

SECTION 4.3.3
POST CONSTRUCION SITE RUNOFF CONTROLS

PC – POST CONSTRUCTION SITE RUNOFF CONTROLS

EPA Requirements and Guidance:

EPA requires the designated city/county to address stormwater runoff from new development and redevelopment projects disturbing one or more acres that discharge into a small MS4, including projects less than one acre that are part of a larger common plan of development or sale. Controls must be in place to prevent or minimize water quality impacts. The program must include the following:

- Strategies which include a combination of structural and/or non-structural best management practices (BMPs) appropriate for the community;
- Ordinance or other regulatory mechanism to address post-construction runoff from new development and redevelopment projects to the extent allowable under State, Tribal or local law;
- Adequate long-term operation and maintenance of BMPs.

EPA recommends that the BMPs chosen be appropriate for the local community, minimize water quality impacts, and attempt to maintain pre-development runoff conditions. In choosing appropriate BMPs, EPA encourages participation in locally based watershed planning efforts, which attempt to involve a diverse group of stakeholders.

EPA recommends that the program include a planning process that identifies the program goals (i.e. minimize water quality impacts resulting from post-construction runoff from new development and redevelopment), implementation strategies (i.e. adopt a combination of structural and/or non-structural BMPs), operation and maintenance policies and procedures, and enforcement procedures. In developing the program, one should consider assessing existing ordinances, policies, programs and studies that address stormwater runoff quality. In addition to assessing these existing documents and programs, the designated city/county should provide opportunities to the public to participate in the development of the program.

The program should include non-structural and structural controls. Non-structural BMPs are preventative actions that involve management and source controls. Examples are as follows:

- Policies and ordinances that (1) provide requirements and standards to direct growth to identified areas, (2) protect sensitive areas such as wetlands and riparian areas, (3) maintain and/or increase open space (including a dedicated funding source for open space acquisition), (4) provide buffers along sensitive water bodies, (5) minimize impervious surfaces, and (6) minimize disturbance of soils and vegetation;
- Policies or ordinances that (1) encourage infill development in higher density urban areas and areas with existing infrastructure; (2) encourage education programs for developers and the public about project designs that minimize water quality impacts; and (3) encourage measures such as minimization of percent impervious

area after development and minimization of directly connected impervious areas.

Structural BMPs include: storage practices such as wet ponds and extended-detention outlet structures; filtration practices such as grassed swales, sand filters and filter strips; and infiltration practices such as infiltration basins and infiltration trenches.

Listed below are the most common BMP's associated with Post Construction Site Runoff Control. Design criteria for these BMP's can be found in this section or in the "Planning and Design Manual for the Control of Erosion, Sediment and Stormwater" (ESC Manual) published by the Mississippi Department of Environmental Quality, Mississippi Soil & Water Conservation Commission and the USDA Soil Conservation Service. BMP's denoted by an asterisk (*) shall be designed according to ESC Manual design standards.

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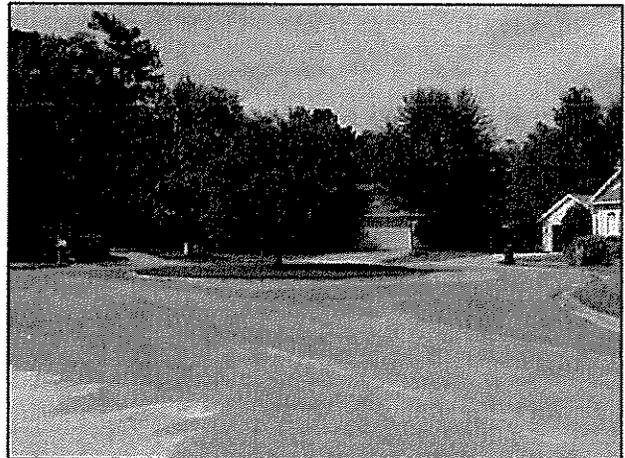
Alternative Turnarounds

Benefits:

