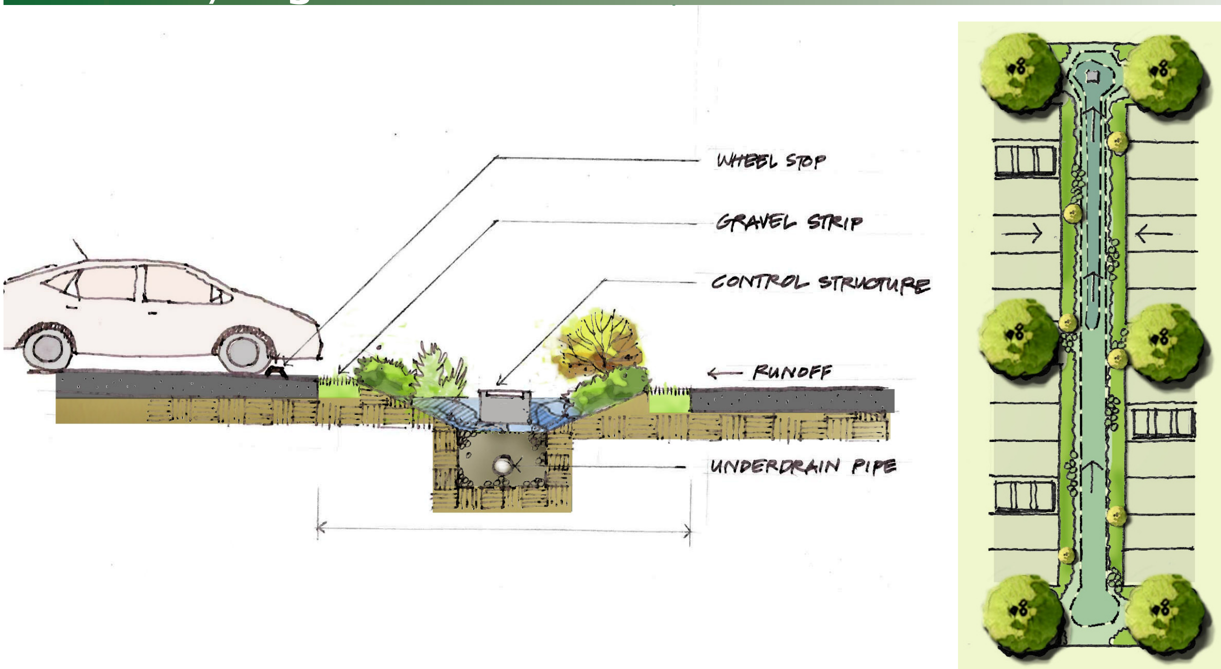
UF UNIVERSITY of FLORIDA
IFAS Extension

Bioswales/Vegetated Swales



This bioswale cross section (left) depicts the swale with an underdrain, which may not be necessary in naturally well drained soils. Surface runoff from the adjacent impervious area enters the swale diffusely through an energy reducing gravel strip and then flows through vegetative buffers along the edge of the bioswale. Swales can be designed with swale blocks (dashed lines perpendicular to flow arrows in plat view (right)) if there is a significant slope or by setting the discharge elevation of the control structure higher than the swale bottom if the swale has little relief.

Definition:

A bioswale or vegetated swale is a form of bioretention used to partially treat water quality, attenuate flooding potential and convey stormwater away from critical infrastructure. These systems are linear, with length to width dimensions much greater than the more typical 2:1 applied to bioretention cells.

Applications

- Parking lot island and medians
- Residential roadside swales
- Highway medians
- Landscape buff

Objectives:

The function of these open-channel (broad) drainageways is to convey stormwater runoff. They are often used as an alternative to, or an enhancement of, traditional stormwater piping. Bioswales are often integrated into parking lot and road medians and parallel to roadways to infiltrate and treat a portion of the stormwater volume. These systems can often be integrated into existing ditch and swale systems to increase their treatment function. Where soils are well drained, infiltration can also be facilitated in the swale by placing ditch blocks or weirs perpendicular to the flow path, causing small volumes of water to be captured in the swale and allowing more time for infiltration.

Overview:

Conveyance systems are often required to move stormwater away from critical infrastructure. The purpose of a bioswale is to increase the function of these conveyance systems by integrating features that improve water quality, reduce runoff volume and enhance landscape aesthetics. By creating in-swale storage opportunities, small storm volumes can be captured and allowed to infiltrate within the bioswale. Where soils are poorly drained, under drain systems may be used to attenuate peak flows and force water stored within the swale through a soil filter media before continuing downstream. For larger flow events, vegetation within the swale and ditch blocks helps to stabilize soils and increase sedimentation potential. The shape and location of the bioswale and selection of vegetation can also be integrated into the site's overall landscaping design to create a multifunctional system. The size of the bioswale will determine the volume of runoff that can be stored or reduced, as well as the treatment benefits. Where the volume of runoff exceeds that of the bioswale(s), further stormwater devices will be required to handle the design storm.

Bioswales can be found in an open area or within a restricted area like a parking lot. Two types of vegetated swales are commonly used. Dry swales provide both quantity (volume) and quality control by facilitating stormwater infiltration. Wet swales use residence time and natural growth to reduce peak discharge and provide water quality treatment. A wet swale typically has water tolerant vegetation permanently growing in the retained body of water. Swales are most effective when used in conjunction with other IMPs, such as bioretention basins and infiltration trenches.

Water Protection Benefits:

Water conservation implications – Like bioretention basins/rain gardens, vegetated swales are designed to capture and retain stormwater in recessed drainageways, which typically do not need irrigation beyond plant establishment. These areas can provide significant aesthetic benefit while avoiding water requirements associated with other landscape types. They can also conserve biodiversity when native plants are used.

