Sand Filter Extended Detention Basin (SFB)

Description

A sand filter extended detention basin (SFB) is a stormwater filter that consists of a runoff storage zone underlain by a sand bed with an underdrain system. During a storm, accumulated runoff ponds in the surcharge zone and gradually infiltrates into the underlying sand bed, filling the void spaces of the sand. The underdrain gradually dewaters the sand bed and discharges the runoff to a nearby channel, swale, or storm sewer.

General Application

A SFB is generally suited to offline, onsite configurations where there is no baseflow and the sediment load is relatively low.

Advantages/Disadvantages

General

Primary advantages of SFBs include effective water quality enhancement through settling and filtering. The primary disadvantage is a potential for clogging if a moderate to high level of silts and clays are allowed to flow into the facility. Such clogging would result in the need for significant maintenance. For this reason, it should **not** be put into operation while construction activities are taking place in the tributary catchment. Also, this BMP should not be located close to building foundations or other areas where expansive soils are a concern, although an underdrain and impermeable liner can ameliorate some of this concern.

Physical Site Suitability

Since an underdrain system is incorporated into this BMP, SFB is suited for about any site; presence of sandy subsoils is not a requirement. This BMP has a relatively flat surface area, so it may be more challenging to incorporate it into steeply sloping terrain.

Pollutant Removal

Although not fully tested to date in the Denver area, the tests on filter vaults in the Denver area and other parts of United States show that the amount of pollutant removed by this BMP should be significant and should at least equal the removal rates by sand filters tested elsewhere. See Table ND-2 for estimated ranges in pollutant removals.

Maintenance Needs

Before selecting this BMP, be sure that the maintenance specified in the Maintenance Requirements chapter of this manual will be provided by either a local government or by the owner. This BMP's performance is critical on having regular maintenance provided.

Design Procedure and Criteria

The following steps outline the design procedure and criteria for an SFB.

1. Basin Storage Volume — Provide a storage volume equal to 100 percent of the WQCV based on a 40-hour drain time, above the sand bed of the basin.

   A. Determine the WQCV tributary catchment's percent imperviousness. Account for the effects of DCIA, if any, on Effective Imperviousness. Using Figure ND-1, determine the reduction in impervious area to use with WQCV calculations.

   B. Find the required storage volume (watershed inches of runoff):

      Determine the Required WQCV (watershed inches of runoff) using Figure SFB-2, based on the SFB's 40-hour drain time.

   C. Calculate the Design Volume in acre-feet as follows:

$$Design\,Volume = \left(\frac{WQCV}{12}\right) * Area$$

      In which:

      $Area$ = The watershed area tributary to the SFB (acres)

2. Basin Depth — Maximum Design Volume depth shall be 2.5 feet.

3. Filter's Surface Area — Calculate the **minimum** sand filter area (A_s) at the basin's bottom with the following equation:

$$A_s = Design\ Volume / 3 \quad *43{,}560 \text{ (square feet)}$$

4. Outlet Works

An 18 inch layer of sand (ASTM C-33) over a 9 inch gravel layer (AASHTO No. 8; CDOT Section 703, #8) shall line the entire SFB for purposes of draining the WQCV.

If expansive soils are a concern or if the tributary catchment has chemical or petroleum products handled or stored, install an impermeable membrane below the gravel layer.

In addition, an overflow shall be provided to convey flows in excess of the WQCV out of the basin.

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 SFB-1
Sand Filter Detention Basin Maintenance Considerations

Required Action	Maintenance Objectives	Frequency
Debris and litter removal	Remove debris and litter from detention area to minimize clogging of the sand media.	Routine – depending on aesthetic requirements.
Landscaping removal and replacement	If the sand filter is covered with rock mulch, bluegrass, or other landscaping covers, the cover must be removed to allow access to the sand media. Replace landscaping cover after maintenance of sand media is complete.	Every 2 to 5 years.
Scarify filter surface	Scarify top 3 to 5 inches by raking the filter's surface.	Once per year or when needed to promote drainage.
Sand filter removal	Remove the top 3 inches of sand from the sand filter. After a third removal, backfill with 9 inches of new sand to return the sand depth to 18 inches. Minimum sand depth is 12 inches.	If no construction activities take place in the tributary watershed, every 2 to 5 years depending on observed drain times, namely when it takes more than 24 hours to empty 3-foot deep pool. Otherwise more often. Expect to clean out forebay every 1 to 5 years.
Inspections	Inspect detention area to determine if the sand media is allowing acceptable infiltration.	Routine – bi-annual inspection of hydraulic performance, one after a significant rainfall.

