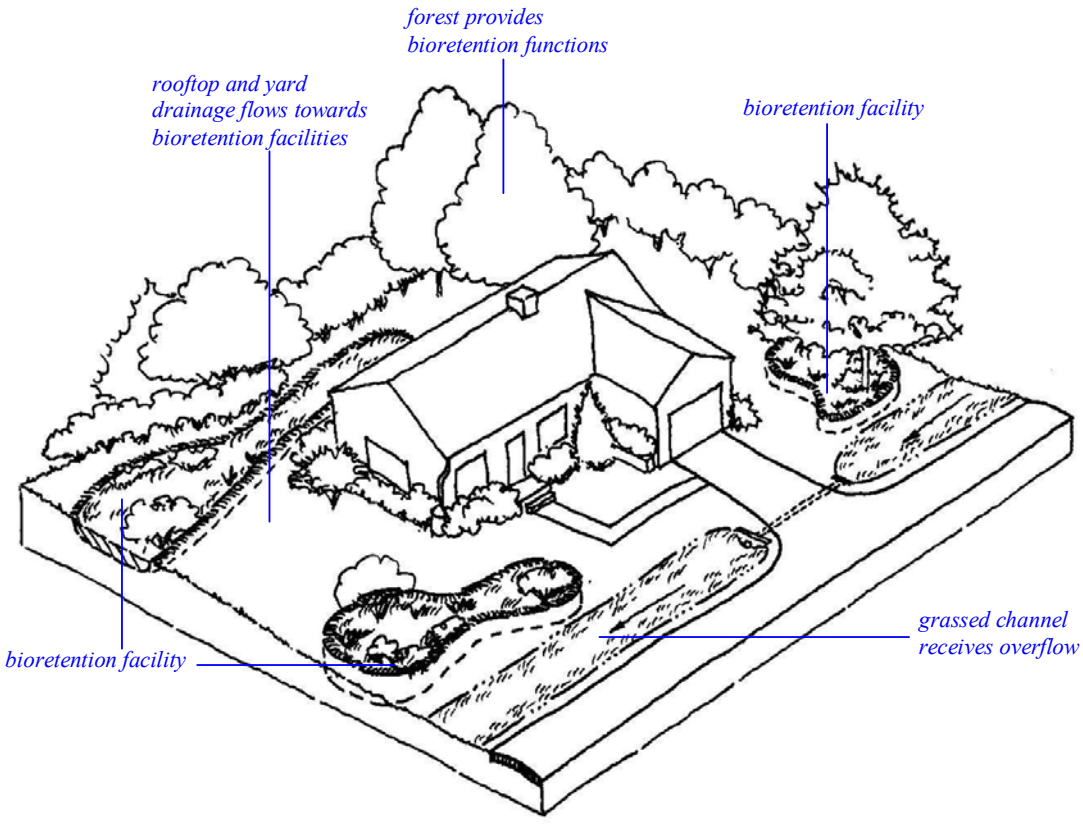
# Bioretention

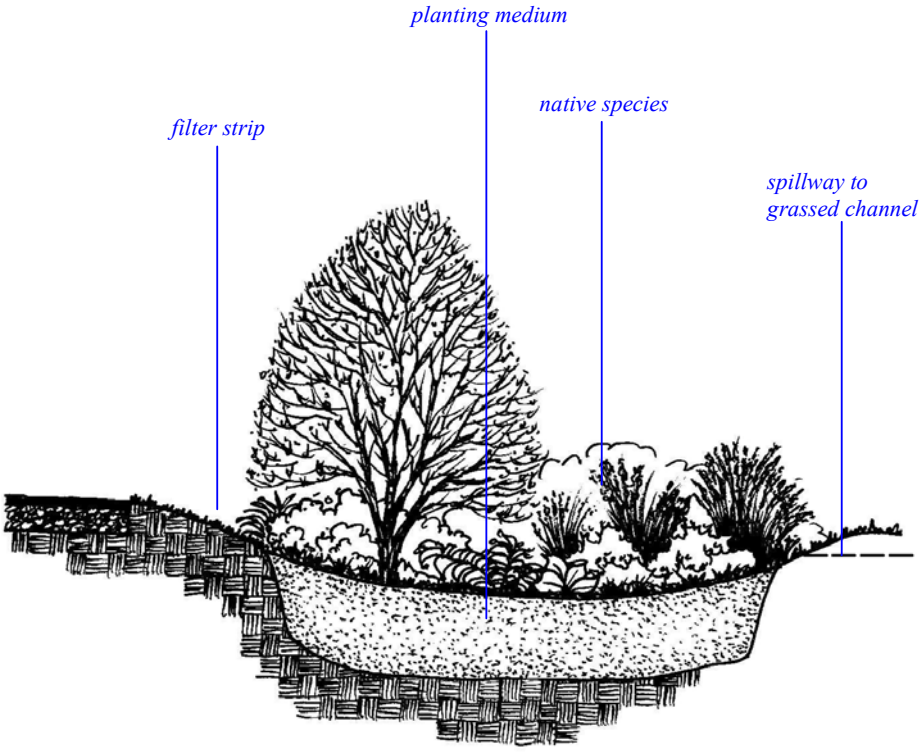
## Description:

Bioretention systems are shallow, landscaped areas used primarily for the water quality treatment of stormwater. Water quality is improved through filtration, sedimentation, and biological processes. Bioretention systems may also be sized to meet water quantity control requirements. Off-line systems capture all of the stormwater from small storms and the initial stormwater flow from larger storms. Temporary shallow ponding occurs in these systems while the remaining flow from large storms is by-passed to other stormwater management systems. Off-line bioretention can be constructed along curbs or to receive overflow from channels.

## Design Characteristics:

Bioretention areas can have almost any shape and size. The sites are landscaped with a variety of native water-tolerant plants including trees, shrubs and herbaceous vegetation. Flow is diverted using deflectors or other devices to intercept flowing runoff. Excess flow






bypasses the facility. To reduce the possibility of clogging by fine sediments, stormwater can pass through a grass filter prior to entering the bioretention area. If stormwater flows are concentrated, a dispersion trench is used to slow and spread out flows prior to entering the grass filter. Space limitations may preclude the use of filters or dispersion trenches.

### Applicability:

These types of bioretention systems can be used in almost any type of land use or in-situ soil. Off-line bioretention is particularly well suited for retrofitting existing development where space is restricted and grade adjustments are difficult. Where adverse slopes are present, a pipe below grade may be used to supply water to the area. The reduction in water requirements for plants in these systems eases maintenance and makes this technique particularly attractive for parking lots and areas adjacent to roads. In areas where safety may be compromised if sight lines are blocked by tall vegetation, a short ground cover can be planted.

### Sources for Additional Information:

- Prince George's County (2001), *Bioretention Manual.*
- Maryland Department of the Environment (1999), *2000 Maryland Stormwater Design Volumes I & II.*

