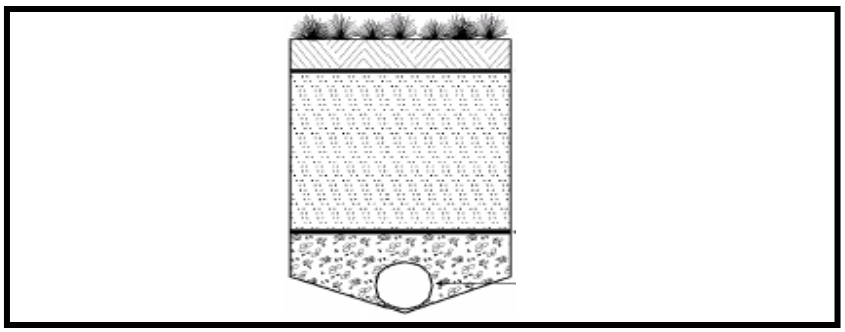
ACTIVITY: Filter / Adsorption Bed

F – 04



Targeted Constituents				
● Significant Benefit	◗ Partial Benefit	○ Low or Unknown Benefit		
◗ Sediment	◗ Heavy Metals	○ Floatable Materials	◗ Oxygen Demanding Substances	
◗ Nutrients	◗ Toxic Materials	◗ Oil & Grease	○ Bacteria & Viruses	○ Construction Wastes

Implementation Requirements			
● High	◗ Medium	○ Low	
● Capital Costs	● O & M Costs	◗ Maintenance	○ Training

Description

The filter, or adsorption, bed is a ground-level open-air structure that can capture and temporarily store stormwater runoff and filter it through a bed of sand. It is capable of treating drainage areas up to 10 acres in size and is typically located off-line. Filter beds can be designed as an excavation with an earthen embankment or as a concrete structure.

Most sand filter systems consist of two-chamber structures. The first chamber is a sediment forebay, which removes debris and heavy sediments, while the second chamber, or filtration chamber, removes additional pollutants by filtering the runoff through a sand bed. The filtered runoff is typically collected and returned to the conveyance system or exfiltrated into the surrounding soil.

Selection Criteria

Because they have few site constraints beside head requirements, filter beds can be used on development sites where the use of other structural controls may be used. However, sand filter systems can be relatively expensive to construct and install.

Sand filter systems are designed primarily as off-line systems for stormwater quality (i.e., the removal of stormwater pollutants) and will typically need to be used in conjunction with another structural control to provide downstream channel protection, overbank flood protection, and extreme flood protection, if required. However, under certain circumstances, filters can provide limited runoff quantity control, particularly for smaller storm events.

Sand filter systems are well suited for highly impervious areas where land available for structural controls is limited. Sand filters should primarily be considered for new construction or retrofit opportunities for commercial, industrial, and institutional areas where the sediment load is relatively low, such as: parking lots, driveways, loading docks, gas stations, garages, airport runways/taxiways, and storage yards. Sand filters may also be feasible and appropriate in some multi-family or higher density residential developments.

To avoid rapid clogging and failure of the filter media, the use of sand filters should be avoided in areas with less than 50% impervious cover, or high sediment yield sites

with clay/silt soils. The following basic criteria should be evaluated to ensure the suitability of a sand filter facility for meeting stormwater management objectives on a site or development.

Design and Sizing Considerations

Some factors to consider in design are included below:

