Semi-Arid Green Infrastructure Toolbox

Biofiltration Swale

What is a Biofiltration Swale?

Biofiltration swales, commonly called bioretention swales or bioswales, are modified swales that use vegetation and an engineered media beneath the swale to improve water quality, reduce the runoff volume, and modulate the peak runoff rate. Biofiltration swales are designed to collect sheet flow of runoff from impervious area adjacent to the swale length and convey that runoff away. They are commonly located along roadways or parking lot edges. In these settings bioswales may be used in place of traditional curbs and gutters. While similar to traditional open conveyances like ditches and vegetated swales biofiltration swales are designed to convey runoff slowly allowing time for pollutant removal via settling and filtration. As a result biofiltration swales are much wider than traditional swales and exhibit lower slopes both longitudinally and on the sides. They also share similarities to bioretention practices but are linear in nature and typically deeper to accommodate larger storm flows.

Benefits

Biofiltration swales provide a number of benefits:

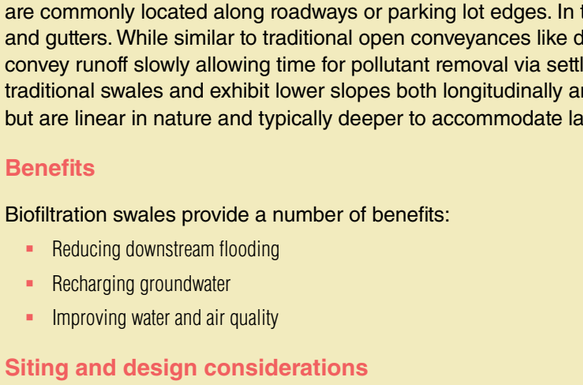
- Reducing downstream flooding
- Recharging groundwater
- Improving water and air quality
- Reduce infrastructure cost
- Create aesthetic multifunctional open space

Siting and design considerations

- Biofiltration swales should be placed adjacent to and along impervious areas. Concentrated inflows should generally be avoided but, if necessary include stabilization measures to protect the swale from scour. Since biofiltration swales inherently serve a runoff conveyance function their design must include hydrologic and hydraulic analysis to determine appropriate dimensions. Depending on longitudinal slope and in-situ permeability check dams and an underdrain system may be appropriate to produce optimum function. While biofiltration swales may be placed over underground utilities designers should carefully evaluate for conflicts between the utility lines and underdrain systems, and consider the impact of infiltration on subsurface utilities.

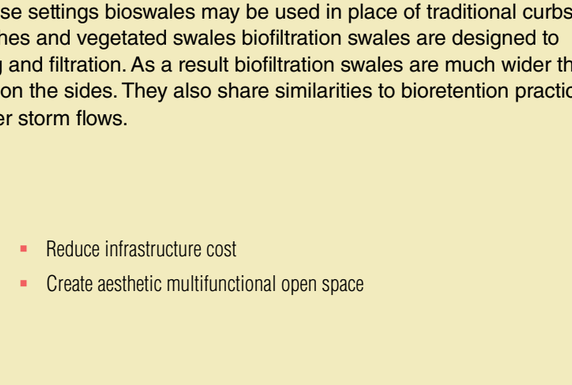
Maintenance requirements

- Like any landscape feature biofiltration swales require regular maintenance to perform as intended. Given the runoff conveyance function which they provide it is critical that biofiltration swales remain clear of debris or dead vegetation to avoid clogging. Similarly the swales should be inspected periodically to ensure that accumulating sediment is not reducing the capacity of the swale to convey water. Maintenance practices are similar to those necessary for common landscaped areas.