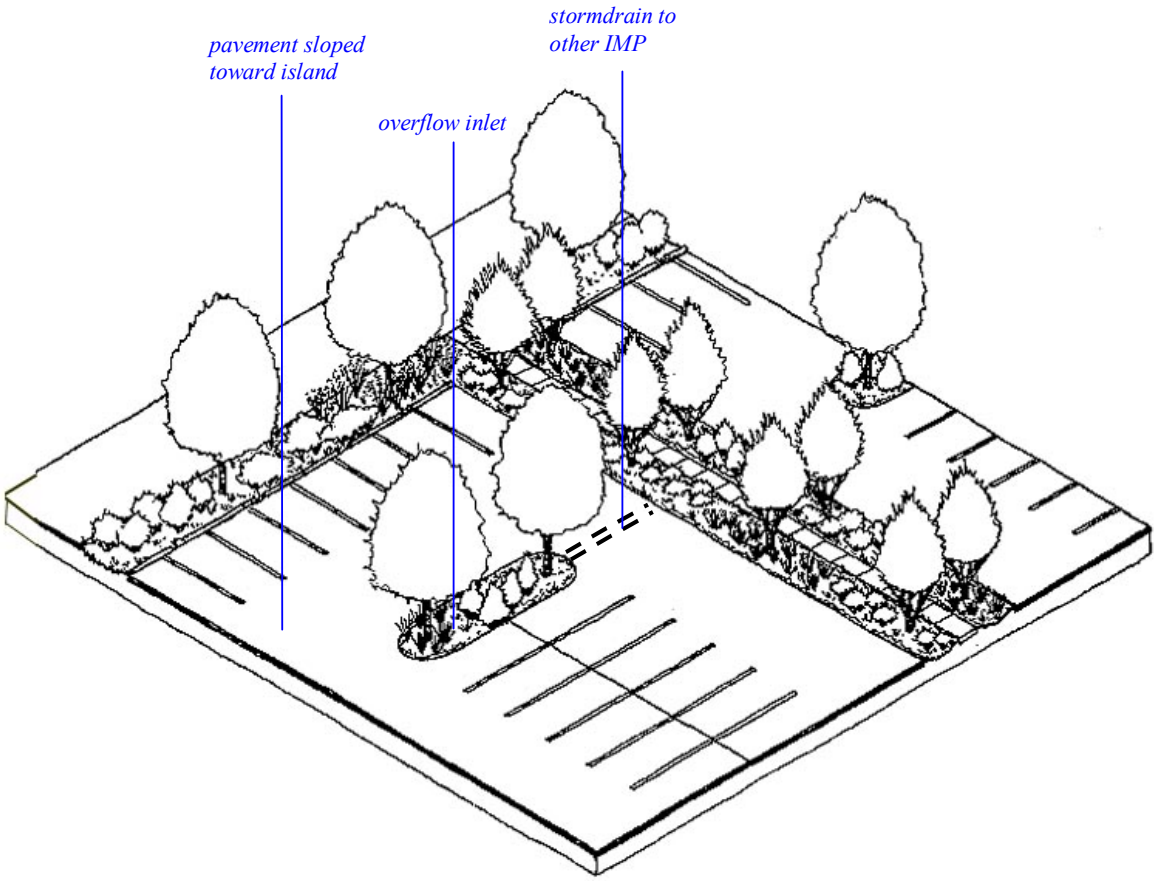
# Bioretention Islands

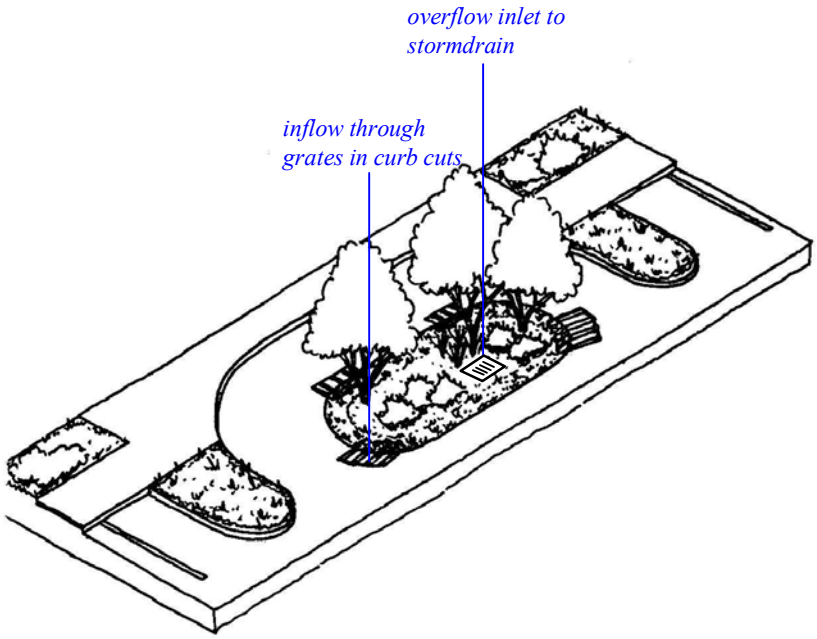
## Description:

Bioretention island systems are shallow, landscaped areas used primarily for the water quality treatment of stormwater. Water quality is improved through filtration, sedimentation, and biological and processes. Bioretention island systems may also be sized to meet water quantity control requirements. Bioretention can be implemented as "islands" receiving runoff from surrounding paved areas. These systems capture all of the runoff from small storms and the initial runoff from larger storms. Temporary shallow ponding occurs in these systems while the remaining stormwater flow from large storms can be by-passed or directed to other stormwater management systems.

## Design Characteristics:

Bioretention islands can have almost any shape or size; therefore, they can be adapted to many locations. In parking lot applications, they may look like long strips between rows of parking stalls. The sites are






landscaped with a variety of native water-tolerant plants including trees, shrubs and herbaceous vegetation. Runoff may need to be directed to the islands. Excess water either bypasses or flows through the facility. To reduce the possibility of clogging caused by fine sediments, stormwater can be passed through a grass filter prior to entering the bioretention area. If stormwater flows are concentrated, a dispersion trench is used to slow and spread out flows prior to entering the grass filter. However, space limitations may preclude the use of filters or dispersion trenches.

### Applicability:

These types of bioretention systems can be used in almost any type of land use or in-situ soil. Bioretention islands are well suited for the retrofitting of existing development where available space is limited and grade adjustments are difficult. Where there are adverse slopes, a pipe below grade may be used to supply water to the area. The reduction in water requirements for plants in these systems eases maintenance and makes this technique particularly attractive for parking lots, street intersections and paved areas adjacent to roads. In areas where safety may be compromised if sight lines are blocked by tall vegetation, a short ground cover can be planted.

### Sources for Additional Information:

- Prince George's County (2001), *Bioretention Manual.*
- Maryland Department of the Environment (1999), *2000 Maryland Stormwater Design Volumes I & II.*