Stormwater implications – Bioretention swales provide both stormwater treatment and conveyance functions. The swale component provides pre-treatment of stormwater to remove coarse to medium sediments, while the bioretention system removes finer particulates and associated contaminants. Bioretention swales filter stormwater via the following processes: 1) passing through surface vegetation; 2) percolating through prescribed filter media, which provides treatment through fine filtration, extended detention treatment and some biological uptake; 3) disconnecting impervious areas from downstream waterways; and 4) providing protection to natural wetland systems from frequent storm events by reducing storm flow velocities when compared to pipe systems.

Benefits:

- *Treat water quality using soil, vegetation and microbes*
- *Reduce total volume of stormwater runoff*
- *Increase infiltration and groundwater recharge*
- *Multifunctional conveyance system*
- *Can be aesthetic part of landscape and improve biodiversity*

Design Considerations:

This is an infiltration dependent practice affected by soil type, groundwater table, size of the area serviced, imperviousness of the contributing watershed, and dimensions and slope of the swale system. Swales are impractical for areas with very flat grades or steep slopes, and should be used to serve areas of less than 10 acres with slopes no greater than 5%. As a simple rule of thumb, the total surface area of the swale should be one percent of the area from which it is receiving stormwater. Large areas should be divided and treated using multiple swales. Vegetated swales should not be installed in areas with high water tables where groundwater reaches the bottom of the swale.

Plant material selection and location are critical design choices. Additional considerations include the following:

- ♦ Bioswale function and treatment is improved when applied in areas with well drained soils.

Design Keys:

- **The design of a bioswale is a balance of stormwater conveyance function with storage, infiltration and soil and biological treatment processes. That means there must be consideration of:**
- **Swale design, including outlet design**
- **Location in the treatment train**
- **Plant material selection**
- **Soil composition**
- **On-going managemen**

- Poorly drained sites require an underdrain system.
- Slopes greater than 5% require multiple ditch blocks or weirs perpendicular to the flow to facilitate storage volume and extend time for infiltration.
- Where phosphorus control is important, soils used in construction should have a low phosphorus content and high phosphorous sorption capacity.
- Where nitrogen control is important, mulch and organic matter incorporated into the soil should have a high carbon to nitrogen ratio.
- A high flow bypass (outlet or control structure) should be included to safely convey high flows.

Vegetation is ideally a fine, close-growing water-tolerant species that provides high amounts of vegetative surface area for contact with stormwater. Plants should be selected specifically for their nutrient uptake ability and site appropriateness. Where possible, use native plants to improve biodiversity.

Check dams, slight slopes, permeable soils, dense vegetative cover, increased contact time, and small storm events all aid pollutant removal. On the other hand, compacted soils, short runoff contact time, large storm events, steep slopes, and high runoff velocities and discharge rates reduce the effectiveness of swales.

Operations and Maintenance:

It is important that the storage capacity and functional integrity of the bioswale be maintained through regular monitoring and maintenance of vegetation, infiltration capacity, and structures. Regular inspection of bioswales should be conducted to identify signs of erosion, accumulation of debris around structures and signs of excessive sedimentation. Soil infiltration capacity should be tested annually to determine if soils are becoming clogged. Maintenance requirements include seasonal trimming of vegetation and removal of debris and trash that may foul downstream structures.

HOA or Regulatory Considerations:

To receive permit credit for a bioswale under Florida's current stormwater regulations requires infiltration of 80% of the runoff from a 3-year, 1 hour storm (2.5 inches).

Credits in Green Building Certification Programs:

- FGBC-Home Standard (waterfront prerequisite: use of terraces, swales or berms to slow stormwater)
- Florida Yards & Neighborhoods (stormwater runoff: swales, terraces and/or rain gardens created to catch and filter stormwater; all rain and storm water drains away from the building foundation using legal drainage conveyance systems on-site)
- LEED for Homes (SS 4.3 management of runoff from roof)
- LEED for Neighborhood Development Pilot (GCT Credit 9: Stormwater Management)
- NAHB Model Green Home Building Guidelines (1.3.5 Manage storm water using low-impact development when possible)

Relative Costs:

Swales are inexpensive relative to traditional curb and gutter treatment or underground stormwater systems. Maintenance is required more frequently but is considerably less costly than curb and gutter system maintenance. Cost of this practice compares favorably to other LID practices. In a U.S. Army Corps of Engineers study from 2004, costs per square foot were $0.50 (source: www.wbdg.org).

References and Resources:

EPA Stormwater BMP Fact Sheet: Grassed Swales http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=75

EPA Storm Water Technology Fact Sheet: Vegetated Swales http://www.epa.gov/owm/mtb/vegswale.pdf

California Stormwater BMP Handbook – Vegetated Swales http://www.cabmphandbooks.com/Documents/Development/TC-30.pdf

Massachusetts LID Toolkit – LID Factsheet – Vegetated Swales

http://www.mapc.org/regional_planning/LID/swales.html

Credits

Authors:

Mark Clark
Soil and Water Science Department

Glenn Acomb
Landscape Architecture Departmen

Fact Sheet Illustrations:

Glenn Acomb
Landscape Architecture Department

Wei Ren
Landscape Architecture Department

Fact Sheet Illustration Assistance:

Brian Niemann
Florida Yards & Neighborhoods

Layout:

Barbara Haldeman
Program for Resource Efficient Communities

This fact sheet was produced with funding from The Elizabeth Ordway Dunn Foundation.