Best Management Practices: Brief Guide For Homeowners

Stormwater Management

ROSSTOWNSHIP

How to use this guide:
Read the first paragraph in each method to see if any are of best interest for your property. Read further if any are believed to work with your stormwater management issue. Contact the Township for further information or assistance if needed.

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Note: This is only a guide for educational purposes.

Note: The guide's information is taken from the Environmental Protection Agency unless otherwise noted: http://www.epa.gov/greeningepa/stormwater/best_practices.htm

Introduction

Best Management Practices (BMPs) is a term used to describe a type of water pollution control. Stormwater BMPs are techniques, measures or structural controls used to manage the quantity and improve the quality of stormwater runoff. The goal is to reduce or eliminate the contaminants collected by stormwater as it moves into streams and rivers. EPA researchers are working to maintain the water quality, which protects both the environment and the public.

Once pollutants are present in a waterbody altering its physical makeup and habitat, it is much more difficult and expensive to restore it. Therefore, the use of BMPs that prevent damage to receiving waters is our target. Stormwater pollution has two main components:

- the increased volume and rate of runoff from water resistant surfaces, such as roads and parking lots, and
- the amount of pollutants in the runoff.

Both components are directly related to urban development. They can cause changes in water quality. This results in a variety of problems:

- environment modification and loss,
- increased flooding,
- decreased native wildlife, and
- increased sedimentation and erosion.

In turn, effective management of stormwater runoff offers a multitude of benefits:

- protection of wetlands and ecosystems,
- improved water quality of streams, rivers and other water bodies,
- protection of water resources,
- protection of public health, and
- flood control.

What is required?

A. Install "Stormwater Management Facilities (BMPs)" to reduce downstream flooding and protect the water quality of our streams.

B. Install erosion and sedimentation control devices during construction to keep silt and sediment from washing into the storm sewers, ditches or streams on or adjacent to the site.

C. Properly record a maintenance agreement to insure the continued maintenance and protection of the BMP facilities.

Note: The guide’s information is taken from the Environmental Protection Agency unless otherwise noted.

RAIN BARRELS AND CISTERNS

Rain barrels and cisterns harvest rainwater for reuse. Rain barrels are placed outside a building at roof downspouts to store rooftop runoff for later reuse in lawn and garden watering. Cisterns store rainwater in significantly larger volumes in manufactured tanks or underground storage areas. Rainwater collected in cisterns may also be used in non-potable water applications such as toilet flushing. Both cisterns and rain barrels can be implemented without the use of pumping devices by relying on gravity flow instead. Rain barrels and cisterns are low-cost water conservation devices that reduce runoff volume and, for very small storm events, delay and reduce the peak runoff flow rates. Both rain barrels and cisterns can provide a source of chemically untreated "soft water" for gardens and compost, free of most sediment and dissolved salts.

Overview

Cistens and rainbarrels are storage tanks that capture runoff water from a catchment area such as a rooftop. Cisterns are essentially large-scale rain barrels. Cisterns can be located above or below ground, depending on site conditions and the preferred use of the harvested rainwater. Runoff collected from rooftops is often relatively clean and can be used for irrigation or for flushing toilets. Rain barrels, often made from 55 gallon drums, are becoming popular with homeowners as a supplemental irrigation source.

Design Considerations

Cisterns or rain barrels can be applied across various site conditions. Because they function independent of soil types and sit slops, the possibilities for residential and commerical application of cisterns throughout Pennsylvania are widespread. Their sizing is based on expected water demands, rainfall pattern, and cistern sustem cost. A general rule of thumb is that the 1" of rain on 1000 sq ft of roof will yield approximately 600 gallons. Rain barrels are often elevated on stands to improve water pressure of the outflow. Cisterns and rain barrels are placed near the catchment site. Cisterns should not be placed near trees whose roots may damage the cistern walls. A spigot is usually attached to the rain barrel or cistern for use and drainage. Submersible or surface pumps can also be used with cisterns to increase pressure for use in most irrigation systems.

