Grass Swale (GS) – Sedimentation Facility

Description

A grass swale (GS) sedimentation facility is an integral part of the MDCIA development concept. They are densely vegetated drainageways with low-pitched sideslopes that collect and slowly convey runoff. Design of their longitudinal slope and cross-section size forces the flow to be slow and shallow, thereby facilitating sedimentation while limiting erosion. Berms or check dams should be installed perpendicular to the flow as needed to slow it down and to encourage settling and infiltration.

General Application

A GS can be located to collect overland flows from areas such as parking lots, buildings, residential yards, roadways and grass buffer strips (GBs). They can be made a part of the plans to minimize a directly connected impervious area by using them as an alternative to a curb-and-gutter system. A GS is set below adjacent ground level, and runoff enters the swales over grassy banks. The potential exists for wetland vegetation to become established if the swale experiences standing water or if there is a base flow. If that condition is possible, consider the use of underdrains. A site with a base flow should be managed as either a swale with an unlined trickle channel, or as a wetland bottom channel, the latter providing an additional BMP to stormwater runoff.

Advantages/Disadvantages

General

A GS, which can be more aesthetically pleasing than concrete or rock-lined drainage systems, is generally less expensive to construct. Although limited by the infiltration capacity of local soils, this BMP can also provide some reduction in runoff volumes from small storms. Dense grasses can reduce flow velocities and protect against erosion during larger storm events. Swales in residential and commercial/industrial settings can also be used to limit the extent of directly connected impervious areas.

The disadvantages of using GSs without underdrains include the possibility of soggy and wet areas in front yards, the potential for mosquito breeding areas, and the potential need for more right-of-way than is needed for a storm sewer.

Physical Site Suitability

A GS is practical only at sites with general ground slopes of less than 4 percent and are definitely not practical for sites steeper than 6 percent. The longitudinal slopes of a GS should be kept to less than 1 percent, which often necessitates the use of grade control checks or drop structures. Where the general terrain slope exceeds 4 percent, a GS is often practical only on the upslope side of the adjacent street.

When soils with high permeability (for example, Class A or B) are available, the swale will infiltrate a portion of the runoff into the ground, but such soils are not required for effective application of this BMP. When Class C and D soils are present, the use of a sand/gravel underdrain is recommended.

Pollutant Removal

Removal rates reported in literature vary and fall into the low to medium range. Under good soil conditions and low flow velocities, moderate removal of suspended solids and associated other constituents can be expected. If soil conditions permit, infiltration can remove low to moderate loads of soluble pollutants when flow velocities are very low. As a result, small frequently occurring storms can benefit the most. See Table ND-2 in section 4.1, *New Development Planning* for estimated ranges in pollutant removal rates by this BMP.

Design Considerations and Criteria

Figure GS-1 shows trapezoidal and triangular swale configurations. A GS is sized to maintain a low velocity during small storms and to collect and convey larger runoff events, all for the projected fully developed land use conditions. If the design flows are not based on fully developed land conditions, the swales will be undersized and will not provide the intended pollutant removal, flow attenuation, or flow conveyance capacity.

A healthy turf grass cover must be developed to foster dense vegetation. Permanent irrigation in some cases may be necessary. Judicious use of GSs can replace both the curb-and-gutter systems and greatly reduce the storm sewer systems in the upper portions of each watershed when designed to convey the "initial storm" (for example, a 2- or a 5-year storm) at slow velocities. However, if one or both sides of the GS are also to be used as a GB, the design of the

GB has to follow the requirements for the Grass Buffer (GB) , as listed previously in this section 4.2.

Design Procedure and Criteria

The following steps outline the GS design procedure and criteria.