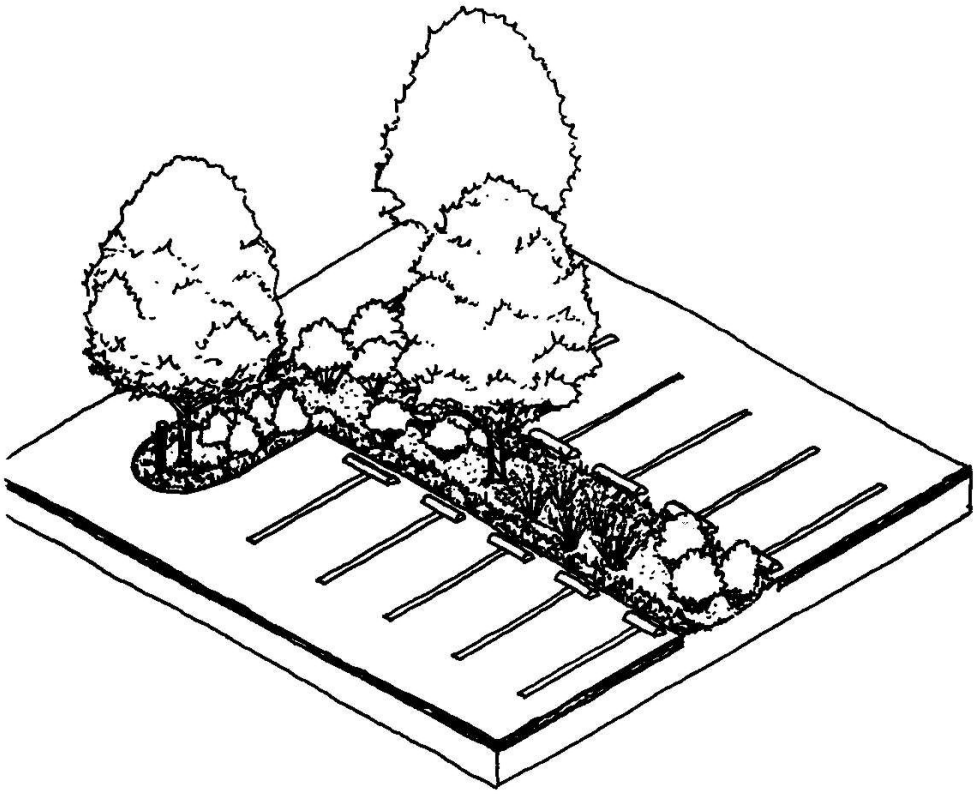
# Linear Bioretention

## Description:

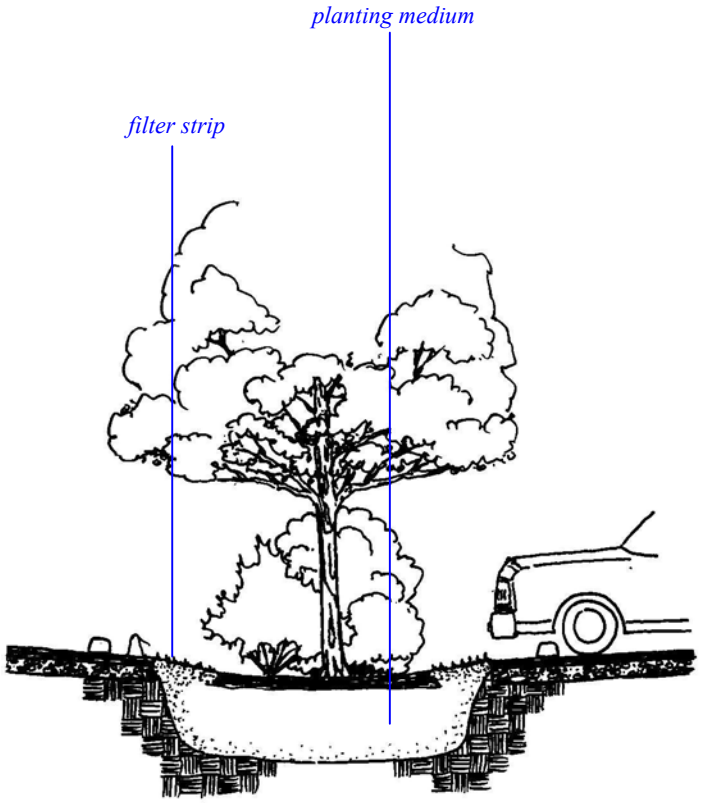
Linear bioretention systems are shallow, landscaped areas used primarily for the water quality treatment of stormwater. Water quality is improved through filtration, sedimentation and biological and processes. Linear bioretention systems may also be sized to meet water quantity control requirements. Off-line systems capture all of the stormwater from small storms and the initial stormwater flow from larger storms. Linear bioretention capture and treat runoff from features such as roads and parking lot perimeters. A portion of the water infiltrates and the excess flows through the facility.

## Design Characteristics:

Bioretention strips improve the water quality of runoff by enhancing infiltration, filtration, biological, and sedimentation processes. Landscaping is maintained by stormwater inputs reducing or eliminating the need for supplemental watering. The sites can be landscaped with a variety of native water tolerant plants including trees, shrubs and herbaceous vegetation. A grass filter strip may be



used to reduce the potential for clogging caused by fine sediments. A berm may be used to prevent excess runoff from entering front yards except perhaps at designated ponding areas. It may be necessary to install an underdrain to remove excess water and discharge it to another IMP or to the stormwater conveyance system.




## Applicability:

These types of bioretention systems can be used in almost any type of land use or in-situ soil. Bioretention strips are particular well-suited for the retrofitting of streets in existing development, provided that removal of the sidewalk leaves sufficient space. The reduction in water requirements for plants in these systems make them particularly useful for providing landscaping in areas adjacent to roads. In areas where sight lines may be blocked by tall vegetation, a short ground cover can be planted.

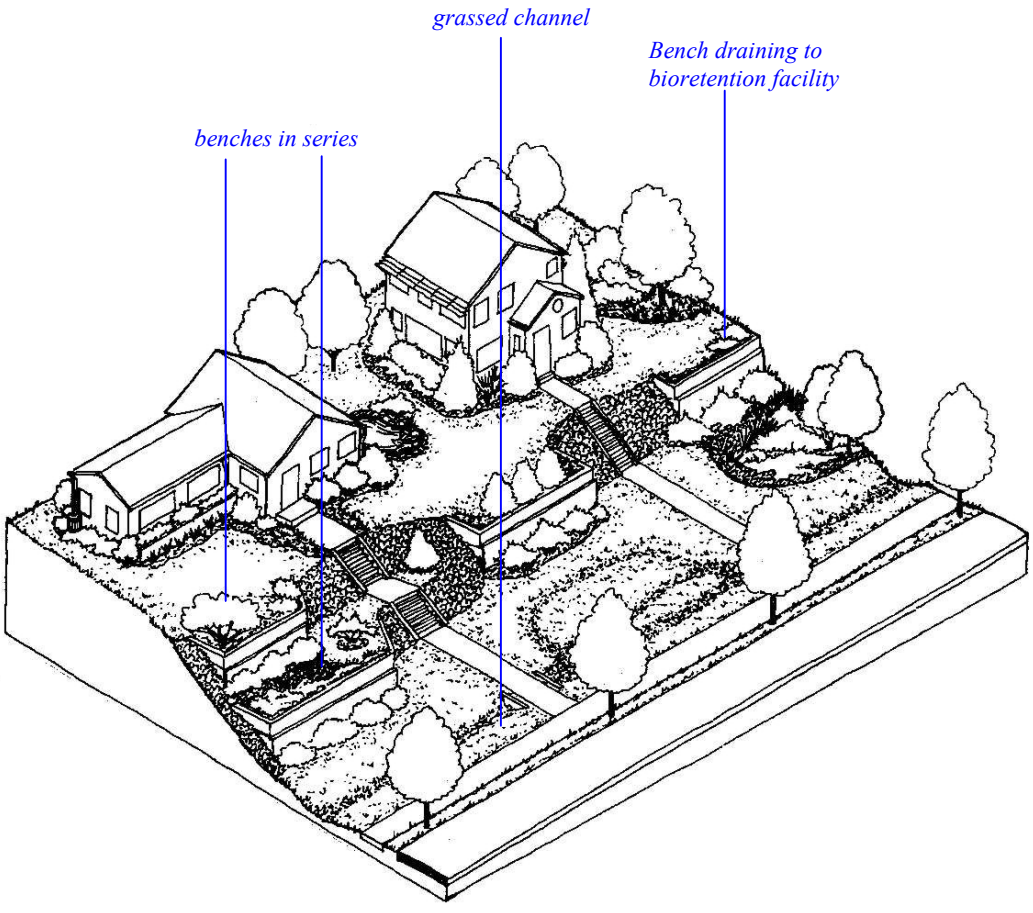
## Sources for Additional Information:

- Prince George's County (2001), *Bioretention Manual.*
- Maryland Department of the Environment (1999), *2000 Maryland Stormwater Design Volumes I & II.*

# Bioretention Bench

## Description:

Bioretention bench systems are shallow, landscaped areas used primarily for the water quality treatment of stormwater. Water quality is improved through filtration, sedimentation, and biological and processes. Bioretention bench systems may also be sized to meet water quantity control requirements. Bioretention benches are landscaped areas on slopes that capture stormwater for treatment while allowing shallow ponding. Water passing through the system exits on the downslope face of the bioretention areas as surface water and continues down slope either to another terrace or as surface flow. Therefore, stormwater is infiltrated through the system but may not recharge groundwater.

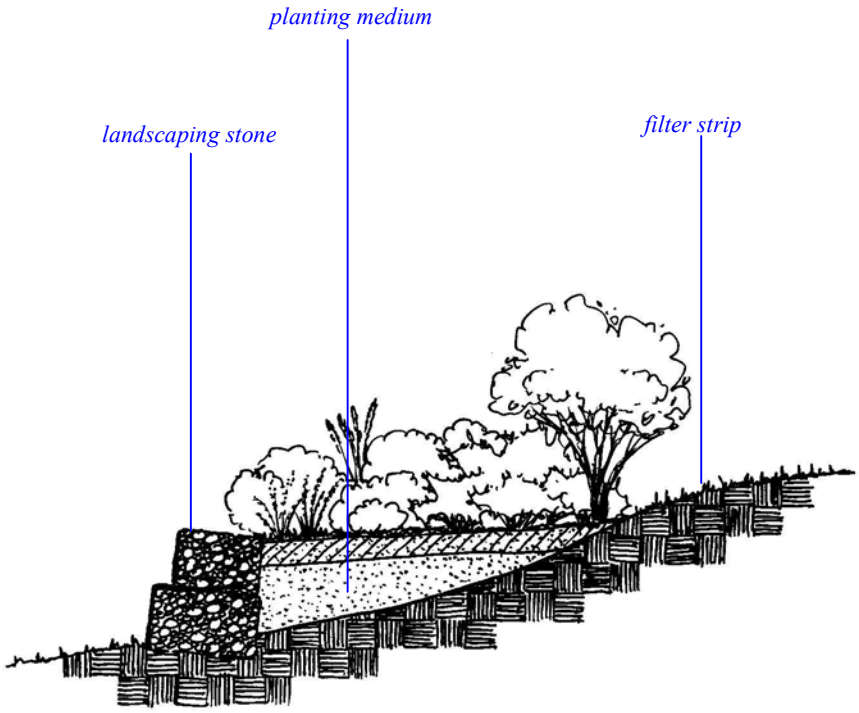


## Design Characteristics:

Bioretention benches are located on slope with a downslope "weeping wall" located above grade on the side of the basin. The retaining walls for the basin can be made of pressure treated lumber or stone. Gabions may be used but may be aesthetically unacceptable. The weeping wall may discharge to a lower bench to achieve a series treatment.

## Applicability:

Uses of bioretention terraces are limited to open spaces with moderate slopes. These types of bioretention facilities are applicable in high-density residential or institutional land uses.