- *Reduce impervious area.*

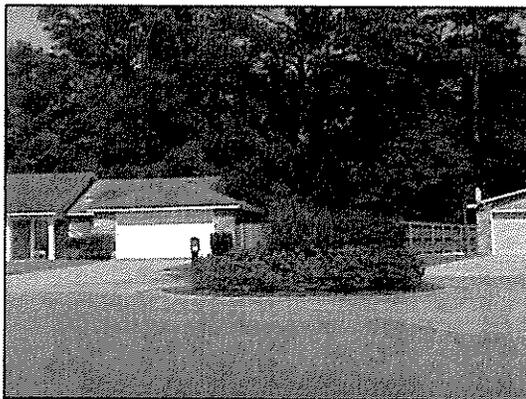
Limitations:

- *Reduce space for emergency vehicles.*
- *Zoning laws may restrict use and may need to be revised.*
- *Concerns regarding property values.*



Costs:

- *Unknown*



Discussion:

Alternative turnarounds involve using optional design practices to replace cul-de-sacs. Using alternative turnarounds can reduce the overall impervious area associated with residential streets. Design options include reduction of cul-de-sac radii, designing loop roads, and using pervious landscaped islands in the center of cul-de-sacs. Local zoning laws may restrict the use of alternative turnarounds and may require modification before alternative turnarounds can be implemented. Inadequate space for access of service and emergency vehicles and perceived property value impacts are often concerns of residents and developers and should be considered carefully before recommending alternative turnarounds.



Bioretention

Benefits:

- Provides pollutant removal through filtration and biological activities.
- Reduces rate of runoff velocity.
- Increases aesthetic quality.

Limitations:

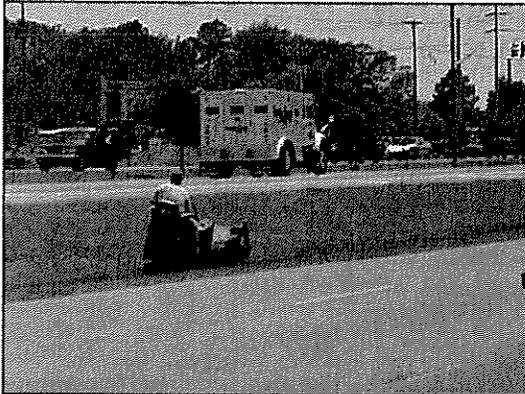
- Are not useful for large drainage areas.
- Provide little overall reduction on runoff volumes.
- Are subject to clogging similar to other filtration and infiltration measures.
- Construction and maintenance costs may be higher than typical filtration methods.



Discussion:

Bioretention involves the use of on-site vegetated landscaped areas designed to receive and treat stormwater runoff. Bioretention methods attempt to remove sediment and pollutants and reduce peak storm flows by mimicking the processes of natural vegetated landscapes. Bioretention areas are often designed for parking lot islands or residential areas. The use of bioretention areas allows great flexibility, and they can be designed to suit a wide range of site conditions. Many designs employ the use of perforated pipe underdrains contained in a layer of coarse aggregate or sand to collect treated runoff and convey the runoff to storm drain systems. Bioretention areas should be sized to handle the anticipated storm volume. Sizes for bioretention areas typically require about 5% of the drainage area to be effective. Emergency drainage should be provided for unexpected storms and can be achieved by including in the design a gutter connected to the storm drain system. Bioretention areas should not be used in areas where the practice may intersect with high groundwater tables. Costs for constructing bioretention areas may be higher than alternative methods, but costs may overlap with planned landscaping and can reduce total project costs by reducing the need for additional measures.

BMP Inspection and Maintenance



Benefits:

- *Ensure proper function and effective implementation of site BMPs.*
- *Protects water quality from impacts of failing practices.*

Limitations:

- *Require sincere cooperation from developers and contractors to conduct inspections and maintain BMPs.*
- *Inspectors must be knowledgeable of proper design and maintenance criteria for the BMPs in question.*

Costs:

Maintenance costs vary depending upon the specific practice in question and may involve materials, equipment, and labor. Inspection costs involve time and staff to conduct inspections and report findings. Additional costs may be necessary to train inspectors.

Discussion:

BMP inspection and maintenance is essential for continued proper function of stormwater management control measures. Inspection and maintenance helps to ensure the proper function of measures and reduce repair needed for failing measures. Under the Stormwater Phase II Program, small MS4 facilities have the responsibility to implement BMP inspection and maintenance programs along with establishing regulations and penalties for violations. Persons familiar with the measures utilized should conduct inspections of BMPs. Maintenance of BMPs should be considered prior to implementation of the practice to establish inspection and maintenance requirements and responsibilities.

Buffer Zones

Benefits:

- *Provide protection of water bodies from pollution, erosion, and heating.*
- *Increase infiltration and remove pollutants.*
- *Provide for stream bank protection by maintaining natural floodways.*
- *Can add aesthetic appeal to urban water bodies and provide area for recreation and habitat for wildlife.*
- *Can reduce costly erosion control and bank stabilization measures in urban streams.*

Limitations:

- *Not effective for managing or treating concentrated flows.*
- *Require large area to be effective.*

Costs:

Studies have shown that buffers can increase property values. Costs involve time and staff to create, enforce, and maintain buffer zones.



Discussion:

Buffer zones involve the protection or establishment of vegetated areas along waterbodies. Buffer zones can provide protection from polluted runoff, reduction of runoff velocities and volumes, flood attenuation, and protection for aquatic and terrestrial wildlife. Establishment of buffer zones can involve the preservation of existing riparian corridors or the creation/restoration of vegetated areas designed to manage stormwater runoff. Adequate space to provide the desired function is essential to success and should be considered carefully. Vegetative cover should be composed of a variety ranging from grasses to mature forest. When selecting the vegetative cover, one should consider stormwater inputs and the desired functions the buffer will provide. Guidelines should be established for activities that are allowed within the buffer area. Buffer zones can incorporate many other stormwater management practices such as urban forestry, grassed swales, bio-engineered erosion control, conservation easements, and education programs.



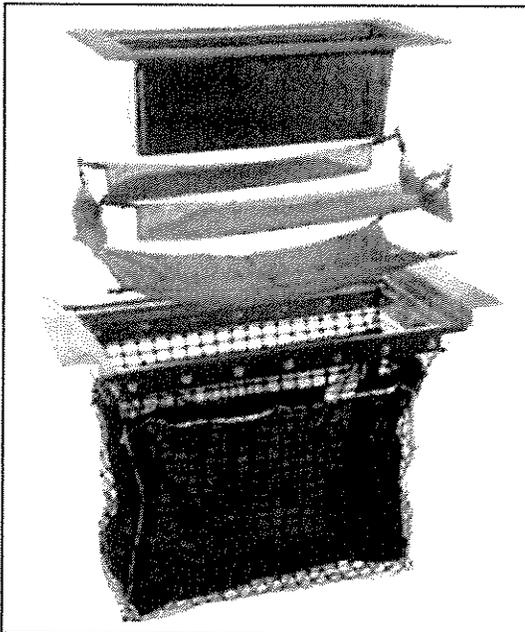
Catch Basins/ Catch Basins Inserts

Benefits:

- *Catch basins can be used in most traditional storm sewer systems.*
- *Remove suspended pollutants such as litter, debris, and sediments.*
- *Inserts can improve the removal rates for dissolved components and fine particles.*

Limitations:

- *Reported removal rates are lower than wet ponds, sand filters, and stormwater wetlands.*
- *Catch basins can resuspend sediments and other pollutants if not regularly cleaned.*
- *Catch basins alone are not effective at removing dissolved pollutants or fine sediments.*



Discussion:

Catch basins are inlets to the storm drain system. They are typically used with curb inlets or grates and a sump to allow for settling and capturing of sediment, debris, and pollutants. Catch basins are best utilized as a pretreatment measure for another stormwater management practice. The efficiency of pollutant removal depends greatly on size and maintenance. Proper design is essential to ensure the size of the inlet and sump are suited to the amount of stormwater flow received. Proper maintenance and cleaning are important to maximize the storage area available and allow for the greatest pollutant removal rate. Catch basins can capture sediments effectively until they reach approximately 60% capacity in the sump (Pitt, 1985). After 60% capacity is reached, sumps can act to resuspend sediments. Cleaning should be conducted annually at a minimum. More frequent cleaning of catch basins serving industrial sites increased the sediment collected from 30 lbs/year during annual cleaning to 180 lbs/year during monthly cleaning (Mineart & Singh, 1994). Efficiency can also be improved by the use of inserts that can be designed to remove specific types of pollutants such as oil and grease, sediment, trash, and debris.

Costs:

USEPA reports typical precast catch basins to cost between \$2,000 and \$3,000. Retrofit inserts range from \$400 to as much as \$10,000.

Effectiveness:

Little published information is available for catch basins and inserts.



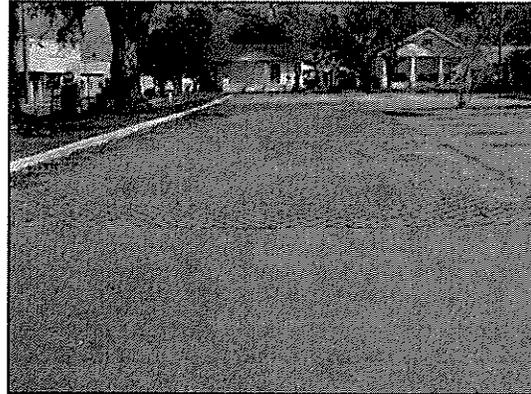
Concrete Grid & Modular Pavement

Benefits:

- *Reduces runoff volumes.*
- *Reduces pollutants in runoff.*
- *Reduces need for additional stormwater management measures.*
- *Increases infiltration and groundwater recharge.*

Limitations:

- *Studies have shown a relatively high failure rate.*
- *Should not be used in area of heavy traffic.*
- *Costs are high compared to traditional pavements.*
- *Maintenance requirements are relatively high.*
- *May not be useful for areas with high pollutant loads due to risks to groundwater contamination.*



Discussion:

Porous pavement is a permeable pavement surface that allows runoff pass through the paved surface and infiltrate into the subsoil. There is more than one type of porous pavement, and examples include porous asphalt, pervious concrete, and stone pavers. Porous asphalt and pervious concrete closely resemble traditional products in appearance, but eliminate fine particles from the design mix leaving additional voids for water to move through. Stone pavers are usually concrete systems of interlocking blocks with gaps allowing grass to grow between. All three types of systems use a crushed stone layer underneath the surface to provide infiltration of stormwater and operate in much the same way as other infiltration methods. Likewise, porous pavement systems have the same limitations as other infiltration methods. Porous pavement should not be used in areas that may receive high sediment loads or high concentrations of hazardous chemicals. Initial studies have demonstrated high failure rates due to clogging that have generally been attributed to poor design, construction, and maintenance. Maintenance should include regular sweeping and washing to remove particles that may lead to clogging.



Conservation Easements

Benefits:

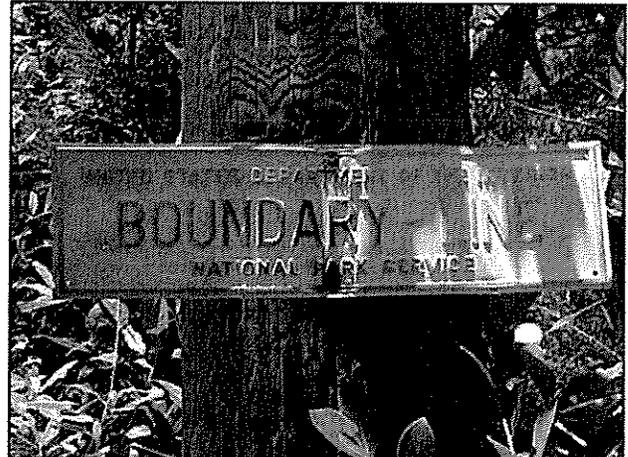
- *Conservation of sensitive areas and buffer areas can protect waterbodies from the impacts of development.*

Limitations:

- *May not be practical in heavily urban areas where availability of suitable land is low.*
- *Easements may eventually be broken and land held may be developed.*

Costs:

- *No costs associated with easements unless costs of legal services are incurred. Tax benefits are provided.*



Discussion:

Conservation easements involve landowners voluntarily setting aside private property with limitations on the amount and type of development that is allowed on the property. Conservation easements can be an effective tool for protecting water quality from runoff by restricting development in sensitive areas such as wetlands or riparian corridors. Landowners can often receive tax benefits for placing land in conservation easements, while turning over maintenance duties to state or land trust agencies. The use of conservation easements to protect sensitive areas from development may have limited use in many urban areas where available land is scarce.



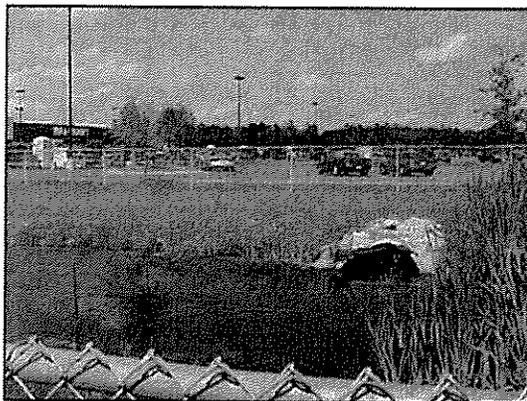
Constructed Wetlands

Benefits:

- Remove pollutants through settling and biological activity.
- Can be designed to provide flood control.
- Can provide benefits to wildlife.
- Can provide aesthetic benefits.

Limitations:

- Requires relatively large amounts of space to construct.
- Improper design and maintenance can result in breeding ground for mosquitoes and other potential nuisance wildlife and plant species.
- Flooding can potentially release nutrients from wetlands during dormant periods.
- Extensive design and maintenance are required for successful implementation.



Discussion:

Stormwater wetlands are among the most effective stormwater controls at removing pollutants. Constructed wetlands are similar to wet detention basins (ponds) that receive and store stormwater, allowing for pollutant settling. In addition to storage, stormwater wetlands use wetland plants to provide for pollutant uptake and removal. Stormwater wetlands can also provide for groundwater recharge, flood control, and channel protection. Stormwater wetlands are designed and constructed specifically for stormwater treatment and are often fundamentally different from natural wetlands. Stormwater should not be diverted into existing wetlands. Many different variations of constructed wetlands exist, making them applicable to almost any situation with the exception of some urban situations. For example, stormwater wetlands can be designed in combination with wet ponds. Stormwater wetland systems can be designed to provide an aesthetic benefit. Siting and design of stormwater wetlands are crucial to the success of constructed wetlands and should be conducted by trained professionals considering soils, hydrology, drainage area and inputs, and plant types to be used. A pretreatment measure for removal of coarse sediments and an emergency spillway are typical design considerations. Stormwater wetlands typically require a large drainage area (~25 acres) and take up considerable surface area. Improper design can lead to problems such as mosquito breeding, failure of vegetation establishment, and failure to maintain an adequate pool. Maintenance requirements such as management of vegetation and removal of accumulated sediments are important to the establishment and continued function of stormwater wetland systems.

Dry Extended Detention Ponds

Benefits:

- Dry extended detention ponds provide flood control by reducing peak flows during storm events.
- Ponds allow settling of suspended particles such as sediments.
- Dry extended detention ponds are inexpensive measures compared to other methods of treating the same drainage area.

Limitations:

- Dry extended detention ponds provide only moderate pollutant removal when compared to many comparable practices, and provide little or no removal of dissolved pollutants. Small temporary pools may provide breeding ground for mosquitoes. Construction can cause damage in stream channels or stream buffers. Dry ponds have been shown to decrease property values. Maintenance to remove litter and control vegetation will be required. The area required for construction may limit use in densely urban areas.