1. Design Discharge	Determine the 2-year flow rate in the proposed GS using hydrologic procedures described in the Storm Runoff section of the City of Colorado Springs and El Paso County Drainage Criteria Manual.
2. Swale Geometry	Select geometry for the GS. The cross section should be either trapezoidal or triangular with side slopes flatter than 3:1 (Horizontal/ Vertical), preferably 4:1 or flatter. The wider the wetted area of the swale, the slower the flow.
3. Longitudinal Slope	Maintain a longitudinal slope for the GS between 0.2 and 1.0 percent. If the longitudinal slope requirements can not be satisfied with available terrain, grade control checks or small drop structures must be incorporated to maintain the required longitudinal slope. If the slope of the swale exceeds 0.5 percent in semi-arid areas of Colorado, the swale must be vegetated with irrigated turf grass.
4. Flow Velocity and Depth	Calculate the velocity and depth of flow through the swale. Based on Mannings equation and a Mannings roughness coefficient of n=0.05, find the channel velocity and depth using the 2-year flow rate determined in Step 1. Maximum flow velocity of the channel shall not exceed 2.0 feet per second and the maximum flow depth shall not exceed 3 feet at the 2-year peak flow rate. If these conditions are not attained, repeat steps 2 through 4 each time altering the depth and bottom width or longitudinal slopes until these criteria are satisfied.
5. Vegetation	Vegetate the GS with dense turf grass to promote sedimentation, filtration, and nutrient uptake, and to limit erosion through maintenance of low flow velocities.
6. Street and Driveway Crossings	If applicable, small culverts at each street crossing and/or driveway crossing may be used to provide onsite stormwater capture volume in a similar fashion to an EDB (if adequate volume is available).
7. Drainage and Flood Control	Check the water surface during larger storms such as the 5-year through the 100-year floods to ensure that drainage from these larger events is being handled without flooding critical areas or residential, commercial, and industrial structures.

Design Example

Design forms that provide a means of documenting the design procedure are included in the *Design Forms* section. A completed form follows as a design example.

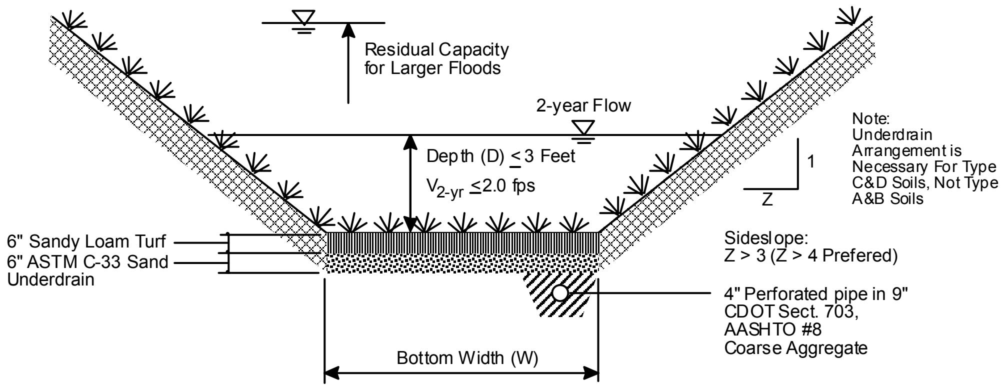
Maintenance Recommendations

Table GS-1 summarizes maintenance needs and related issues and shows the recommended frequency of various maintenance activities.

Healthy grass can generally be maintained without using fertilizers because runoff from lawns and other areas contains the needed nutrients. Occasionally inspecting the grass over the first few years will help to determine if any problems are developing and to plan for long-term restorative maintenance needs.

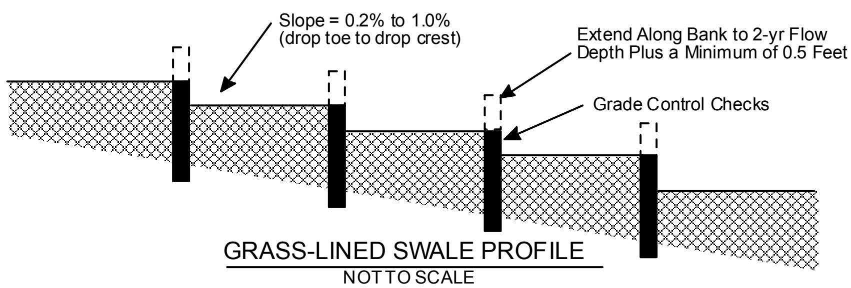
TABLE GS-1
Grass-Lined Swale Maintenance Considerations