Operations and Maintenance

Rain barrels and cisterns require minimal maintenance. The tank should be cleaned out about once a year if debris is present. Gutters and downspouts should eb inspected regularly and kept clean. If a first flush bypass is used, remove debris from the bypass and make sure drain holes are kept open so that the systemm properly. No maintenance is required to prevent mosquito breeding in a rain barrel if all surgaces at the downspout enterance are sealed. However, the seals should be inspected periodically, and if mosquitoes become a problem, mosquite dunks [floating donut shaped briquettes containing the biological insectidice *Bacillus thuringiensis* (Bt)] can be used.

Relative Cost

Materials and installation vary. A single residential rain barrel with typical attachments and accessories costs around $50 for the parts for self assembly and $200 assembled, whereas cisterns costs can start at about $1,500. These upfront costs can be partially offest by reduced demand for potable water, but they no directly offset regularly incurred materials and installation costs of concentional stormwater system components.

References and Resources:

Bucklin, Ray. 2003. Cisterns To Collect Non-Potable Water For Domestic Use. University of Florida/ IFAS, Agricultural and Biological Engineering Department. EDIS # AE64.

Hillsborough County UF Extension. *Rain Barrels.* http://hillsborough_fyn.ifas.ufl.edu/RainBarrels.html

Rainwater Harvesting from Rooftop Catchments (Organization of American States Department of Sustainable Development): www.oas.org/dsd/publications/Unit/oea59e/ch10.htm.

Southwest Florida Water Management District. *Recycle the Rain: A How-to For Installing a Rain Barrel:* http://www.swfwmd.state.fl.us/conservation/rainbarrel/

Specifications of Rain Barrels and Cisterns (Low Impact Development Center, Inc.): www.lid-stormwater.net/raincist/raincist_specs.htm.

Tampa Bay Water. 2007. *A Review of Applicable Policies and Permitting Requirements For Non-Potable Use of Cisterns*. http://www.tampabaywater.org/documents/conservation/cisterns.pdf

Texas Water Development Board. 2005. *The Texas Manual on Rainwater Harvesting*. http://www.twdb.state.tx.us/publications/reports/RainwaterHarvestingManual_3rdedition.pdf

RAIN GARDEN

A rain garden is a bowl-shaped garden designed to capture and absorb rainfall and snowmelt (collectively referred to as "stormwater"). When stormwater runs off impervious surfaces such as parking lots, roofs, compacted soils, and roads, it accumulates pollutants and delivers them to a nearby lake or river either directly or via a storm drain. Stormwater pollutants typically include sediment; nutrients (nitrogen and phosphorus); bacteria from animal waste; and oil, grease, and heavy metals from cars. Stormwater also causes increased flooding, which erodes stream banks resulting in additional problems. However, if captured by a rain garden, stormwater soaks into the ground recharges the groundwater at a rate 30% greater than that of a typical lawn. Ultimately, if we all work together to create landscape features that absorb the stormwater, we can restore and help preserve the waterways that make Pennsylvania so beautiful.

Rain Garden Benefits

Rain gardens provide several benefits:

- Vegetation and soils within the rain garden use physical and biological processes to remove contaminants carried by stormwater runoff.
- Infiltrating stormwater into native, underlying soils helps mimic natural drainage processes and reduces the volume of stormwater runoff.
- Stormwater runoff reduction improves the physical and biological integrity of receiving streams by reducing stream bank erosion and negative effects on aquatic communities.
- Rain gardens improve the aesthetics of an area compared to conventional infrastructure.

Goals

The rain garden has three goals:

- Reduce stormwater runoff by reducing impervious surfaces.
- Quantify the hydrologic performance—the ability to accept, store, and infiltrate stormwater—of rain gardens through changes in season and rain garden age.
- Test the effect on hydrologic performance of multiple ratios of impervious surface area to rain garden area.