## Sources for Additional Information:

- Prince George's County (2001), *Bioretention Manual.*

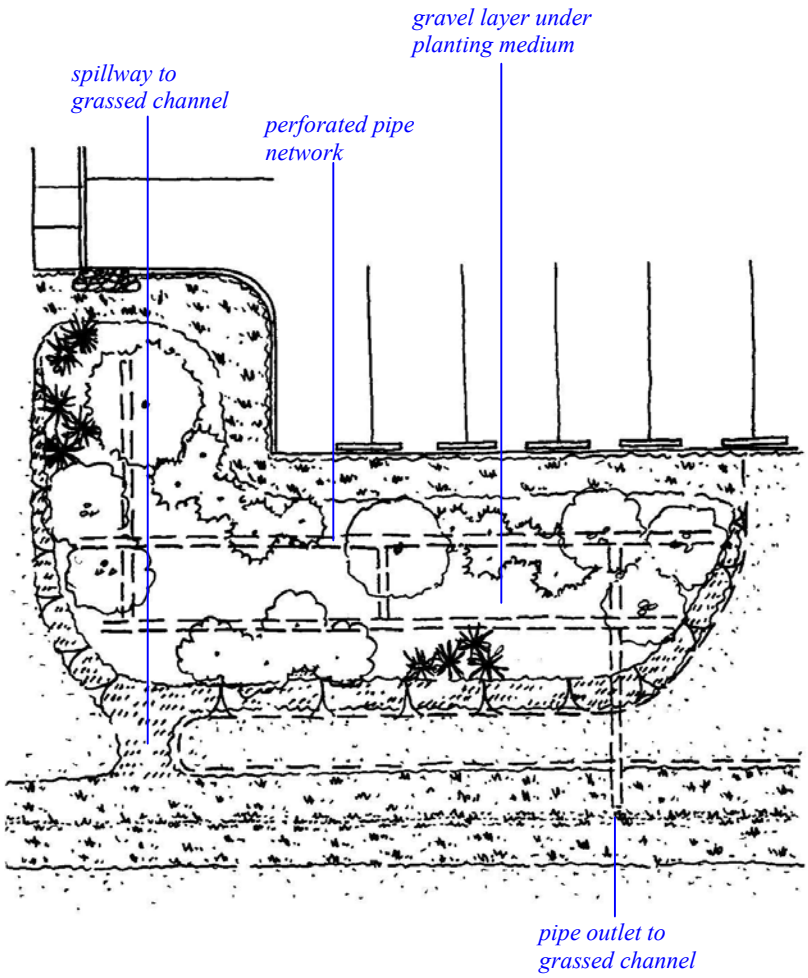
# Underdrained Bioretention

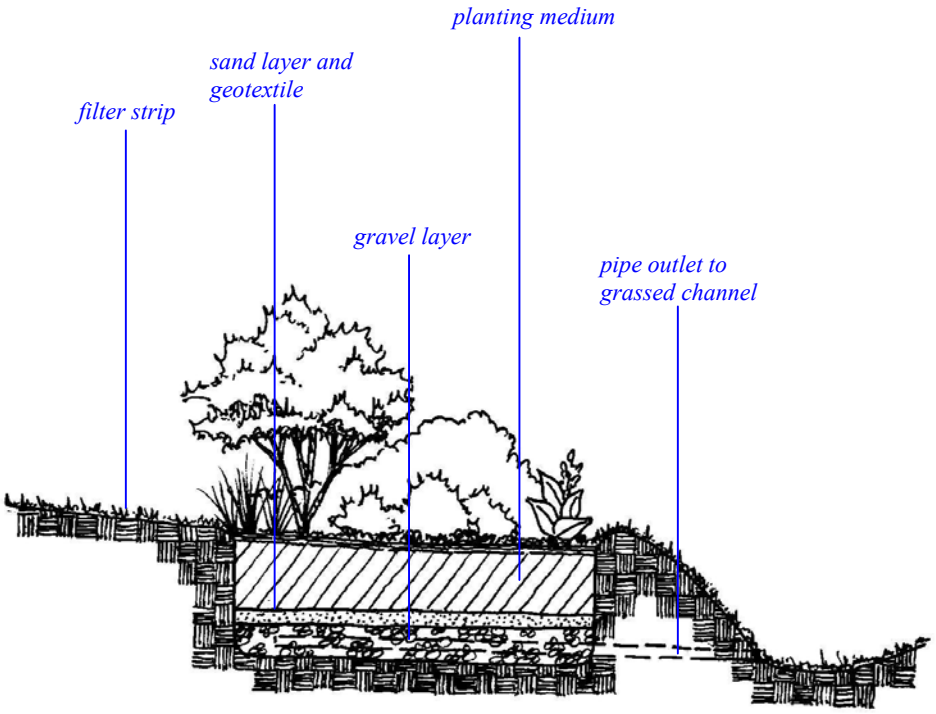
## Description:

Underdrained bioretention systems are similar to conventional bioretention facilities; however, the proximity of buildings or the presence of in-situ soils with poor drainage requires that these systems have underdrain systems. The underdrain may discharge to other stormwater management systems.

## Design Characteristics:

The underdrain system can include perforated pipes, gravel layers, and collector pipes. The facilities may be designed to accommodate larger flows than a conventional bioretention area. Excess flows may be bypassed or discharged to the underdrain system through a spillway. Landscaping must be tolerant of drought conditions or must be watered during dry periods.






## Applicability:

These types of bioretention systems can be applied in almost any type of land use and are suited to retrofitting of existing development on poorly drained soils. They are particularly useful in locations that have limited space for IMPs and an existing storm drain system.