Required Action	Maintenance Objective	Frequency of Action
Lawn mowing and lawn care	Maintain irrigated grass at 2 to 4 inches tall and nonirrigated native grass at 6 to 8 inches tall. Collect cuttings and dispose of them offsite or use a mulching mower.	Routine – As needed.
Debris and litter removal	Keep the area clean for aesthetic reasons, which also reduces floatables being flushed downstream.	Routine – As needed by inspection, but no less than two times per year.
Sediment removal	Remove accumulated sediment near culverts and in channels to maintain flow capacity. Replace the grass areas damaged in the process.	Routine – As needed by inspection. Estimate the need to remove sediment from 3 to 10 percent of total length per year, as determined by annual inspection.
Grass reseeding and mulching	Maintain a healthy dense grass in channel and side slope.	Nonroutine – As needed by annual inspection.
Inspections	Check the grass for uniformity of cover, sediment accumulation in the swale, and near culverts.	Routine – Annual inspection is suggested.



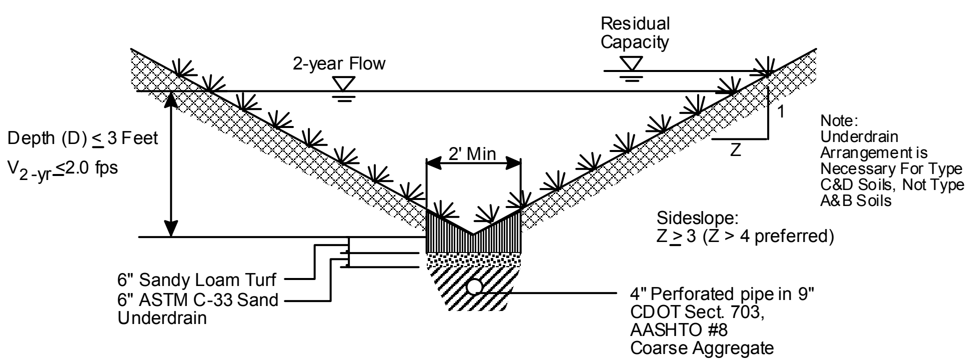
TRAPEZOIDAL GRASS-LINED SWALE SECTION

NOT TO SCALE



GRASS-LINED SWALE PROFILE

NOT TO SCALE



TRIANGULAR GRASS-LINED SWALE SECTION

NOT TO SCALE

FIGURE GS-1
Profile and Sections of a Grass Swale

Design Procedure Form: Grass Swale (GS) Sedimentation Facility

Designer: __________
Company: __________
Date: **May 23, 2002**
Project: __________
Location: __________

1. 2-Year Design Discharge (Total)	Q_2 =	10.0	cfs
2-Year Design Flow Velocity (V_2, 2.0 fps Maximum)	V_2 =	1.30	fps
2. Swale Geometry			
A) Channel Side Slopes (Z, horizontal distance per unit vertical)	Z =	4.00	(horizontal/vertical)
B) 2-Year Design Flow Depth (D_2, 3 feet Maximum)	D_2 =	1.4	feet
C) Bottom Width of Channel (B)	B =	0.0	feet
3. Longitudinal Slope			
A) Froude Number (F, 0.50 maximum, reduce V_2 until F $\leq$ 0.50)	F =	0.28	
A) Design Slope (S, Based on Manning's n = 0.05, 0.01 Maximum)	S =	0.0032	feet/feet
B) Number of grade control structures required		5	(number)
4. Vegetation (Check the type used or describe "Other") (Must use irrigated turf grass if S >0.005 in semi-arid areas of Colorado)			Dryland Grass
		X	Irrigated Turf Grass
			Other:
5. Outlet (Check the type used or describe "Other")		X	Infiltration Trench w/ Underdrain
			Grated Inlet
			Other:

Notes: