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Best Management Practice Fact Sheet 12:

Filtering Practices

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This fact sheet is one of a 15-part series on urban *stormwater management* practices.

Please refer to definitions in the glossary at the end of this fact sheet.
Glossary terms are *italicized* on first mention in the text. For a comprehensive list, see Virginia Cooperative Extension (VCE) publication 426-119, "Urban Stormwater: Terms and Definitions."

What Are Filtering Practices?

A stormwater *filtering practice* (FP) treats *stormwater* runoff by passing it through an engineered *filter media* consisting of either sand, gravel, organic matter, and/or a proprietary manufactured product, collecting it in an *underdrain*, and then discharging the effluent to a *stormwater conveyance system*. FPs are *stormwater treatment practices* that are often obtained from the marketplace due to unique proprietary technologies (see figure 1).

Figure 1. Photograph of filtration practice.
Source: Washington County, Md., Public Works, 2011.

Where Can FPs Be Used?

FPs are useful for treating runoff from small, highly *impervious* sites, including *hot spots*. They work on most commercial, industrial, institutional, or municipal sites and can be located underground if surface area is not available.

Volume-based filters are designed based upon a specific treatment volume. Rate-based filters are designed based on a treatment residence time. Volume-based filters are smaller and generally offline, and they provide pretreatment. Rate-based filters require more detention volume and provide outlet treatment.

A constraining factor to placing FPs is available *hydraulic head*. This is generally the amount of elevation that must be provided to overcome energy losses due to friction within the filter media. Generally, 2 to 10 feet is recommended, and when this space is unavailable, the unit can be placed underground.

How Do FPs Work?

FPs provide runoff water quality treatment; however, they do not normally run off. Filter design usually employs two chambers: one for *settling* of large particles and a second to filter pollutants contained in the stormwater (see figure 2).

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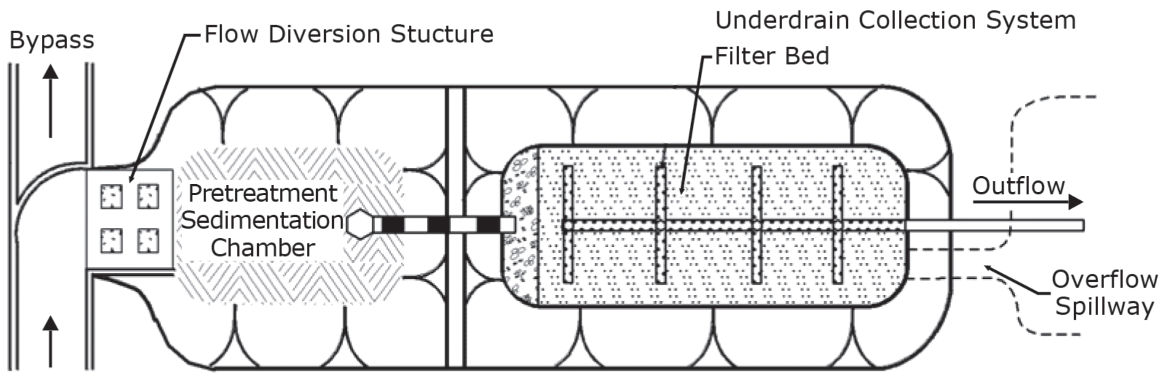

Figure 2. Plan view of typical filtration practice. Source: Metropolitan government of Nashville, Tenn., 2006.

The types of pollutants treated for depend on the filtering media. Organic matter achieves greater removal of *heavy metals* and *hydrocarbons* due to increased *cationic exchange capacity*. Microbial films may also form on the surface of the filtering media, increasing potential for *microbial decomposition* and *nutrient* removal. Physically, FPs may also remove suspended *sediment*, refuse, and other *floatables* from stormwater with little risk of *groundwater contamination*.

Limitations

- Drainage area smaller than 5 acres.
- Restricted to stabilized, *impervious surfaces* to minimize filter media clogging.
- High cost.
- Requires a drop in elevation, or hydraulic head, of 8 to 10 feet and, thus, is difficult to use in flat terrain.
- Does not aid in runoff volume control. Filters may be susceptible to freezing, and some design adjustments may be required.
- Generally not aesthetically pleasing unless covered with vegetation or located underground.

Maintenance

Routine Maintenance (annual)

- Frequent maintenance is required to prevent filter media clogging. Clogging results in ponding and a bypass of the filter.
- Remove trash, debris, and other floatables.
- Inspect and clean spillway.
- Inspect observation wells and cleanouts.

Nonroutine Maintenance (as needed)

- Perform sediment cleanouts of initial settling chamber.
- Remove or replace filter media as needed.
- Stabilize contributing drainage area and side slopes to prevent *erosion*.
- Rake media as needed to break up the surface layer of the media and prevent clogging.
- Provide mosquito and odor control.

Performance

Filtering practices are effective at removing multiple pollutants from incoming runoff. A typical FP is expected to reduce total phosphorus (TP) by 60 percent and total nitrogen (TN) by 30 percent (VA-DCR 2011). Advanced designs have more stringent requirements, but they can increase TP removal to 65 percent and TN removal to 45 percent (VA-DCR 2011).

Besides nutrient removal, different types of FPs may also treat for heavy metals, hydrocarbons, sediment, *pathogens*, floatables, oil and grease, and other dissolved pollutants. The effectiveness of FPs depends on continued maintenance.

Expected Cost

Filtering practices are a relatively expensive type of *stormwater treatment practice* when compared to other alternatives, especially considering the size of the treatable area. A preliminary estimate of average construction cost is $23,500 per acre of impervious area treated (EPA 2006). The value of land does not need to be included for underground systems, which makes this an attractive option for ultra-urban areas; however, this may not offset higher construction costs. Maintenance costs are generally 11 percent to 13 percent of construction costs, or approximately $2,800 annually. Failure to maintain the system regularly will likely render its water quality properties useless and may cause other damages such as flooding.