## Sources for Additional Information:

- Prince George's County (2001), *Bioretention Manual.*

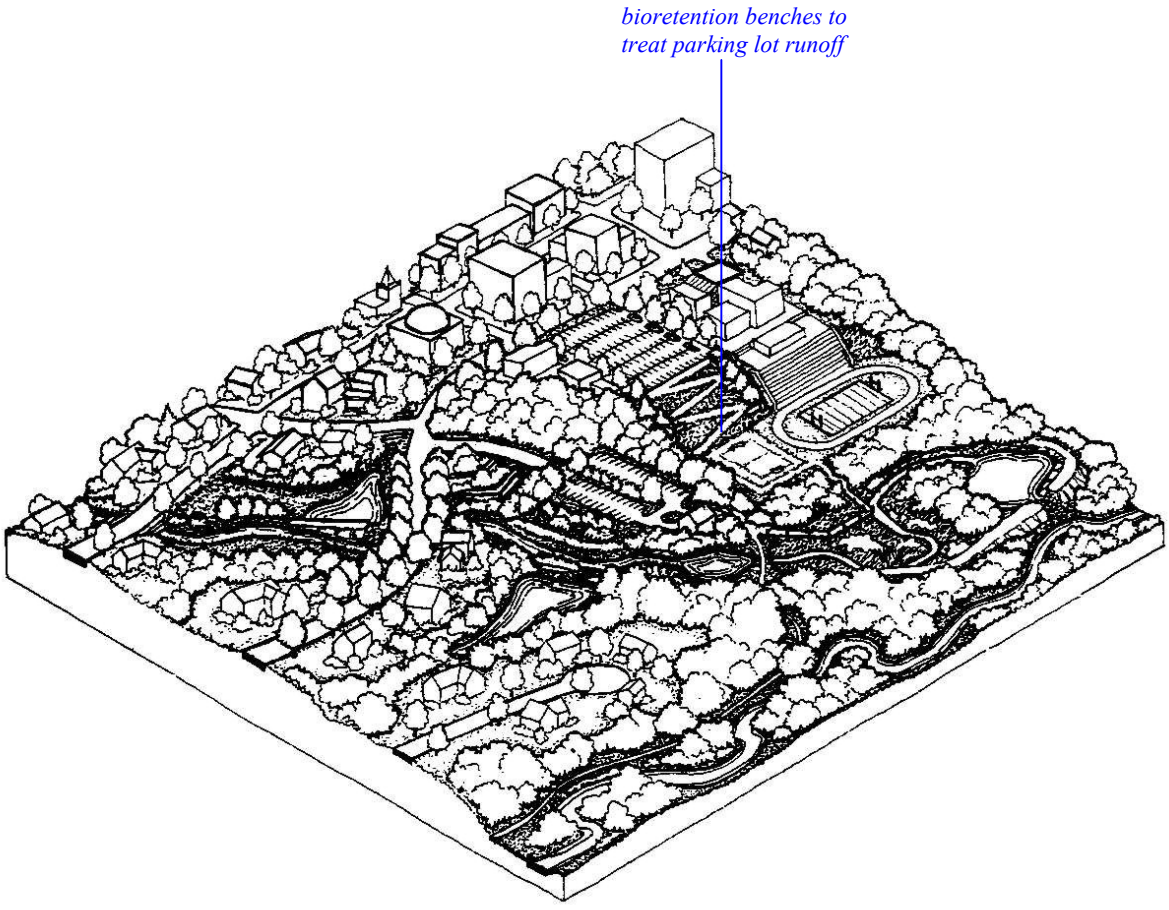
# Slope Reduction Bench

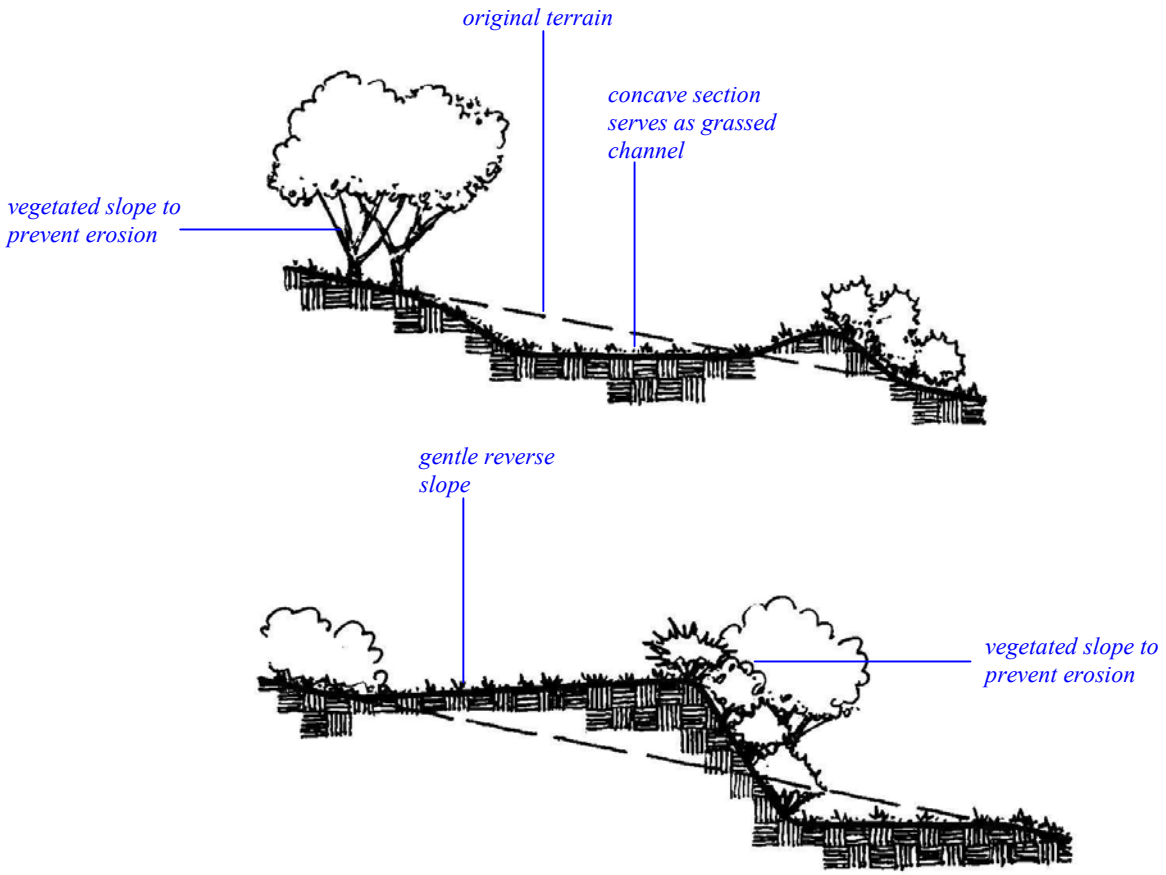
## Description:

This technology involves the reshaping of sloped ground surfaces to control stormwater and minimize soil erosion. The terraces are broad level benches or flat channels constructed on a sloping area. The terraces redirect the water to flow along the slope contours as opposed to down the slope. This IMP affects the timing of runoff distribution by increasing the flow distances. In addition, the IMP facilitates settling of solids and provides some storage.

## Design Characteristics:

The width of terraces varies with the slope and soil stability conditions. As shown in the figures, there are many possible configurations that can be used to break the slope into one or a series of terraces. The presence of roads and other features may affect the number and types of terraces that can be used. Vegetation should be planted to stabilize the terraces.






## Applicability:

Use of terraces is generally suitable to large, sloped areas that will be re-vegetated; for example, slopes resulting from cut-and-fill operations in residential development. Terraces may be used along road, rail, or utility right-of-ways.

## Sources for Additional Information:

- American Society of Agricultural Engineers (1992), *ASAE Standards*, Standard: ASAE S268.4, St. Joseph, MI.

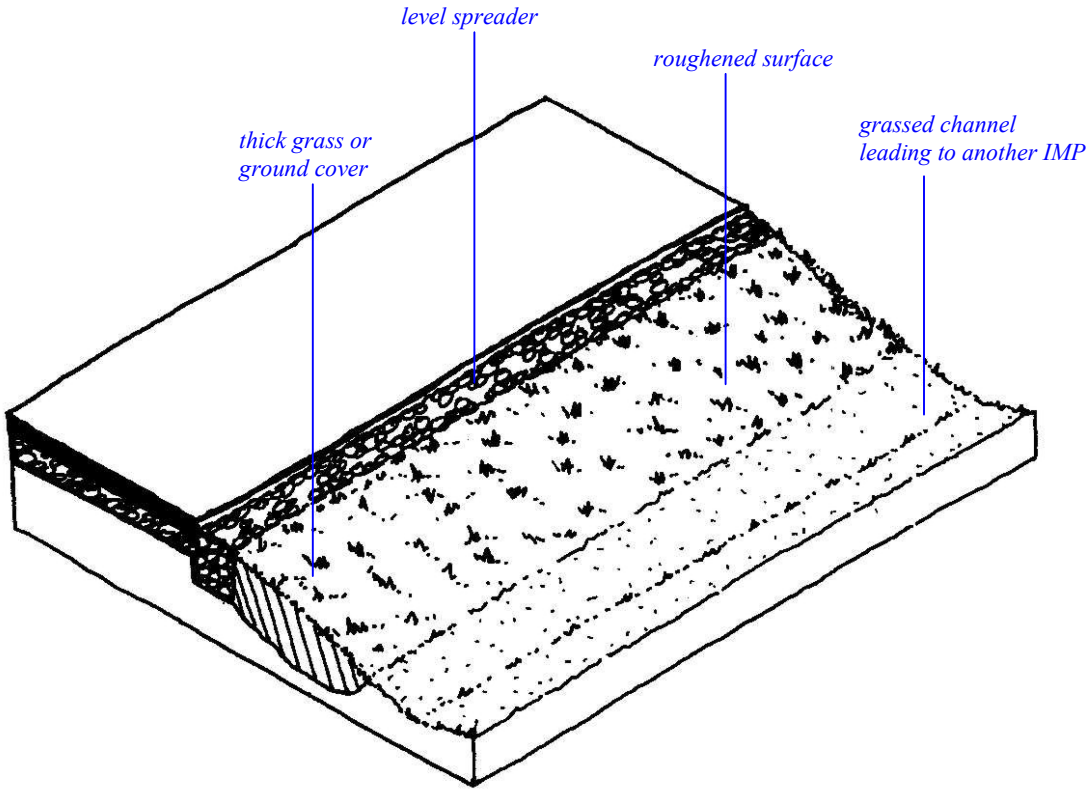
# Filter Strips

## Description:

Filter strips, also known as vegetated buffer strips, are used to slow down and filter stormwater runoff. In a filter strip, water moves as sheet flow across a rough vegetated area by which it is slowed and filtered. Depending on soil conditions, infiltration may also take place. A dense vegetative cover, long flow path, and low gradient provide the most effective conditions.

## Design Characteristics:

A filter strip is commonly used as a pre-treatment IMP located upstream of other IMPs. As a stand-alone IMP, filter strips can only treat the low intensity rainfall events. Filter strips cannot generally treat high-velocity flows and do not provide enough storage or infiltration to effectively reduce peak discharges to predevelopment levels. Flow spreaders must be used to disperse concentrated flows prior to the use of a filter strip.



Small berms may be installed at the downslope edge of the filter strip to detain the water and allow more time to infiltrate into underlying soils. The effectiveness of this IMP increases with the size and thickness of the vegetation on it. However, tall or rough vegetation may be objectionable aesthetically.