Impacts

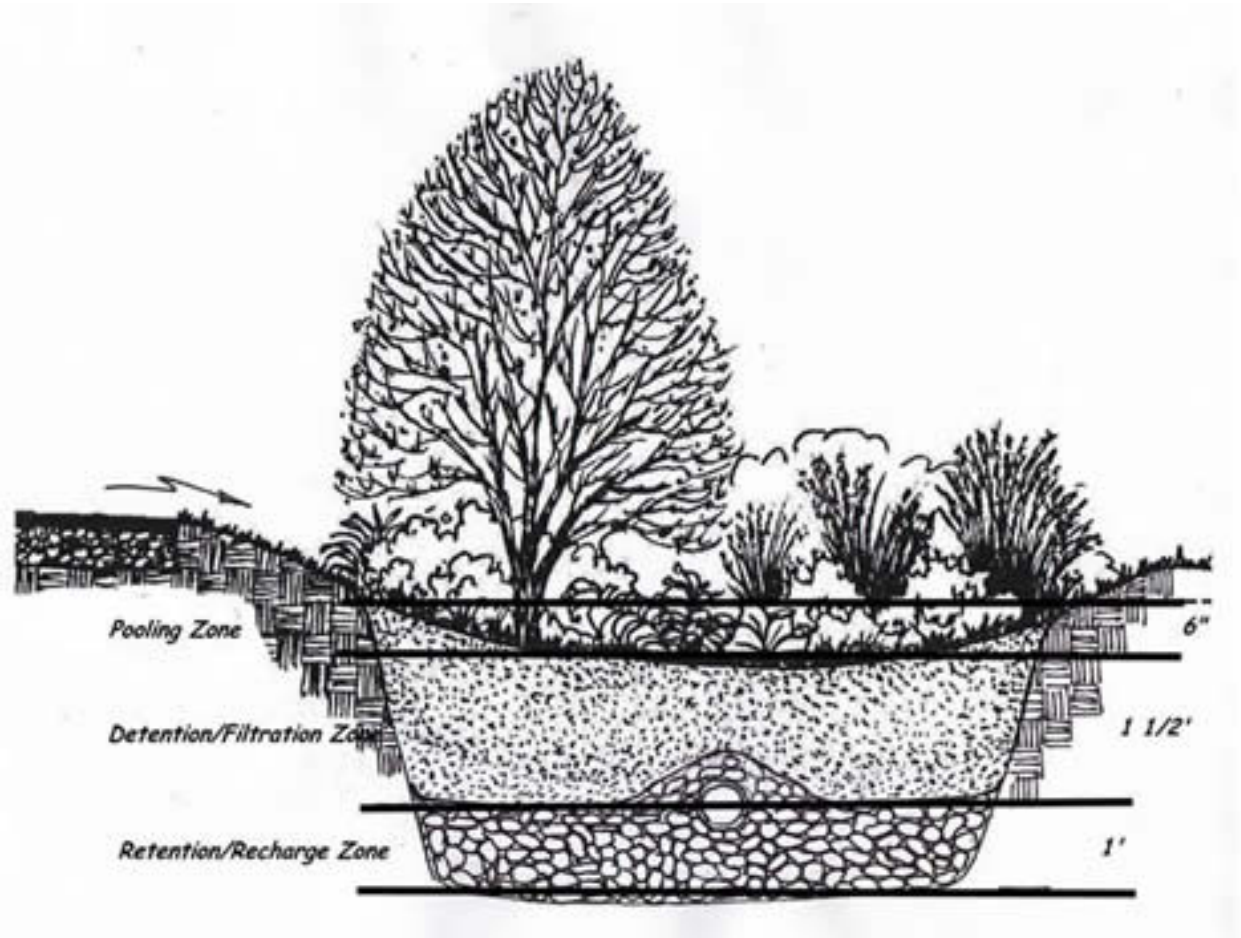
The benefits to the area around the rain garden will include:

- A reduction in runoff volume to the conventional storm sewer system due to stormwater infiltration into rain garden media and underlying native soil.
- Improved runoff quality through physical and biological removal of stormwater contaminants during stormwater infiltration through rain garden systems.

The successful application of bioretention and porous pavement systems at Edison's parking lot demonstration site, as determined by the results of the research and monitoring effort, will help facilitate:

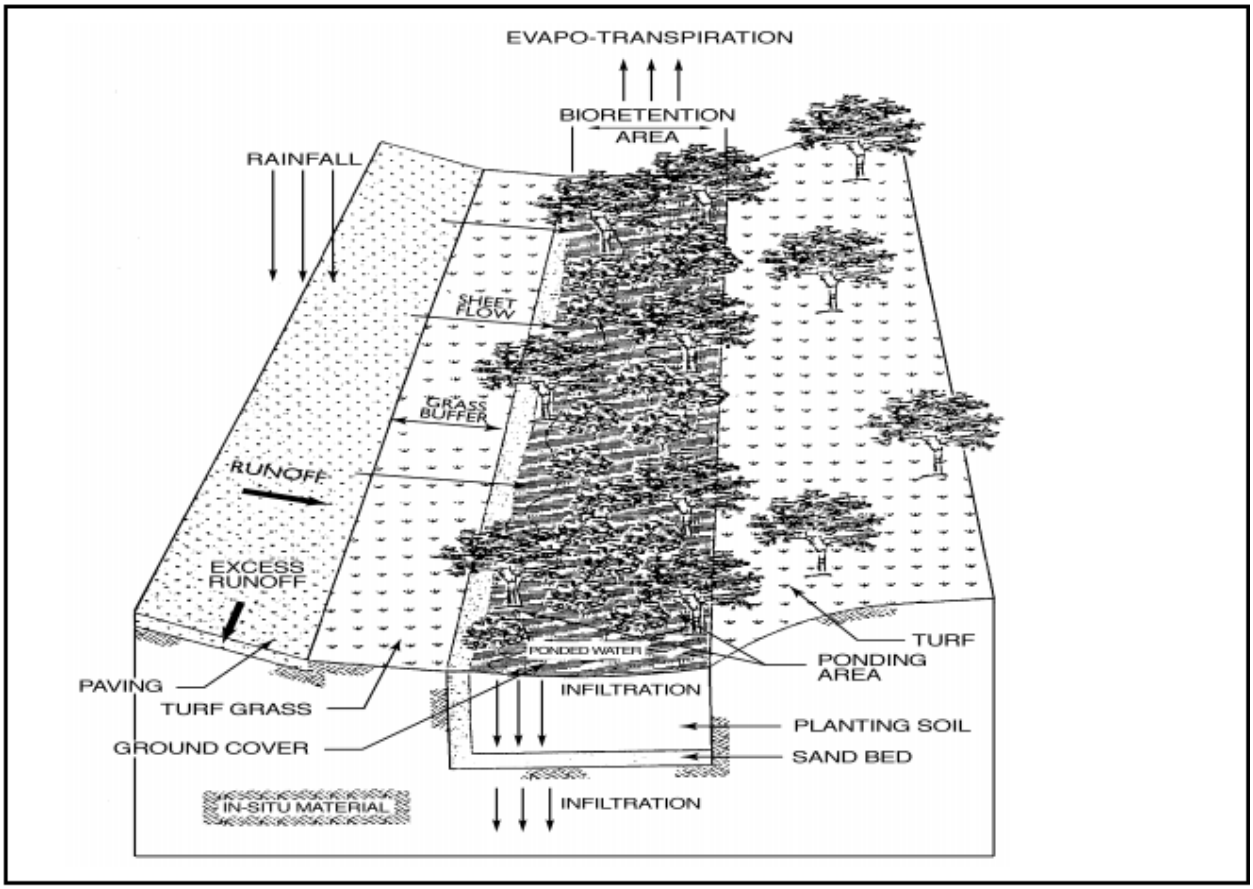
- Technology transfer to other federal facilities and to municipalities considering adopting green infrastructure to alleviate combined sewer overflow problems.
- A more complete understanding of how rain gardens function, enabling EPA to provide information nationwide on rain garden design, construction, maintenance, and monitoring, which local organizations can use to reduce peak flows to receiving waters.
- The reduction of stormwater peak flows, which will help maintain the function and integrity of receiving streams.
- The continuing supply of high-quality, potable water needed for human life by helping watershed managers use rain gardens and other management tools to help assure that receiving waters meet the "fishable and swimmable" goals that Congress outlined in the Clean Water Act of 1972.

Typical Design



BIORETENTION CELLS

A bioretention cell or rain garden is a depressed area with porous backfill (material used to refill an excavation) under a vegetated surface. These areas often have an underdrain to encourage filtration and infiltration, especially in clayey soils. Bioretention cells provide groundwater recharge, pollutant removal, and runoff detention. Bioretention cells are an effective solution in urban areas where green space is limited.



Source: PGDER, 1993.