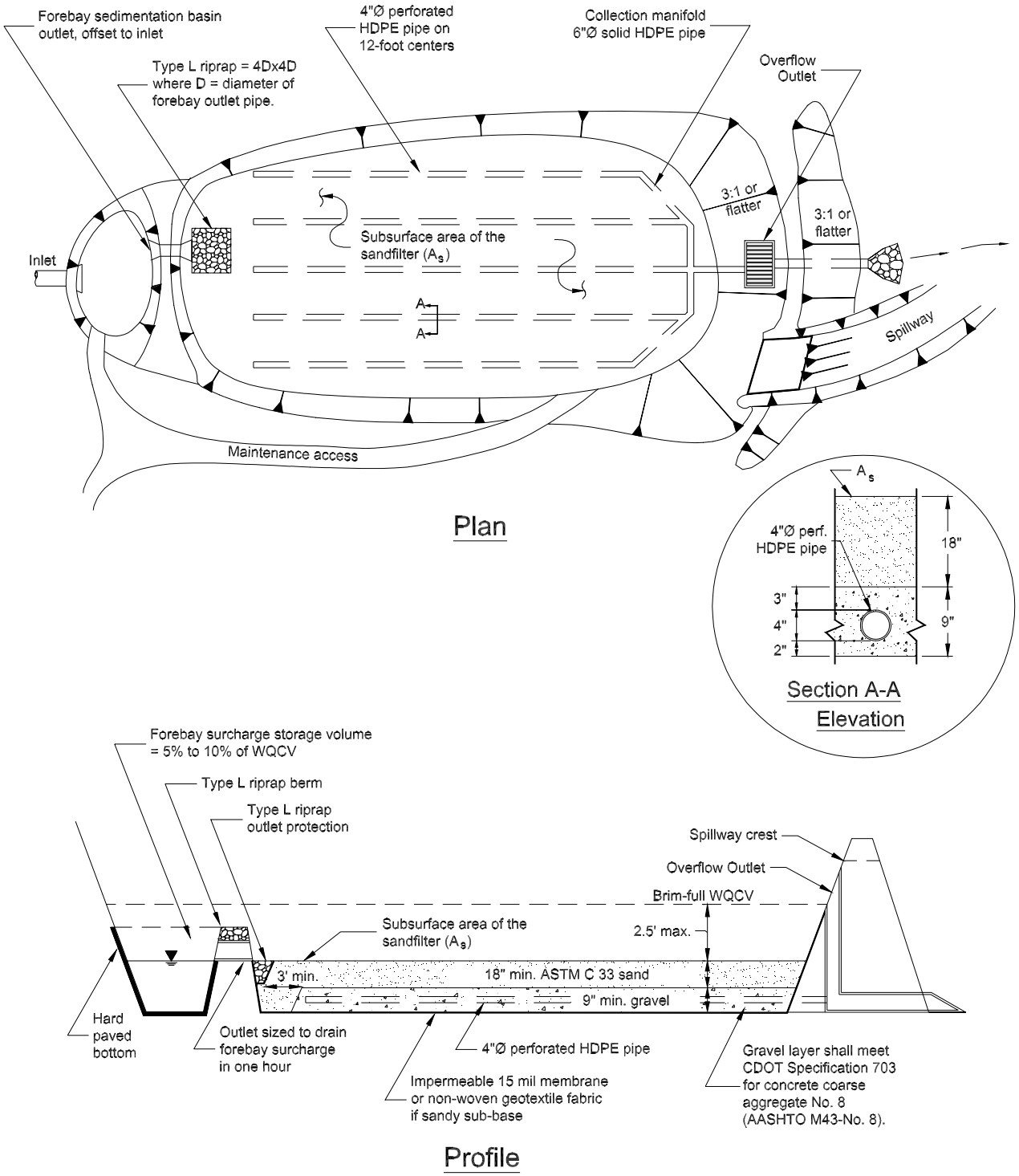

FIGURE SFB-1
Sand Filter Basin

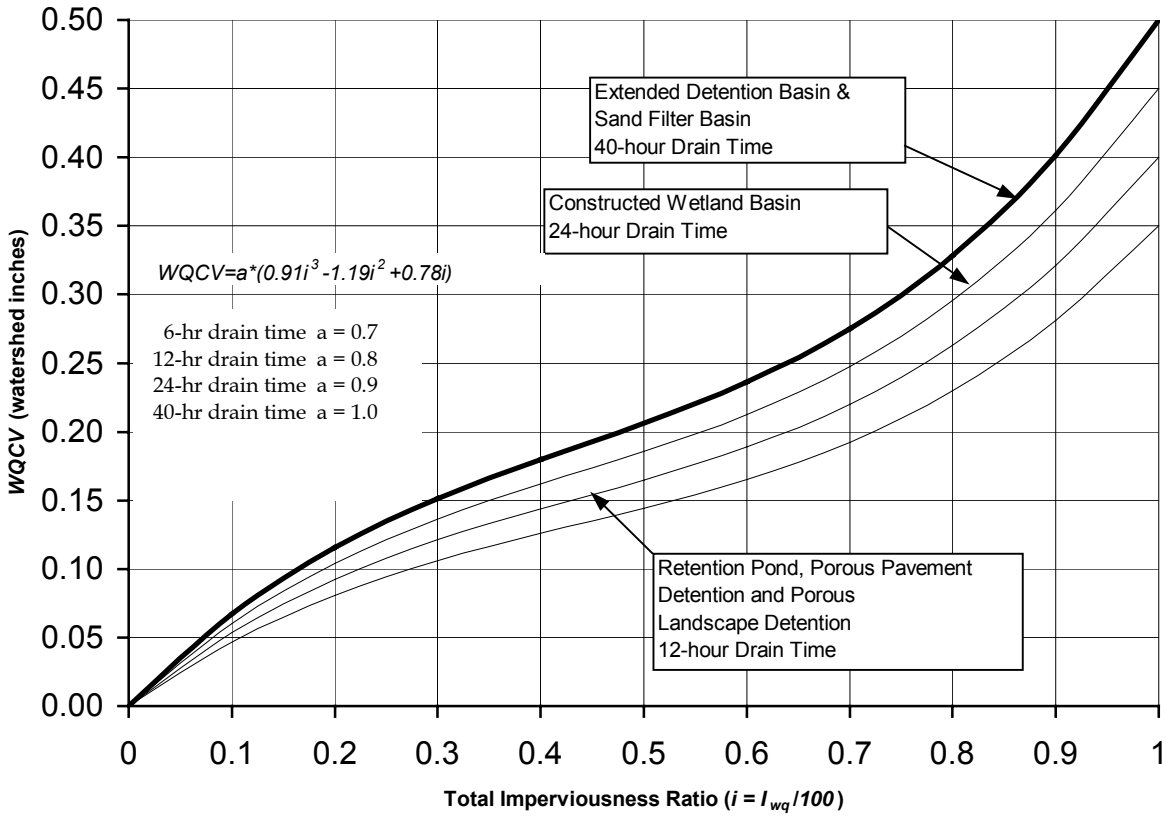

FIGURE SFB-2
Water Quality Capture Volume (WQCV), 80th Percentile Runoff Event

Design Procedure Form: Sand Filter Basin (SFB)

Designer: _____

Company: _____

Date: **September 22, 1999**

Project: _____

Location: _____

1. Basin Storage Volume	
A) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	I_a = 50.00 % i = 0.50
B) Contributing Watershed Area (Area)	Area = 40.00 acres
C) Water Quality Capture Volume (WQCV) (WQCV =1.0 * (0.91 * I^3 - 1.19 * I^2 + 0.78 * I))	WQCV = 0.21 watershed inches
D) Design Volume: Vol = (WQCV / 12) * Area	Vol = 0.688 acre-feet
2. Minimum Filter Surface Area: A_s = (Vol / 3) * 43,560	A_s = 9,983 square feet
Filter Surface Elevation	5478.50 feet
Average Side Slope of the Filter Basin (3:1 or flatter)	Z = 4.0
3. Estimate of Basin Depth (D), based on filter area A_s	D = 2.6 feet
4. Outlet Works	
A) Sand (ASTM C-33) Layer Thickness (18" min.)	18 inches
Gravel (AASHTO No. 8; CDOT Section 703) Layer Thickness (9" min.)	9 inches
B) Overflow Elevation At Top of Design Volume (Filter Surface Elev. + Estimate of Basin Depth (D))	5481.10 feet
5. Draining of porous pavement (Check a, **or** b, **or** c, **answer** d) Based on answers to 5a through 5d, check the appropriate method	_____ Infiltration to Subgrade with Permeable Membrane: 5(c) checked **and** 5(d) = no
a) Check box if subgrade is heavy or expansive clay [ ]	**X** Underdrain with Impermeable Membrane: 5(a) checked **or** 5(d) = yes
b) Check box if subgrade is silty or clayey sands [ ]	
c) Check box if subgrade is well-draining soils [X]	_____ Underdrain with Permeable Membrane: 5(b) checked **and** 5(d) = no
d) Does tributary catchment contain land uses that may have petroleum products, greases, or other chemicals present, such as gas station, hardware store, restaurant, etc.? yes [X] no [ ]	_____ Other: _____
6 Describe Provisions for Maintenance	_____

Notes: _____