- Maximum contributing drainage area to an individual stormwater filtering system should be less than 10 acres.
- Pretreatment measures such as filter strips are required to prevent sediment, oil, and grease from clogging the filter.
- Most sand filters normally require one to six feet of head.
- Sand filter systems are designed for intermittent flow and must be allowed to drain completely in 48 hours and re-aerate between rainfall events. They should not be used on sites with a continuous flow from groundwater, sump pumps, or other sources.
- Inlet structure should be designed to spread the flow uniformly across the surface of the filter media.
- An emergency overflow structure should be included in design to bypass larger storms. See P-01, Detention Ponds, for more information.
- Stone riprap or other dissipation devices should be installed to prevent gouging of the sand media and to promote uniform flow.
- Underdrain pipes should consist of main collector pipes and perforated lateral branch pipes.
- The underdrain piping should be designed or reinforced to withstand the weight of the overburden.
- Internal diameters of lateral branch pipes should be 4 inches or greater (6 inches preferred) and perforations should be 3/8 inch. Maximum spacing between rows of perforations should not exceed 6 inches.
- All piping should be schedule 40 polyvinyl chloride or greater strength.
- Maximum grade across filter should be 6%.
- Minimum grade of piping should be 1%.
- At least two feet are required between the bottom of the sand filter and the elevation of the seasonally high water table.
- Access for cleaning all underdrain piping should be provided.
- Surface filters may have a grass cover to aid in pollution adsorption.
- Sand/peat beds have higher removal effectiveness due to adsorptive properties of peat.

Two sand bed configurations are recommended for use. A typical sand media cross section is shown as Figure F-04-2.

Sand Bed with Gravel Layer

- Top layer of sand should be a minimum of 18 inches of 0.02 - 0.04 inch diameter sand (smaller sand size is acceptable).
- A layer of one-half to 2-inch diameter gravel under the sand should be provided for a minimum of 2 inches of cover over the top of the under-drain lateral pipes.
- No gravel is required under the lateral pipes.
- A layer of geotextile fabric (permeable filter fabric) should separate the sand and gravel.

Sand Bed with Trench

- Top layer of sand is to be 12-18 inches of 0.02 - 0.04 inch diameter sand (smaller size is acceptable).
- Laterals to be placed in trenches with a covering of one-half to 2-inch gravel and geotextile fabric.
- The lateral pipes are to be underlain by a layer of drainage matting.
- A presettling basin and/or biofiltration swale is recommended to pretreat runoff discharging to the sand filter.
- A maximum spacing of 10 feet between lateral underdrain pipes is recommended.

Construction/ Inspection Considerations

Some construction considerations are as follows:

- Heavy construction equipment, vehicles, and even excessive foot travel can compact the filter media and reduce its effectiveness.
- Filter beds will not function properly if clogged with sediment and debris, and therefore most of the designs are not recommended near construction areas without appropriate sediment control.
- Vegetation should be established over the contributing drainage areas before runoff can be accepted into the facility.

Maintenance

Some maintenance guidelines to consider are below:

- Inspect filter beds on a regular basis, typically every month and after heavy rainfalls. Record observations in an inspection log and take pictures as necessary to document conditions. Make immediate repairs as needed. Clean or replace filtration media as needed to prevent clogging.
- Remove trash, debris, sediments or clogged media as needed, and then dispose of them properly. Sediments or clogged media may contain heavy metals or other toxic substances and should be handled as hazardous waste. Removal of sediment or clogged media depends on the accumulation rate, available storage, watershed size, nearby construction, industrial or commercial activities upstream, etc. Sediment or clogged media should be tested for identification of pollutants prior to disposal.
- Some sediment may contain contaminants for which the Tennessee Department of Environment and Conservation (TDEC) requires special disposal procedures.

Consult TDEC - Division of Water Pollution Control if uncertain about what the sediments contain or if it is known to contain contaminants. Generally, give special attention or sampling to sediments accumulated in industrial or manufacturing facilities, fueling centers or automotive maintenance areas, large parking areas, or other areas where pollutants are suspected to accumulate.

- Scrape off sediment layer buildup during dry periods with steel rakes or other devices.
- Replace some or all of the sand when permeability of the filter media is reduced to unacceptable levels, which should be specified in the design of the facility. When the bed does not completely drain within 48 hours of the end of a rainfall, the top layers of media (topsoil and 2 to 3 inches of sand) should be removed and replaced.
- It is generally more cost efficient to clean the filtration media than to replace it. For sand filters, cleaning or replacement of the top few inches may restore the permeability rate. Failure to clean the filter surface regularly may result in the need to replace the entire media because of penetration of fines into the filter.
- A very important consideration is the allocation of long-term resources for inspection, maintenance and repair.
- It is important to keep the filters clean. Any debris, sediment, grass clippings, etc. should be removed from the system and properly disposed.

Cost Considerations

Capital costs and maintenance can be relatively expensive for this type of BMP.

Limitations

Some limitations of filter beds are as follows:

- Filter beds will require more frequent inspection and maintenance than most other stormwater treatment BMPs. Filtration media will need to be cleaned and/or replaced frequently. There is very high potential for severe clogging or reduced pollutant removal efficiency in filtration systems, particularly if there are unstabilized soil surfaces upstream. Do not operate filtration systems until upstream erosion areas are controlled.
- Media filtration systems cause a large head loss that may require special consideration in the hydraulic design of the overall stormwater collection system. Systems may typically require vertical filtration through at least 18 inches of sand and underdrain material.
- There is a possibility of pulse loadings due to resuspension of pollutants from dirty filters during intense storms.
- It is difficult to dispose of spent filter media in methods that are environmentally sound and cost-effective.

Additional Information

See attached figures.

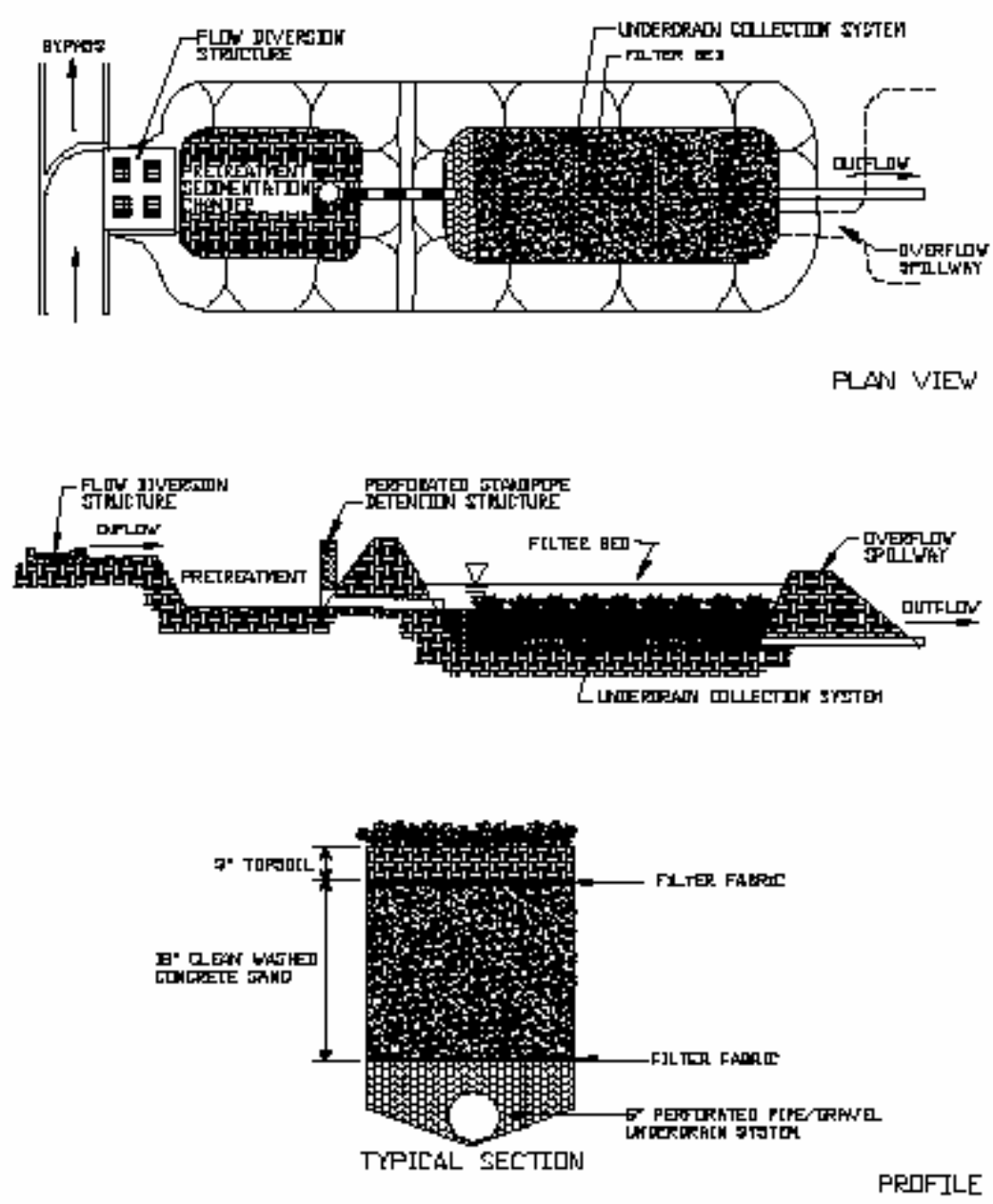


Figure F-04-1
Typical Filter Bed Layout

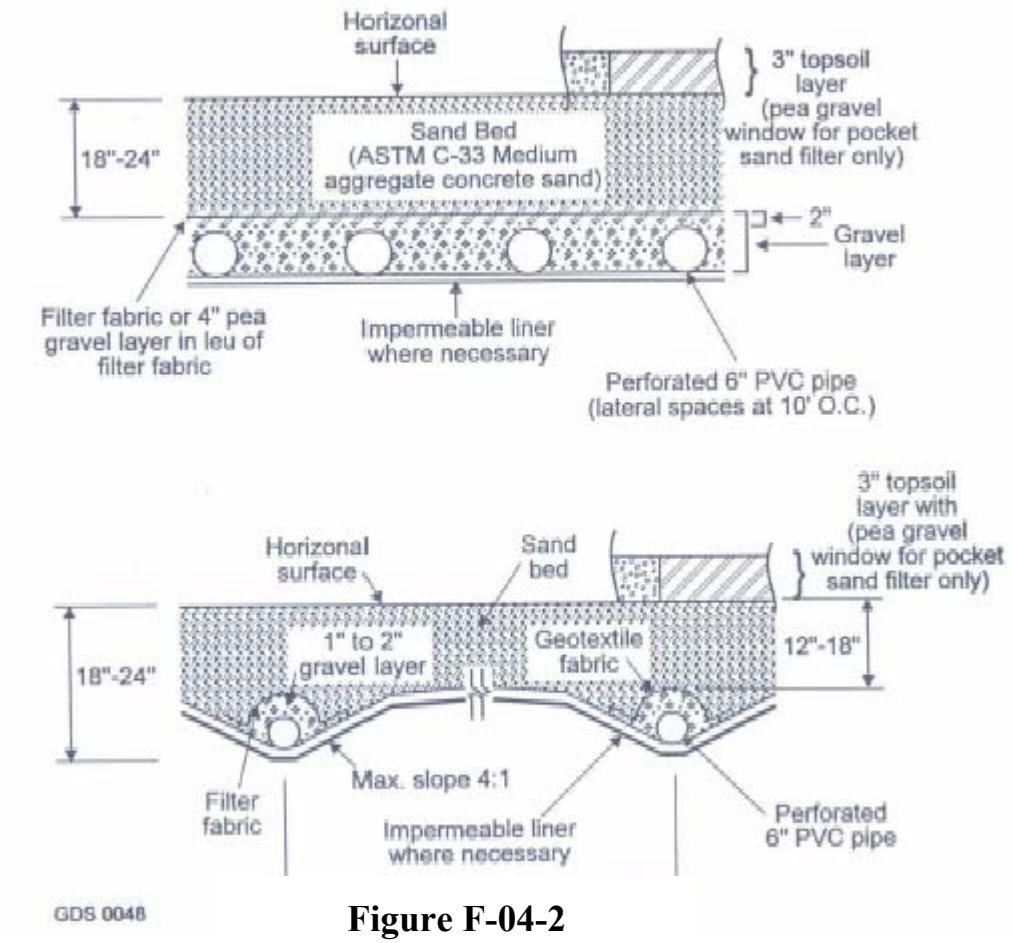


Figure F-04-2
Typical Sand Filter Media
Cross Sections

References

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Center for Watershed Protection. "Design of Stormwater Filtering Systems", 1996. Center for Watershed Protection website: www.cwp.org.

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