Curb and gutter elimination

Curbs and gutters transport flow as quickly as possible to a stormwater drain without allowing for infiltration or pollutant removal. Eliminating curbs and gutters can increase sheet flow and reduce runoff volumes. Sheet flow, the form runoff takes when it is uniformly dispersed across a surface, can be established and maintained in an area that does not naturally concentrate flow, such as parking lots. Maintaining sheet flow by eliminating curbs and gutters and directing runoff into vegetated swales or bioretention basins helps to prevent erosion and more closely replicate predevelopment hydraulic conditions. A level spreader, which is an outlet designed to convert concentrated runoff to sheet flow and disperse it uniformly across a slope, may also be incorporated to prevent erosion.

Applicability

The use of engineered swales in place of curbs and gutters should be encouraged in low- and medium-density residential zones where soils, slope and housing density permit. However, eliminating curbs and gutters is generally not feasible for streets with high traffic volume or extensive on-street parking demand (i.e., commercial and industrial roads). Nor is it a viable option in arid and semi-arid climates where grass cannot grow without irrigation.

Developers can eliminate curbs and gutters to disconnect imprevious surfaces and promote infiltration of stormwater on vegetated areas (such as this grass-lined channel in a residential neighborhood)

Effectiveness

Removal of curbs and gutters decreases the peak flow discharge to receiving waters. Futhermore, under the proper design conditions, grass swales can be effective in removing pollutants from urban stormwater (Schueler, 1996). More information on the pollutant removal capability of various grass swale designs can be found in the Grassed Swales fact sheet.

Cost Considerations

Engineered swales are a much less expensive option for stormwater conveyance than the curb and gutter systems they replace. Curbs and gutters and the associated underground storm sewers have been documented to cost as much as $36 per linear foot, which is roughly twice the cost of a grass swale (Schueler, 1995, and CWP, 1998). Consequently, when curbs and gutters are eliminated, the cost savings can be considerable.

GRASSED SWALES

Grassed swales are shallow grass-covered hydraulic conveyance channels that help to slow runoff and facilitate infiltration. The suitability of grassed swales depends on land use, soil type, slope, imperviousness of the contributing watershed, and dimensions and slope of the grassed swale system. In general, grassed swales can be used to manage runoff from drainage areas that are less than 4 hectares (10 acres) in size, with slopes no greater than 5 percent. Use of natural, low-lying areas is encouraged and natural drainage courses should be preserved and utilized.

Applicability

Vegetated swales can be used wherever the local climate and soils permit the establishment and maintenance of a dense vegetative cover. The feasibility of installing a vegetated swale at a particular site depends on the area, slope, and perviousness of the contributing watershed, as well as the dimensions, slope, and vegetative covering employed in the swale system. Vegetated swales are easy to design and can be incorporated into a site drainage plan. While swales are generally used as a stand-alone storm water Best Management Practice (BMP), they are most effective when used in conjunction with other BMPs, such as wet ponds, infiltration strips, wetlands, etc. While vegetated swales have been widely used as storm water BMPs, there are also certain aspects of vegetated swales that have yet to be quantified. Some of the issues being investigated are whether their pollutant removal rates decline with age, what effect the slope has on the filtration capacity of vegetation, the benefits of check dams, and the degree to which design factors can enhance the effectiveness of pollutant removal.