Discussion:

Dry extended detention ponds are known by many names such as dry ponds and extended detention ponds. These ponds are designed to receive stormwater runoff and release the stormwater at rates comparable to pre-development runoff rates. Dry ponds allow settling of suspended particles; therefore, reducing suspended particles in the stormwater. These ponds serve as flood controls if sized according to anticipated storm volumes. Unlike wet detention ponds, dry ponds do not maintain a large permanent pool, although small pools are often designed near the outlets and inlets. Detention basin size is dependent on the drainage area from which it receives runoff. Dry ponds are capable of receiving runoff from large areas and are not recommended for sites with drainage areas of less than 10 acres. Dry ponds are applicable to a wide range of sites; however, the area needed to construct a dry pond may limit usefulness for densely urban areas. Dry ponds typically provide only moderate removal pollutant rates and are ineffective at removing dissolved pollutants. To maximize pollutant removal, dry ponds may be used in conjunction with additional practices (ex. oil and water separator as a pretreatment method for runoff from parking lots). Initial studies have indicated that dry ponds may detract from property values, and dry ponds that maintain a temporary pool may become a breeding ground for mosquitoes. Regular inspection and maintenance are required to ensure proper function.



Eliminating Curbs and Gutters

Benefits:

- *Reduces runoff velocities and volumes.*
- *Can provide removal of pollutants (curbs and gutters provide none).*

Limitations:

- *Pavement edges can crack and fall.*
- *Shoulder and grassed swales may require more maintenance than gutters.*
- *Local ordinances may restrict the elimination of curbs and gutters.*

Costs:

Engineered vegetated swales are a less expensive means of stormwater conveyance than curb and gutter systems (CWP, 1998).



Discussion:

Elimination of curbs and gutters promotes the use of grassed swales to receive and convey stormwater runoff from roadways and yards as a replacement for curbs and gutters. Elimination of curbs and gutters can allow for greater infiltration of runoff, reduction of runoff velocities and volumes, removal of pollutants, and lower overall costs for stormwater management measures. Local zoning laws or ordinances often require curbs and gutters and may need to be revised before this measure can be implemented. Grassed swales occupy more space than curbs and gutters and may not be suitable for all situations. Sites with impermeable soils, dense development, or high water tables may not be suited for this practice. Maintenance requirements typically include activities such as mowing and removal of accumulated sediments and debris.

Grade Stabilization Structure

Benefits:

- Controls head cutting and major gully erosion in channels
- Maintenance is minimal

Costs:

- Costs can be very expensive up front depending on the type structure used.



Discussion:

Grade stabilization structures are used to control the grade in natural or constructed channels to prevent erosion. They may be vertical drop weir spillways, chutes, or pipe drop structures and may be of reinforced concrete, steel sheet piling, concrete block, riprap, corrugated metal, plastic, or concrete pipe, depending on site conditions. This should be used in locations where beds of intersecting channels are at different elevations, and where flatter grades are needed in proposed channels to control velocities. Locate these structures in straight channel sections. Stabilize foundation materials, and ensure that flood bypass capability is able to protect the structure from flows greater than design. The design of large structures (100cfs or greater) should be undertaken only by a qualified engineer, experienced in hydraulics and structural design. Inspections should be made periodically and after all major storms.



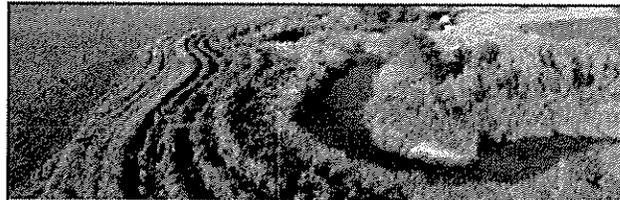
Grassed Filter Strips

Benefits:

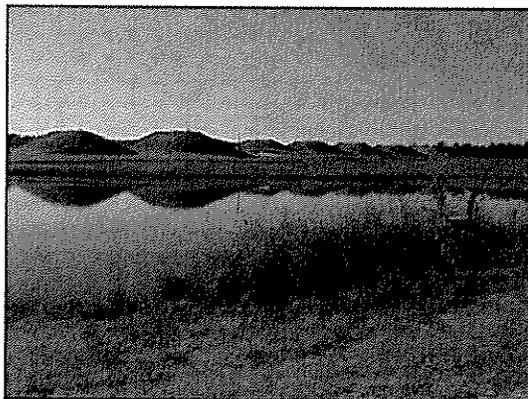
- *Slow runoff and provide filtering of pollutants, especially sediments.*

Limitations:

- *Filter strips require a large amount of surface area (often equal to the surface of the drainage area) to be effective.*
- *Careful design and maintenance are critical to successful implementation.*
- *Filter strips provide little effectiveness in managing concentrated flows.*



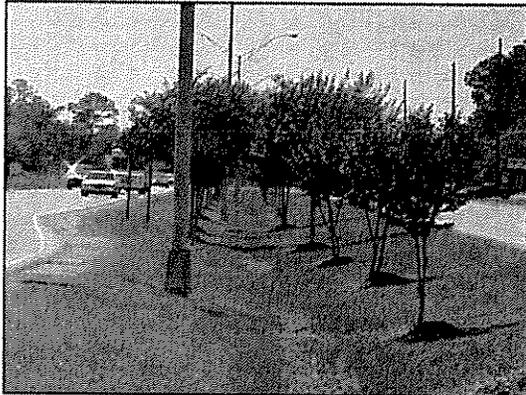
Grassed filter strips protect water quality by filtering pollutants before they reach the water. (Source: USDA, 1997)



Discussion:

Grassed filter strips (vegetated filter strips, filter strips) are vegetated areas designed to treat surface flow from adjacent surfaces by reducing runoff velocities, filtering sediments and other pollutants, and allowing infiltration. Vegetated filter strips were originally used in agriculture to treat runoff from crop fields before entering water bodies. It has been proven that with proper design and maintenance, filter strips can provide relatively high pollutant removal from sheet flow. Gravel diaphragms (level spreaders) are often used to provide even sheet flow to filter strips. They are most useful in urban practices for treating runoff from roads and highways, small impervious areas such as parking lots and roof downspouts, and as a pretreatment method used in connection with structural practices. Vegetated filter strips may not be useful in many heavily urbanized areas due to the large surface area they require to be effective. Filter strips are not designed to treat runoff from concentrated flows.

Grassed Swales



Benefits:

- *Provide reduction of runoff velocity.*
- *Provide pollutant removal.*
- *Provide infiltration of runoff.*
- *Can be useful alternatives to traditional storm sewer systems, providing greater pollutant removal and lower construction costs.*

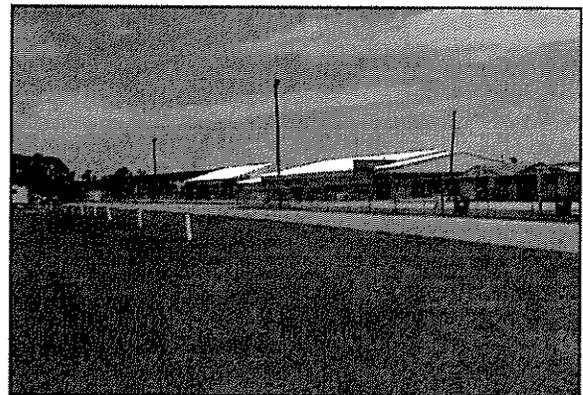
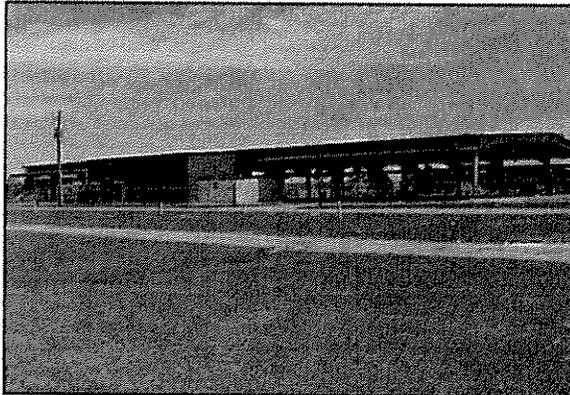
Limitations:

