Department of Permitting Services
Land Development Division
255 Rockville Pike, 2nd Floor
Rockville, MD 20850-4166
Phone: 311 in Montgomery County or (240)-777-0311
Fax (240)-777-6339
http://www.montgomerycountymd.gov/permittingservices/

BIO SWALE (BS)

The Bio Swale methods described in the following section are based on the Bio Swale design found in Chapter 5 of the Maryland Storm Water Design Manual and the ESD Process & Computations Supplement dated July 2010. Where deemed appropriate, the design specifications have been modified by the Montgomery County Department of Permitting Services (DPS).

A. Facility Description

A Bio Swale is a channel that provides conveyance, water quality treatment and flow attenuation of stormwater runoff. Pollutant removal is achieved through vegetative filtering, sedimentation, biological uptake, and infiltration. Principal components of the system include: a) vegetated surface, b) a 2-foot planting media layer, c) a 6 inch thick sand layer, and d) a 12-inch gravel underdrain layer. The facilities should be heavily vegetated with appropriate grasses, and may also be landscaped to enhance their function and appearance.

B. System Design Considerations

1. Applicability

Bio Swales are appropriate for new and redevelopment applications. Because they incorporate an underdrain system, they are acceptable in fill soils. They may be used in public and private rights-of-way, and in other areas where swales would generally be incorporated into the project design.

2. Conveyance

Wherever practical, Bio Swales should be designed to receive flow along their entire length via sheet flow. They may be designed as treatment for piped flow or for other areas of concentrated flow when necessary and when safe inflow characteristics are employed. Overflow inlets should be installed as necessary.

The channel slope shall be between 1% and 4.0%. Maximum ESD flow velocity for the 1-year storm (2.6 inches) may not exceed 1.0 fps. Flow rate shall be calculated per Appendix D.10 of the 2000 Maryland Stormwater Design Manual. Channel side slopes may not exceed 3:1.

3. Groundwater

Bio Swales shall not be located where the water table is within 2 feet of the bottom of the facility. If the 2 ft. clearance requirement cannot be met, an alternative stormwater practice must be proposed.

4. Setbacks

Bio Swales shall be located at least 30 feet from water supply wells and 25 feet from septic systems. Practices should be located down gradient and setback at least 10 feet from building foundations.

C. Specifications and Details

1. Sizing

The Bio Swale shall be sized to capture and store 100% of the target treatment volume within the filter media (planting medium, sand, and underdrain stone). Surface ponding may not be calculated for swales since swales do not pond water, they convey it away. The surface of the Bio Swale shall be 2 to 8 feet in width. Planting medium shall be 24 inches deep. The width of the filter medium shall not be greater than the bottom width of the swale. Subsurface storage provided beyond the limits of the swale surface, or storage provided in excess of that required to treat the runoff for the 1 year, 24-hour design storm shall not be counted towards
the total ESDv provided. The total storage provided in the facility shall be computed as the storage provided in the filter medium, sand and underdrain stone layers. Computations shall account for the porosity (n = 0.40) of the filter media.

Bio Swales may not be "enhanced" by placing additional stone storage below the 12-inch stone underdrain layer.

2. Inflow Design Criteria

Runoff shall enter the Bio Swale in a non-erosive manner (less than 2 fps). Inflow may be via sheet flow, depressed curbs with wheel stops, curb cuts, level spreaders, over grass, or other acceptable conveyance methods.

3. Overflow Design Criteria

Safe conveyance of the developed 10-year storm through the Bio Swale must be demonstrated. Overflow inlets may be installed as required. The invert of the inlet shall be 6 inches above the elevation of the flow channel to encourage filtration of flows, and a berm will be required to be installed behind the inlet. Berms or check dams are not allowed elsewhere in the swale. All underdrains must outfall to safe, stable locations. Overflow devices must not feed into perforated or slotted pipe sections or into the stone underdrain layer.

4. Underdrain Pipe

Underdrain piping is only required where inlets are installed to intercept flow, such as at locations along a swale where the allowable velocity in the channel is exceeded, or at the downstream end of a facility where it becomes necessary to outlet the underdrain stone to grade. At these locations, a 10-foot section of perforated underdrain must be installed which will drain directly into the inlet.

The underdrain pipe consists of 6-inch diameter schedule 40 or stronger perforated PVC pipe at 0.00% slope. The underdrain pipe will be placed within the gravel layer. A minimum of three inches of gravel must be placed under the pipe, with a minimum of 3 inches of gravel over the pipe. Perforations must be 3/8 inch in diameter and must be located 4 inches on center, every 90 degrees around the pipe. Perforated pipe must begin at least 12" inside the filter media. Filter fabric must **not** be wrapped around the underdrain pipe. An acceptable alternative to perforated pipe is 6" diameter schedule 40 slotted PVC pipe with 0.125 inch slots. Slots shall be 0.125 inches wide and a minimum of 1.9 inches in length, with a minimum of 4 slots per row and 4 rows per linear foot of pipe.

Access for cleaning all underdrain piping is needed. Watertight clean-outs for each pipe shall be level with the surface of the media. All cleanouts shall have a removable waterproof cap. Cleanouts must be capped immediately after filter media is in place.

The stone layer must run the length of the swale, including under driveway crossings.

5. Gravel Layer

The gravel layer must meet MSHA size #7 (Table 901A), and shall be 12-inckes in depth. No geotextile or filter fabric is allowed to be placed horizontally anywhere within the filter media, except at driveway crossings, as shown in the typical section.

6. Sand Bed

A minimum 6-inch fine aggregate sand layer shall be provided below the planting media. ASTM C33 or AASHTO M6 Fine Aggregate Concrete Sand is required per Montgomery County sand specifications.

7. Planting Medium

The planting media shall be 24" thick and shall consist of 1/3 perlite or Solite, 1/3 compost and 1/3 topsoil. The perlite shall be coarse grade horticultural perlite. The compost shall be high grade compost free of stones and partially composted woody material. The topsoil shall meet the following minimum criteria: contain no more than 10% clay, 10-25% silts and 60-75% sand. The soil shall be free of stones, stumps, roots or other similar objects larger than 2 inches. The first layer of the planting medium shall be lightly tilled to mix it into the sand layer, so as not to create a definitive boundary. The planting material shall be flooded after placement. Any settlement that occurs shall be filled back to the design elevation.

8. Mulch

When vegetated with grass, the Bio swale does not require a mulch layer. A typical location for a grassed Bio Swale would be in a public right-of-way. When the Bio Swale is landscaped with vegetation other than grass, a mulch layer is required. The surface mulch layer will consist of standard double shredded aged hardwood mulch. The mulch should be applied uniformly to a depth of 3 inches. Yearly replenishing may be necessary. Pine bark is not acceptable.

9. Plant Materials

Plants, through their pollutant uptake and evapo-transpiration of stormwater runoff, play a key role in the overall effectiveness of the Bio Swale. As mentioned above, the Bio Swale may be planted in turf grass where it is appropriate to do so, such as along roadways where visibility is a concern and where active landscape maintenance is unlikely. In cases where the Bio Swale is proposed to be landscaped in materials other than grass, tree, shrub and herbaceous plantings may be used. Both the number and type of tree and shrub plantings for the system may vary, especially where aesthetics or other considerations are critical to site development. While native plants are encouraged, they are not always appropriate in all situations. While no hard planting rule exists, the plants should be a mix of trees, shrubs and herbaceous materials. However, there should be 2 to 3 shrubs planted per tree and herbaceous plantings shall make up 40% of the total number of plants. Trees shall be a minimum of 1 ½ in. caliper, shrubs shall be minimum 2 gal. size and herbaceous plants shall be a minimum 1 gal size. Mature plant canopy should cover 85% of the Bio Swale. Alternative planting schemes, including use of ornamental grasses, may be considered in some situations, so long as the planting plan is designed by a Registered Landscape Architect registered in the State of Maryland, however lawn grasses are not appropriate for these facilities. All plantings shall be in accordance with the Montgomery County landscape guidelines. All landscape plans must be sealed by a registered landscape architect. Since the plants are an integral part of the Bio Swale system, no changes to the approved landscape plan will be allowed unless an alternate plant list, prepared by a registered landscape architect, has been approved by DPS prior to installation. Since plant availability can change, DPS suggests including an alternate plant list on the landscaping plans.

Bio Swale Sizing Example

A Bio Swale is being designed to treat the runoff from a parking lot that is part of a larger development. The target ESD_V for the overall project has already been determined. The total treatment area to the facility is 20,000 square feet (17,500 square feet impervious area and 2,500 square feet of pervious area, yielding an impervious percentage of 88%).

Calculate the maximum volume that can be stored in the facility:

ESDv(MAX) = [(Pe) (Rv) (A)]/12

= [(2.6")(0.84)(20,000sf)]/12

= 3,640 cf

Rv = 0.05 + (.009 x I)

= 0.05 + (.009*88) = 84

Calculate the minimum volume that must be stored in the facility:

ESDv(MIN) = [(Pe) (Rv) (A)]/12

= [(1.0")(0.84)(20,000sf)]/12

= 1,400 cf

Rv = 0.05 + (.009 x I)

= 0.05 + (.009*88) = 84

To calculate the ESDv provided by this facility we will assume a 4' wide channel width and 3.5' thick media layer (2.0' planting medium, 0.5' sand, 1.0' gravel). The porosity for the media layer is n = 0.40. Assume the swale is 350 feet in length, resulting in area of the filter bed (Af) = 4*350 = 1,400 sf.

- ESDv = Storage in Filter Media

  = 0.4*(1,400*3.5) = 1,960 cf

Since the proposed ESDv exceeds the minimum storage required, the Bio Swale design is acceptable.