### Applicability:

By design, filter strips are relatively flexible IMPs; the gradient, width and length can be set to meet local constraints. In the urban environment; however, they have limited application due to the required flow length. There must be adequate flow length and gradient to adequately treat the stormwater. Filter strips add an aesthetic value to the landscape as long as they are maintained and litter and debris are regularly removed. Vegetative filter strips are primarily effective along roadways. Runoff that would otherwise discharge directly to a receiving water body first passes through the filter strip before entering a conveyance system.

### Sources for Additional Information:

- Maryland Department of the Environment (1999), *2000 Maryland Stormwater Design Volumes I & II.*

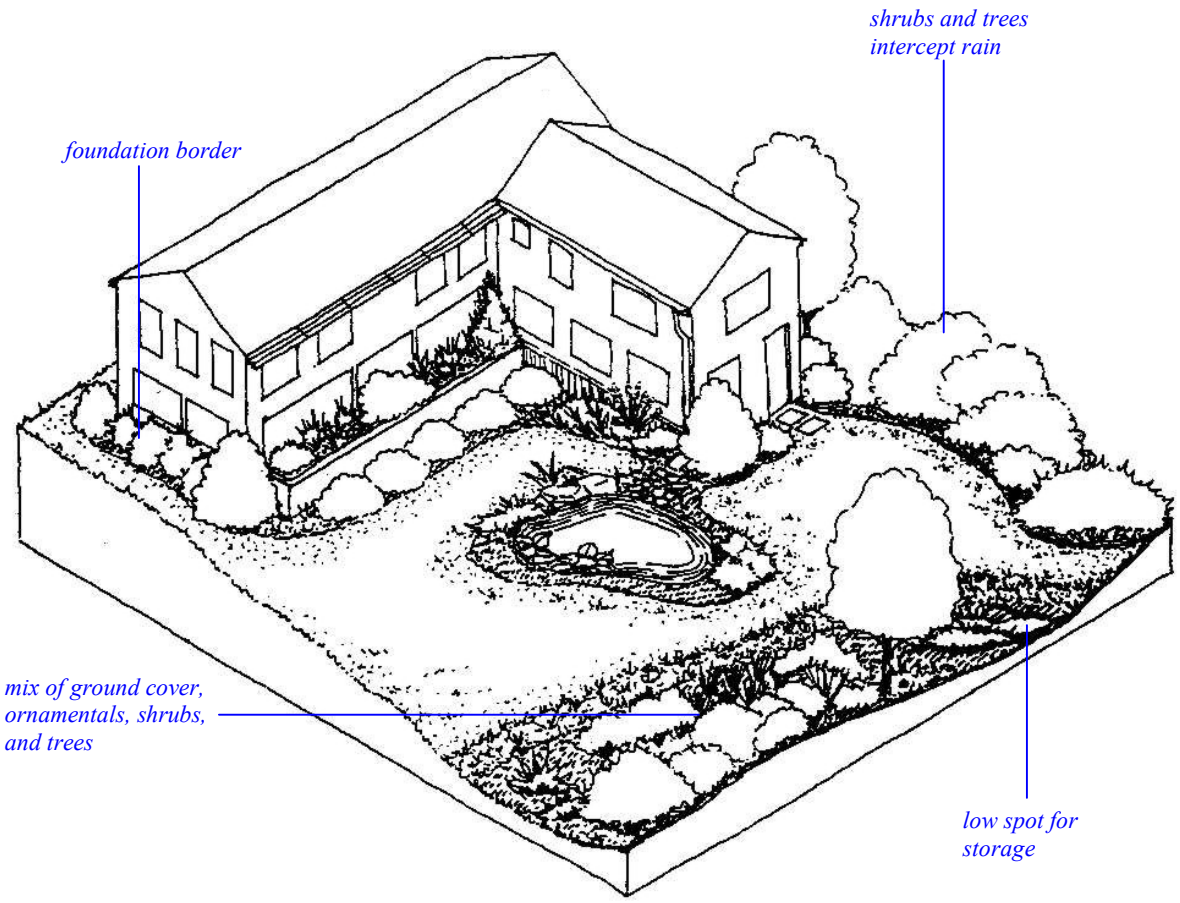
# Rain Gardens

## Description:

Rain gardens are low-lying areas, away from homes, where water can safely accumulate during heavy rains. These areas are natural topographic features that slow down water flowing into drainage systems and streams and may help alleviate flooding downstream. Many homeowners have low spots in their yard already. Rather than filling or draining these areas, rain gardens take advantage of these natural hydrologic conditions to introduce water tolerant landscaping features. The gardens can be designed with a landscaping theme; for example, a "Zen Garden."

## Design Characteristics:

Rain gardens can have grasses, shrubs, and trees. In addition to runoff control, the plants in rain gardens can increase water infiltration and evapotranspiration rates. Only water-tolerant plant



varieties are suitable for these areas. Local agencies can provide lists of native plants that can tolerate periodic or permanent ponding.

### Applicability:

Rain gardens are techniques that can be in used in new development and can also work as a retrofit in existing communities, especially where yards are large.

### Sources for Additional Information:

- Hynes, E., and S. McLure (1994), *Rodale's Successful Organic Gardening: Low Maintenance Landscaping*, Rodale Press.
- Berry, S. and S. Bradley (2000), *The Low-Maintenance Garden*, Firefly Books.

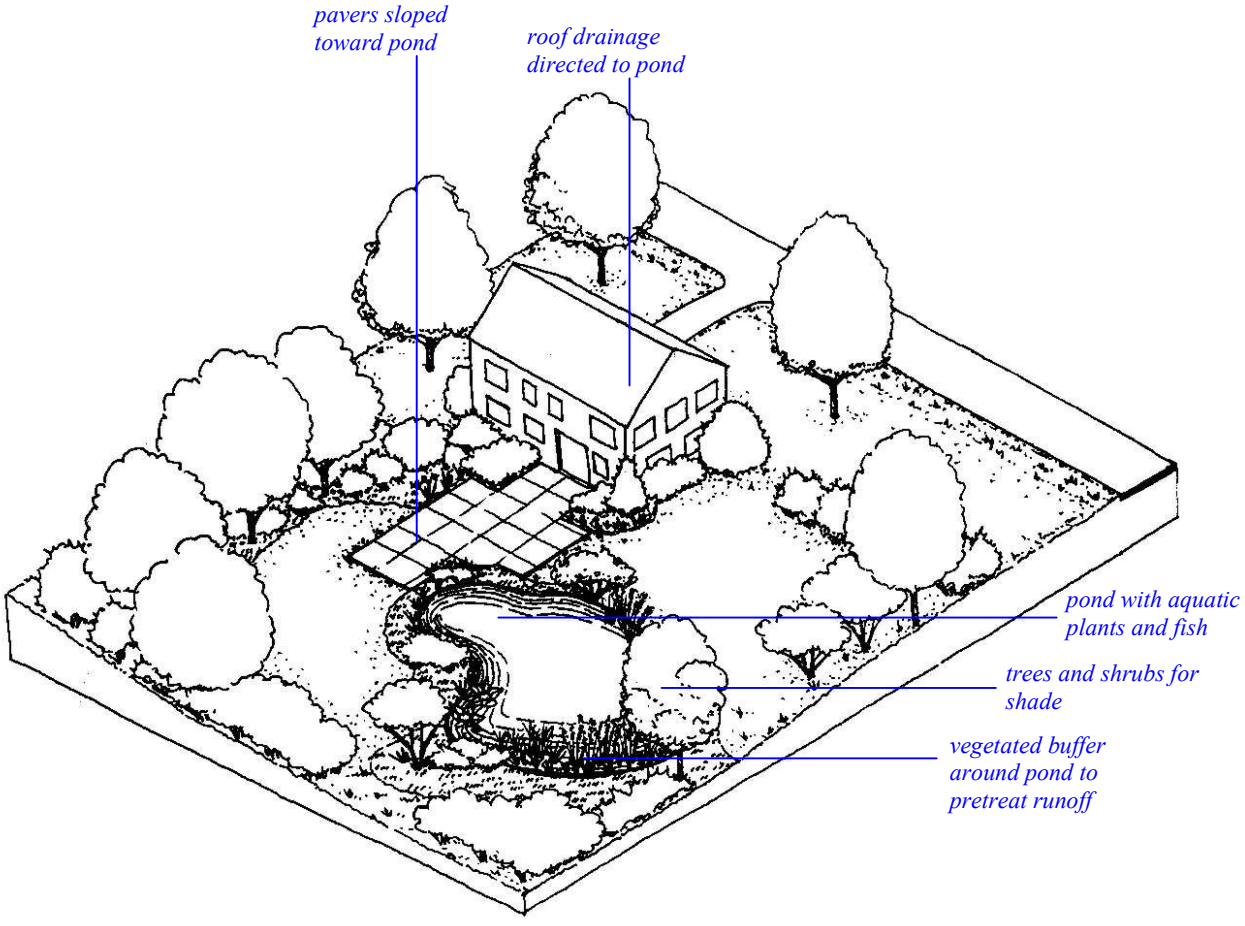
# Fish Pond

## Description:

Runoff from impervious areas can be directed to water features used for landscaping. Roof runoff can be diverted to a fish pond, which provides storage and helps in removing solids. Rainwater is preferred over tap water for fish ponds because of the use of chlorine in municipal systems.