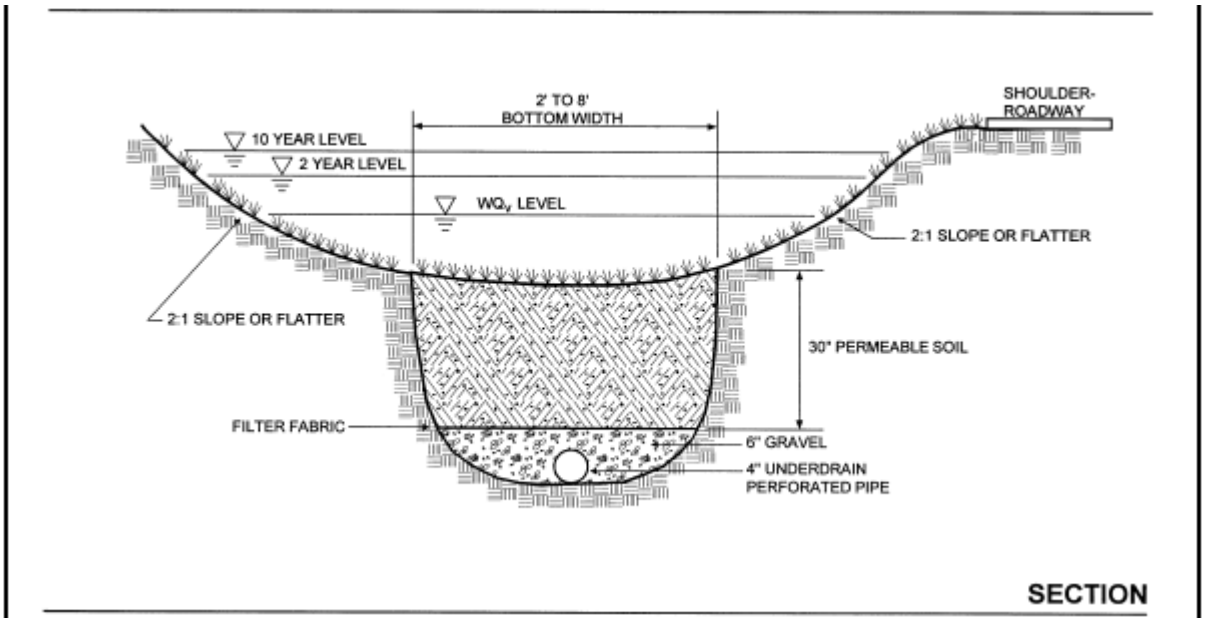
Advantages and Disadvantages

Swales typically have several advantages over conventional storm water management practice, such as storm sewer systems, including the reduction of peak flows; the removal of pollutants, the promotion of runoff infiltration, and lower capital costs. However, vegetated swales are typically ineffective in, and vulnerable to, large storms, because high-velocity flows can erode the vegetated cover.

Limitations of vegetated swales include the following:
• They are impractical in areas with very flat grades, steep topography, or wet or poorly drained soils.
• They are not effective and may even erodemwhen flow volumes and/or velocities are high.
• They can become drowning hazards, mosquito breeding areas, and may emit odors.
• Land may not be available for them.
• They are impractical in areas with erosivesoils or where a dense vegetative cover is difficult to maintain.
Negative environmental impacts of vegetated swales may include:
• Leaching from swale vegetation may increase the presence of trace metals and nutrients in the runoff.
• Infiltration through the swale may carry pollutants into local groundwater.
• Standing water in vegetated swales can result in potential safety, odor, and mosquito problems

Location

Vegetated swales are typically located along property boundaries along a natural grade, although they can be used effectively wherever the site provides adequate space. Swales can be used in place of curbs and gutters along parking lots.



(Maryland Stormwater Design Manual, 2009)

PERMEABLE PAVEMENT

Permeable pavement is an alternative to asphalt or concrete surfaces that allows stormwater to drain through the porous surface to a stone reservoir underneath. The reservoir temporarily stores surface runoff before infiltrating it into the subsoil. The appearance of the alternative surface is often similar to asphalt or concrete, but it is manufactured without fine materials and instead incorporates void spaces that allow for storage and infiltration. Underdrains may also be used below the stone reservoir if soil conditions are not conducive to complete infiltration of runoff.

Permeable pavers promote groundwater recharge. Permeable interlocking concrete pavements (PICP) are concrete block pavers that create voids on the corners of the pavers (pictured to the right). Concrete grid paver (CGP) systems are composed of concrete blocks made porous by eliminating finer particles in the concrete which creates voids inside the blocks; additionally, the blocks are arranged to create voids between blocks. Plastic turf reinforcing grids (PTRG) are plastic grids that add structural support to the topsoil and reduce compaction to maintain permeability. Grass is encouraged to grow in PTRG, so the roots will help improve permeability due to their root channels.

Why would a homeowner choose permeable pavement?

- To prevent/remedy erosion on property
- To minimize excessive pooling in low lying areas due to runoff
- To retain water on property which will
    - Benefit plants on property
    - Return water to the water table on property
    - Contribute to the improvement of the environment by
        - Diminishing stormwater contaminants in streams, rivers
        - Providing ―groundwater recharge and reduc(ing) stormwater runoff volume
        - Preserving and preventing erosion of stream beds and river banks if property drains directly into a stream

What materials/methods are used for permeable paving?

- Porous asphalt

Homeowner use: driveways, parking areas Porous asphalt is the same as regular asphalt except it is manufactured with the fine material omitted, leaving open spaces that allows water to filter through to a ―rechargeǁ or drainage bed.

- Pervious concrete

Homeowner use: driveways, parking areas, sidewalks, patios not adjoining house, pool decking Pervious concrete is composed of materials that result in voids when it is dry, thus allowing water to drain through. Installation requires the same type of drainage bed as that described under Porous Asphalt.

● Concrete/brick pervious pavers

Homeowner use: Parking areas, patios not adjoining house, sidewalks, pool decks Driveways--Snow removal equipment may catch edges, rollers may be needed Precast concrete or brick manufactured in many sizes and shapes are laid with a drainage base and permeable joint material, allowing water to slowly seep into the ground. ―Pervious pavers are most effective with other LID (Low Impact Development) treatment...(e.g. vegetated swales, cisterns or exfiltration tanks.

● Open-Celled pavers

Homeowner use: Parking areas: Only for overflow parking if grass fill is used; grass will die if there is not enough sun Patios not adjoining house: For summer use, and only with furniture that has legs wider than the cells Open-celled pavers are made by installing a plastic or concrete grid over a bed of drainage material and soil. Then the voids are seeded with grass or turf plugs are embedded. Alternatively the voids may be filled with aggregate. They must be constructed with a drainage bed similar to the illustration shown above under Concrete/Brick Pervious Pavers.

Reference

University of Maryland Extension. *Permeable Pavbement Fact Sheet.* https://extension.umd.edu/sites/default/files/_docs/programs/master-gardeners/Howardcounty/Baywise/PermeablePavingHowardCountyMasterGardeners10_5_11%20Final.pdf

SAND AND ORGANIC FILTERS

Sand and organic filters direct stormwater runoff through a sand bed to remove floatables, particulate metals, and pollutants. Sand and organic filters provide water quality treatment, reducing sediment, biochemical oxygen demand (BOD), and fecal coliform bacteria, although dissolved metal and nutrient removal through sand filters is often low. Sand and organic filters are typically used as a component of a treatment train to remove pollution from stormwater before discharge to receiving waters, to groundwater, or for collection and reuse. Variations on the traditional surface sand filter (such as the underground sand filter, perimeter sand filter, organic media filter, and multi-chamber treatment train) can be made to fit sand filters into more challenging design sites or to improve pollutant removal.

Regional Applicability

Although sand filters can be used in both cold and arid climates, some design modifications might be necessary (See Siting and Design Considerations).

In cold climates, filters can be used, but surface or perimeter filters will not be effective during the winter months, and unintended consequences might result from a frozen filter bed. Using alternative conveyance measures such as a weir system between the sediment chamber and filter bed may avoid freezing associated with the traditional standpipe. Where possible, the filter bed should be below the frost line. Some filters, such as the peat/sand filter, should be shut down during the winter. These media will become completely impervious during freezing conditions. Using a larger under drain system to encourage rapid draining during the winter months may prevent freezing of the filter bed. Finally, the sediment chamber should be larger in cold climates to account for road sanding (up to 40 percent of the water quality volume). Filters have not been widely used in arid climates, however, it is probably also necessary to increase storage in the sediment chamber to up to 40 percent of the water quality volume to account for high sediment loads.

Ultra-Urban Areas

Ultra-urban areas are densely developed urban areas in which little pervious surface is present. Sand filters in general are good options in these areas because they consume little space. Underground and perimeter sand filters in particular are well suited to the ultra-urban setting because they consume no surface space.

SOIL AMENDMENTS

Soil amendments increase the soil's infiltration capacity and help reduce runoff from the site. They have the added benefit of changing physical, chemical, and biological characteristics so that the soils become more effective at maintaining water quality. Soil amendments, which include both soil conditioners and fertilizers, make the soil more suitable for the growth of plants and increase water retention capabilities. The use of soil amendments is conditional on their compatibility with existing vegetation, particularly native plants.

Soil amendments improve the physical nature of soil. They reduce compaction, aerating the soil to allow water and nutrients to more easily move through it and reach plant roots. Some soil amendments also add nutrients to the soil and help retain moisture.

Common organic soil amendments are listed below:

- **Sphagnum peat moss** absorbs water, slowly releasing it for use by plant roots. It lightens clay soil, providing aeration, and adds mass to sandy soil, helping prevent the leaching of nutrients. Don't confuse sphagnum peat moss with decorative sphagnum moss, which is primarily a floral design product.
- **Humus** consists of decayed organic matter. It improves fertility and aeration and helps soil hold moisture.
- **Composted manure** is an odorless farm byproduct. In addition to improving aeration and moisture retention, it enriches the soil. Dehydrated manure is a similar product that contains less moisture.
- **Mushroom compost** is a mixture of straw, peat moss and other organic components, formulated for use in commercial mushroom production. The mixture is used for one round of growing and then packaged as an amendment for the home garden.
- **Topsoil** is commercially produced compost that's usually partially decomposed. Because of its rough texture, use topsoil in the yard or mixed with other products, and not as a potting soil.

ROCK SUMP

A Dry Well, sometimes called a Seepage Pit, is a subsurface storage facility that temporarily stores and infiltrates stormwater runoff from the roofs of structures. Roof leaders connect directly into the Dry Well, which may be either an excavated pit filled with uniformly graded aggregate wrapped in geotextile or a prefabricated storage chamber or pipe segment. Dry Wells discharge the stored runoff via infiltration into the surrounding soils. In the event that the Dry Well is overwhelmed in an intense storm event, an overflow mechanism (surcharge pipe, connection to larger infiltration area, etc.) will ensure that additional runoff is safely conveyed downstream.

By capturing runoff at the source, Dry Wells can dramatically reduce the increased volume of stormwater generated by the roofs of structures. Though roofs are generally not a significant source of runoff pollution, they are still one of the most important sources of new or increased runoff volume from developed areas. By decreasing the volume of stormwater runoff, Dry Wells can also reduce runoff rate and improve water quality. As with other infiltration practices, Dry Wells may not be appropriate for "hot spots" or other areas where high pollutant or sediment loading is expected without additional design considerations. Dry Wells are not recommended within a specified distance to structures or subsurface sewage disposal systems.

Design Criteria and Specifications

The use of a single stage rock sump is one of several alternatives that may be appropriate for small project area developments. Site parameters which must be considered when determining the suitability of a sump for stormwater control include the following:

- Soil type
- Slope
- Slope Stability
- Discharge location
- Basement elevation
- Offsite stormwater conveyance systems
- Offsite detention systems

OTHER METHODS

STORMWATER PLANTERS

Stormwater planters are small landscaped stormwater treatment devices that can be placed above or below ground and can be designed as infiltration or filtering practices. Stormwater planters use soil infiltration and biogeochemical processes to decrease stormwater quantity and improve water quality, similar to rain gardens and green roofs but smaller in size—stormwater planters are typically a few square feet of surface area compared to hundreds or thousands of square feet for rain gardens and green roofs. Types of stormwater planters include contained planters, infiltration planters, and flow-through planters.

TREE BOX FILTERS

Tree box filters are in-ground containers used to control runoff water quality and provide some detention capacity. Often premanufactured, tree box filters contain street trees, vegetation, and soil that help filter runoff before it enters a catch basin or is released from the site. Tree box filters can help meet a variety of stormwater management goals, satisfy regulatory requirements for new development, protect and restore streams, control combined sewer overflows (CSOs), retrofit existing urban areas, and protect reservoir watersheds. The compact size of tree box filters allows volume and water quality control to be tailored to specific site characteristics. Tree box filters provide the added value of aesthetics while making efficient use of available land for stormwater management. Typical landscape plants (for example, shrubs, ornamental grasses, trees and flowers) are an integral part of the bioretention system. Ideally, plants should be selected that can withstand alternating inundation and drought conditions and that do not have invasive root systems, which may reduce the soil's filtering capacity.

VEGETATED FILTER STRIPS

Filter strips are bands of dense vegetation planted downstream of a runoff source. The use of natural or engineered filter strips is limited to gently sloping areas where vegetative cover can be established and channelized flow is not likely to develop. Filter strips are well suited for treating runoff from roads and highways, roof downspouts, very small parking lots, and impervious surfaces. They are also ideal components for the fringe of a stream buffer, or as pretreatment for a structural practice.