- *Are not intended to manage runoff from larger drainage areas.*
- *If slopes are too steep or vegetation is too sparse, grassed swales will have little effectiveness.*
- *Are not intended to receive high runoff velocities as the potential for erosion of channel vegetation exists.*

Discussion:

Grassed swales (vegetated swales, grassed channels) are open channels designed specifically to treat and attenuate stormwater runoff for a specified water quality volume. This measure builds upon the traditional drainage ditch and incorporates additional design features to produce a treatment and conveyance system. Vegetative swales are most useful for sites with slopes less than 4 percent, permeable soils, and drainage areas under 5 acres. Steep slopes can produce high runoff velocities and reduce filtering and infiltration rates, and too large a drainage area can require too large a swale to be practical. Proper design is essential for effective pollutant removal. Proper slope, size per drainage area, and proper vegetation selection and establishment are important considerations for effective vegetative swales. Different designs for the vegetative swales are available. Usefulness depends on site conditions and desired function. Grassed channels are more like traditional drainage ditches and rely on lower velocity storm flow for filtering and infiltration. Dry swales are similar to bioretention methods and are designed for rapid infiltration. Dry swales often use a soil bed of sand with an underdrain system of gravel and perforated pipe. This method allows for high pollutant removal and some floodwater attenuation. Wet swales incorporate a shallow permanent pool and wetland vegetation to provide stormwater management. This method can provide high pollutant removal rates, as well as flood attenuation. One potential drawback is the standing water may be seen as a nuisance if used in commercial or residential settings. Maintenance for grassed swales consists mainly of managing the vegetation to maintain a thick coverage.

Green Parking



Benefits:

- *Reduces impervious area*
- *Reduces runoff values*
- *Treats stormwater runoff*

Limitations:

- *Educating people on benefits is a challenge and changing old habits can be difficult.*

Costs:

- *Unknown*

Discussion:

Green parking involves methods for reducing the impervious area associated with parking lots. Methods involve controlling the number of new lots created, minimizing the sizes and number of spaces, utilizing alternative pavers in overflow parking areas, using bioretention and reversed elevation landscaping, encouraging shared parking lots, and providing economic incentives for structured parking. Many parking lot designs include far more space than actually necessary. By effectively implementing green parking practices impervious cover can be significantly reduced, runoff volumes can be reduced, treatment of stormwater can be provided, and overall reduction of stormwater management costs can be achieved.



In-Line Storage

Benefits:

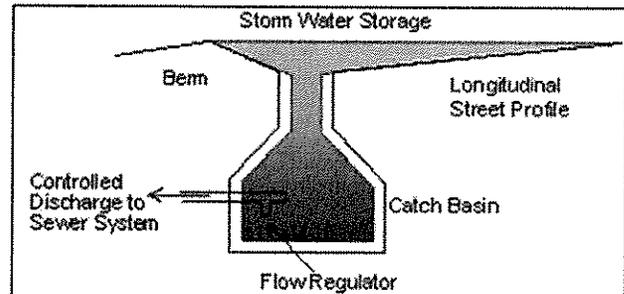
- *Can reduce peak runoff flows.*

Limitations:

- *Provides no pollutant removal or water quality improvements.*
- *Improper design can lead to upstream flooding.*

Costs:

Are relatively low cost and require little maintenance.



Note: Not to scale and great vertical exaggeration

Catch basins can be equipped with flow restrictors to temporarily detain storm water in the conveyance system

Discussion:

In-line storage involves using devices to slow the flow of runoff by detaining flows within the storm drain system. In-line storage includes a number of different methods to achieve the reduction of runoff flow such as check dams. The use of in-line storage practices can reduce peak flows, but are not designed to provide pollutant removal. Improper design or siting can produce flooding upstream.