## Design Characteristics:

The pond should be designed to allow additional storage above the normal level. An outlet is constructed to slowly release excess volume and a spillway is installed to handle overflows. Fish species should be pollution tolerant (*e.g.*, gold fish). An impermeable liner is needed to maintain water in the pond. Supplemental water may be necessary during dry periods. More than six hours of sunlight are needed; however, excessive sun may cause algae growth or increase



the water temperature, which may affect the fish. Pumps, filters, and other equipment may be needed to maintain proper conditions. The water depth must be at least 15 inches deep to maintain a habitat for the fish during winter. Ornamental ponds and other water features without fish could also be installed but the fish help control any potential mosquito breeding problems.

### Applicability:

Fish ponds can be used as an amenity in numerous situations: house backyards, schools, office buildings, and shopping malls.

### Sources for Additional Information:

- Deal, C. (1998), *Ponds: Planning, Design, Construction*, United States Government Printing Office.
- Nash, H (1998), Low-Maintenance Water Gardens, Sterling Publications.

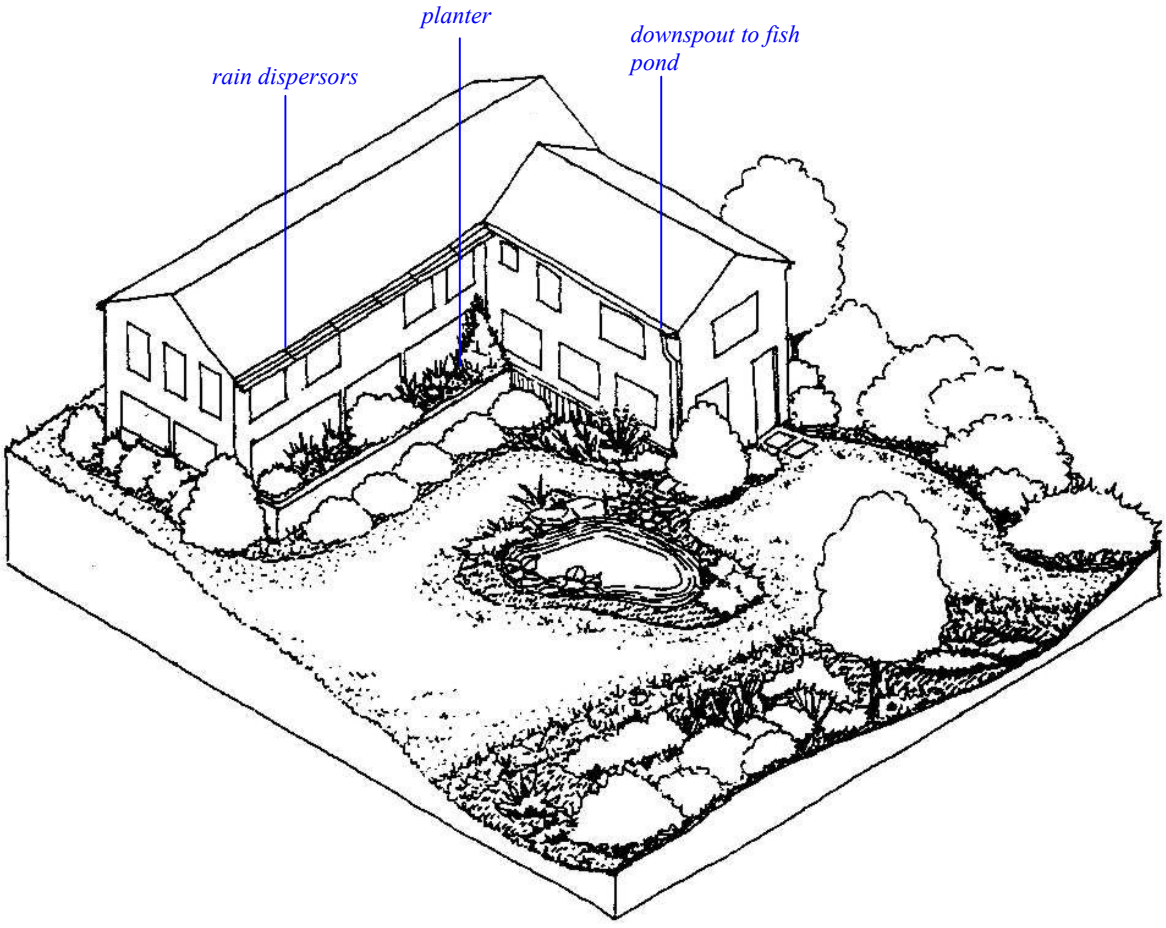
# Dripline Planter Box

## Description:

The dripline planter box IMP refers to a number of landscaping features that can be placed to receive runoff from roofs to water vegetation. Possible configurations include foundation plantings below the edge of the roof or above ground box planters along the side of a building.

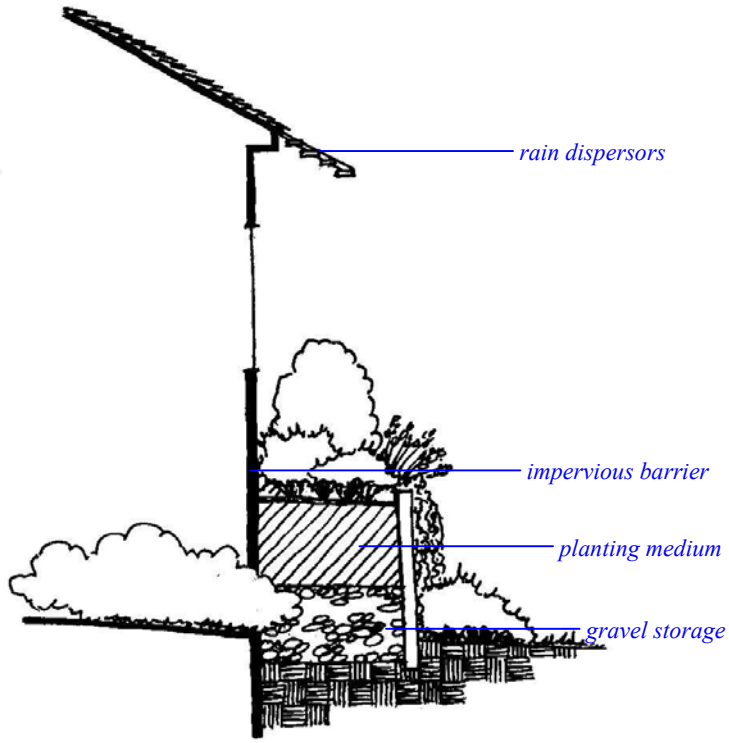
## Design Characteristics:

Runoff can be conveyed to the planter from downspouts or directly as a spray using rain dispersers instead of gutters. Additional storage can be obtained placing a coarse medium at the bottom of the box planter. The volume of the planter should be estimated according to the area of the roof. If using foundation plantings, care must be exercised to avoid leakage into basements. The bed should slope away from the foundation.



## Applicability:

The dripline planter box can be applied in new and existing development in virtually any type of building.