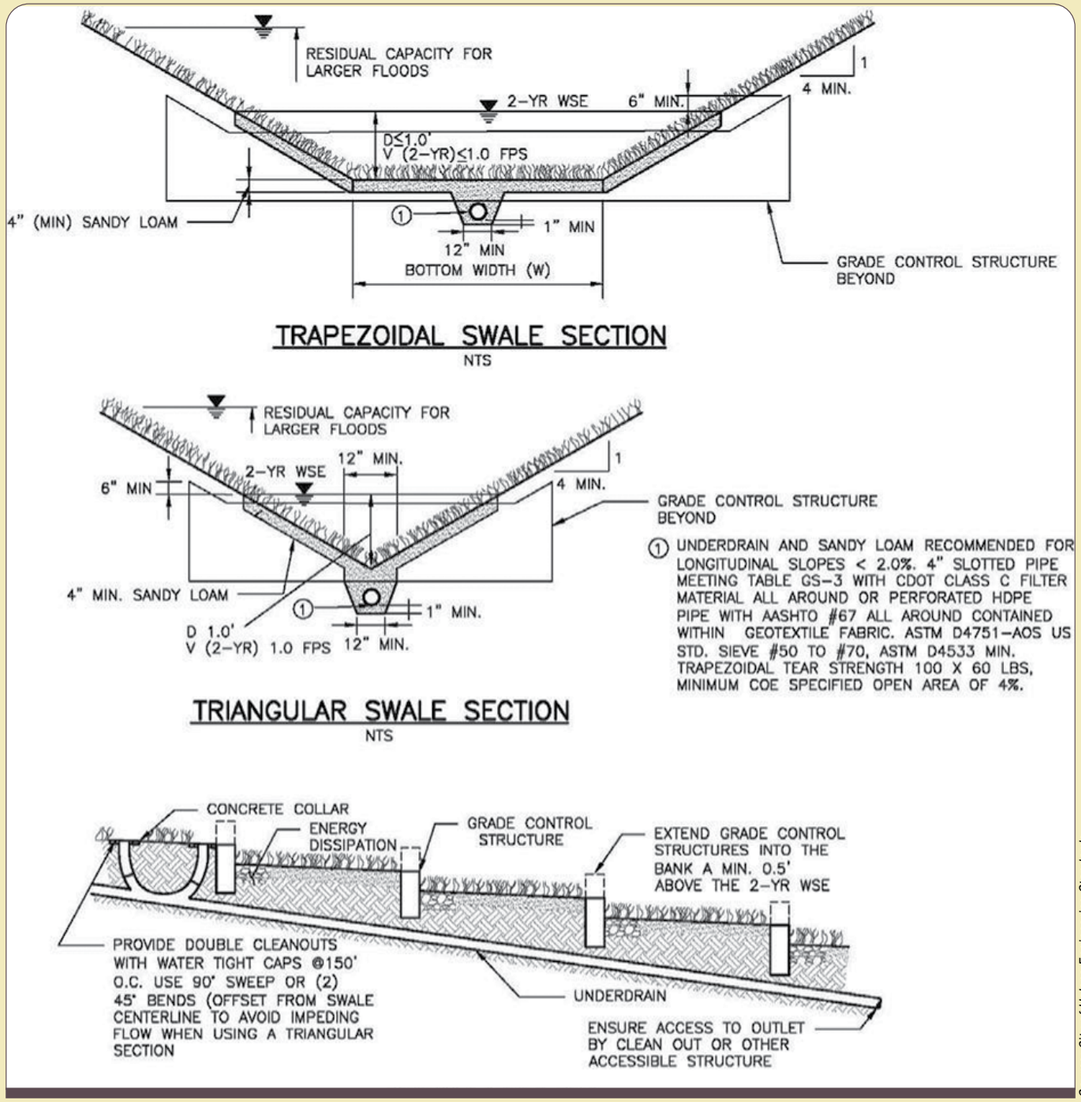
Source: USEPA Region 8

Biofiltration swale between parking lot and road in Denver, CO



Source: USEPA Region 8

Natural biofiltration swale in Fort Carson, CO



Source: City of Helena Engineering Standards

Biofiltration swales are typically trapezoidal or triangular in cross section and may incorporate check dams or underdrain systems as needed.

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How to plan, implement, and maintain biofiltration swales

Planning and Design: Biofiltration swales are more complex to design and implement than related bioretention or vegetated swale practices. Since they rely on hydraulic residence time to encourage infiltration and pollutant removal designers should seek to maximize the length of biofiltration swales when possible. Due to their space requirements biofiltration swales are infrequently used in urban settings however they are particularly suited to low density and rural settings. There are a variety of design manuals and sizing tools/calculations which may be appropriate in implementing biofiltration swales in semi-arid environments. Refer to guidance provided by available municipal design manuals such as those provided by the Mile High Flood District for more detailed design guidance. Given the particular importance that vegetation plays in ensuring structural integrity of the biofiltration swale designers should verify that soil conditions are conducive to plant vigor and that supplemental irrigation is suppled during establishment.

In areas in which stakeholders are not well versed in low impact development it may be beneficial to implement a public education program including public meetings or informational signs where practices are installed to provide information on how biofiltration swales function.

Maintenance: Maintenance of biofiltration swales is similar to other members of the bioretention family with additional considerations for maintaining a dense grass mat and ensuring that erosion or scour is not an issue. Other maintenance tasks should focus on regularly removing debris and ensuring that vegetation height is maintained according to the designed criteria (designers should provide guidance on mowing height and frequency).

Design Criteria:		
	Geometry	Triangular or trapeziodal
	Design storm	2-yr 24-hr storm*
	Longitudinal slope	Typically greater than 2%
	Design velocity	1 foot per second or less for design storms
	Design flow depth	1 foot for design storm
	Sideslope	4:1 or flatter
	Soil preparation	Consult applicable design standards

**Swale should be sized to safely convey larger storm based on local regulations and site objectives*

Vegetation selection: Vegetation in biofiltration swales must protect the swale bottom and side slopes from erosion by flowing water. The designers should select durable, dense, and drought tolerant species. In arid environments plant species well adapted to the area of implementation should be considered. Other low growing, dense species that are locally suitable for grassed swales may also be considered.

Do	Don't
Take advantage of topography and locate biofiltration where there are existing swales ☑	Fail to remove collected sediment which can reduce hydraulic capacity ☒
Provide irrigation to vegetation during establishment and if necessary for the life of the practice ☑	Install over top of utility connections ☒
Use grass and other low growing vegetation which is well adapted to the semi-arid environment. ☑	Install without evaluating existing soil infiltration/permeability ☒
Trim and remove vegetation to maintain aesthetics and function ☑	Install in areas with shallow groundwater levels (typically at least 2 feet below bottom of underdrain or soil media) ☒

Additional examples of biofiltration swales

Source: Watershed Management Group

Biofiltration swale planted with native sweetgrass

Source: USEPA Region 8

Before: This recently constructed biofiltration swale in a park in Helena exhibits shallow ponding of water after a rain event

Source: USEPA Region 8

After: Within 6-12 hours the retained water has drained or infiltrated leaving a dry bottom