Additional Information

The Virginia departments of Conservation and Recreation (VA-DCR) and Environmental Quality (VA-DEQ) are the two state agencies that address nonpoint source pollution. The VA-DCR oversees agricultural conservation; VA-DEQ regulates stormwater through the Virginia Stormwater Management Program.

Additional information on best management practices can be found at the Virginia Stormwater BMP Clearinghouse website at http://vwrrc.vt.edu/swc. The BMP Clearinghouse is jointly administered by the VA-DEQ and the Virginia Water Resources Research Center, which has an oversight committee called the Virginia Stormwater BMP Clearinghouse Committee. Committee members represent various stakeholder groups involved with stormwater management.

Online Resources

Chazen Companies – www.chazencompanies.com/sustainable_design/..%5CSustainable_Design%5Cdocs%5CDefinitions_and_Examples_of_Stormwater_Management_Tools.pdf

Chesapeake Stormwater Network – www.chesapeakestormwater.net/all-things-stormwater/filtering-design-specification.html

Maryland Department of the Environment – www.mde.state.md.us/assets/document/chapter3.pdf

Metropolitan Government of Nashville and Davidson County, Tennessee – www.nashville.gov/stormwater/docs/SWMM/Volume04_BMPs/12_Organic_Filter.pdf

University of Minnesota – http://stormwaterbook.safl.umn.edu/content/filtration-practices

U.S. Environmental Protection Agency – www.epa.gov/greeningepa/stormwater/best_practices.htm#additional_techniques

Virginia BMP Stormwater Clearinghouse – http://vwrrc.vt.edu/swc/

Companion Virginia Cooperative Extension Publications

Daniels, W., G. Evanylo, L. Fox, K. Haering, S. Hodges, R. Maguire, D. Sample, et al. 2011. *Urban Nutrient Management Handbook*. Edited by J. M. Goatley. VCE Publication 430-350.

Gilland, T., L. Fox, M. Andruczyk, and L. Swanson. 2009. *Urban Water-Quality Management - What Is a Watershed?* VCE Publication 426-041.

Sample, D., et al. 2011-2012. Best Management Practice Fact Sheet Series 1-15, VCE Publications 426-120 through 426-134.

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Virginia Department of Conservation and Recreation (VA-DCR). 2011. *Virginia DCR Stormwater Design Specification No. 12: Filtering Practices*, Version 1.7. http://vwrrc.vt.edu/swc/april_22_2010_update/DCR_BMP_Spec_No_12_FILTERING_PRACTICES_Final_Draft_v1-7_03082010.htm.

Glossary of Terms

Best management practice – Any treatment practice for urban lands that reduces pollution from stormwater. A BMP can be either a physical structure or a management practice. Agricultural lands use a similar, but different, set of BMPs to mitigate agricultural runoff.

Cationic exchange capacity – The maximum quantity of total cations (metals) that a given soil is capable of holding for exchange within the soil solution. Used as an indicator for nutrient retention capacity and groundwater contamination resistibility.

Erosion – A natural process by either physical processes, such as water or wind, or chemical means that moves soil or rock deposits. Excessive erosion is considered an environmental problem that is very difficult to reverse.

Filter media, engineered filter media – Designed material that removes pollutants through filtration; usually consists of sand, organic matter, or propriety product.

Filtering practice – A stormwater treatment practice that passes runoff through a filter media to remove pollutants.

Floatables – Litter and debris that float and travel with water.

Groundwater contamination – The presence of unwanted chemical compounds in groundwater. In this case we would normally be referring to dissolved nitrogen compounds such as nitrates.

Heavy metals – Elements such as zinc and copper that accumulate in urban areas mainly due to automobile use. These metals are readily available to bind to soil and clay particles, but in certain conditions can be transported with runoff and contaminate groundwater.

Hot spots – Areas that generate exceedingly high concentrations of pollutants due to land use or activities adjacent to the waterway.

Hydraulic head – The difference in elevation between two points of flowing water.

Hydrocarbons – Molecules containing the elements carbon and hydrogen; classified as pollutants due to their contribution to ground level ozone and smog.

Infiltration – The process by which water (surface water, rainfall, or runoff) enters the soil.

Impervious surfaces – Hard surfaces that do not allow *infiltration* of rainfall into them; not pervious.

Microbial decomposition – The breakdown of compounds or organic matters into smaller ones with the aid of microorganisms.

Nutrients – The substances required for growth of all biological organisms. When considering water qualities, the *nutrients* of the greatest concern in stormwater are nitrogen and phosphorus, because they are often limiting in downstream waters. Excessive amounts of these substances are pollution and can cause algal blooms and dead zones to occur in downstream waters.

Pathogen – A microbe or microorganism that causes disease.

Sediment – Soil, rock, or biological material particles formed by weathering, decomposition, and erosion. In water environments, sediment is transported across a *watershed* via streams.

Settling – The process by which particles that are heavier than water fall to the bottom under the influence of gravity.

Stormwater – Water that originates from *impervious surfaces* during rain events; often associated with urban areas and also called runoff.

Stormwater conveyance system – Means by which stormwater is transported in urban areas.

Stormwater treatment practice – A type of *best management practice* that is structural and reduces pollution in the water that runs through it.

Underdrain – A perforated pipe in the bottom of a best management practice, such as bioretention or permeable pavement, designed to collect water that does not infiltrate native soils.

Watershed – A unit of land that drains to a single "pour point." Boundaries are determined by water flowing from higher elevations to the pour point. The pour point is the point of exit from the watershed, or where the water would flow out of the watershed if it were turned on end.