## Sources for Additional Information:

- SaveTime Corp. (2000), "RainhandleR," http://www.rainhandler.com/ (September 20, 2000)

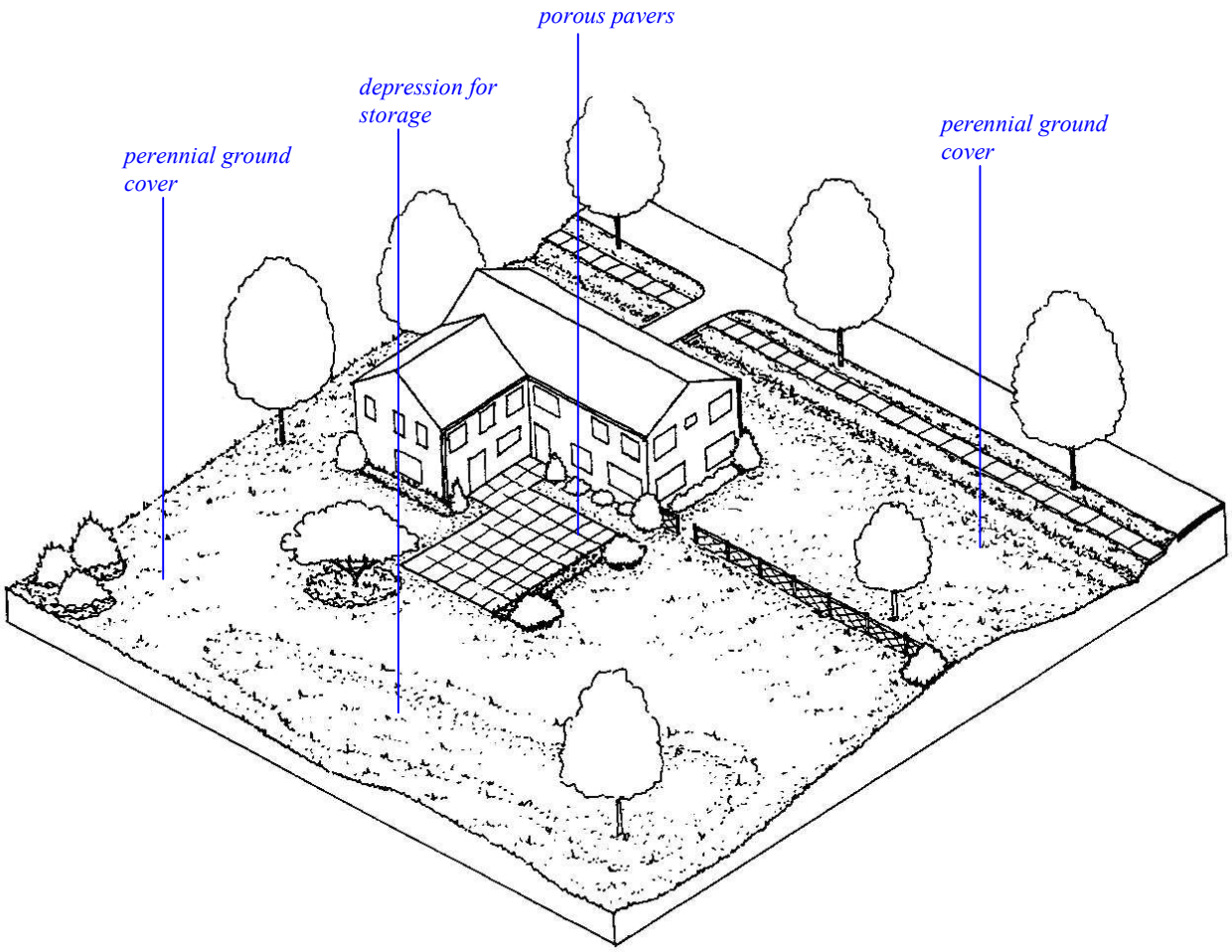
# Native Groundcover Landscaping

## Description:

Turf areas generate up to 50 percent more runoff than forested areas. The conversion of unused portions of lawn to native ground covers, shrubs, and trees can create infiltration characteristics similar to those of forested areas.

## Design Characteristics:

The use of native plants can be a low-maintenance alternative to lawn areas. These plants can also provide habitat and create food sources for songbirds and small mammals. Plants should be chosen considering their maintenance needs. This kind of landscaping can be used to provide screening from adjacent properties, summer shade and year-round landscaping interest.



## Applicability:

Landscaping changes are feasible for any land-use type. Slopes require special consideration to prevent erosion after turf is removed and before new plants become established.

## Sources for Additional Information:

- University of Maryland (1991), *Landscape Design to Reduce Surface Water Pollution in Residential Areas,* Cooperative Extension Services, University of Maryland, College Park, Maryland.

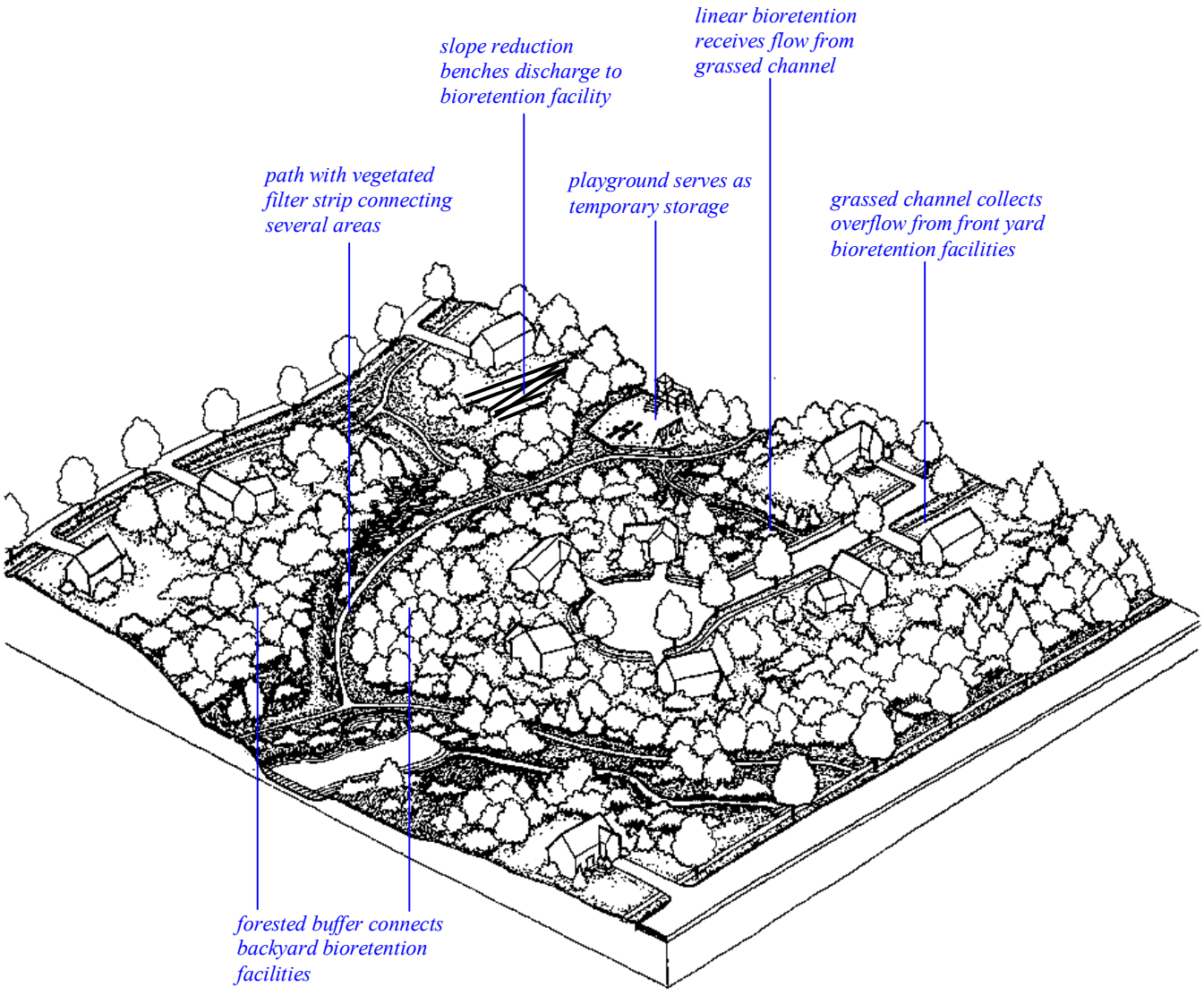
# Green Alleys

## Description:

Green alleys consist of linear networks of bioretention basins, infiltration trenches, and channels that provide redundant stormwater water quality management and stormwater conveyance functions. They create landscaped features along the edge of developments, backyard fence lines or along roads. The can also function as landscaped barriers or as boundaries between different land uses.

## Design Characteristics:

The design features of green alleys incorporate the features of individual components. Connections between individual components



can be made using underground perforated or solid pipe, infiltration trenches, or sand filters.

### Applicability:

Green alleys can be used where linear pervious areas permit the installation of a linear network of IMPs.

### Sources for Additional Information:

- Virginia Department of Conservation & Recreation (1999), *Virginia Stormwater Management Handbook, Volumes I & II.*

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