Preface

The City of Somerset Public Works Department participated in efforts to develop a Statewide NPDES Phase II Communities Consortium to promote familiarity, consistency and cost-sharing in the development of Phase II materials. This manual represents a product developed in coordination with the Consortium and tailored to the City of Somerset.

The intent of the manual is to provide guidance regarding the selection and use of a number of Stormwater Best Management Practices (BMPs), and should be used in conjunction with the city's ordinances. Ultimately the goal is clean water and reduction of the pollutants associated with urban activities (construction for example). Common sense and good judgment by all participants and stakeholders (designers, contractors, inspectors, reviewers, officials, regulators, and owners) are required and encouraged.

This manual contains specific recommendations and criteria to be considered when implementing Best Management Practices; however, it is not a design document. The manual does not contain complete detailed design information for all practices that are referenced. Sound engineering judgment and experience must be exercised in all instances of BMP implementation.

The examples, recommendations and criteria highlight some of the major principles and notable points related to the practices based upon the information available from a variety of sources. These sources should be used with caution since you must demonstrate the appropriateness and applicability of the practice to your project in particular.

The review process that will examine the appropriateness and applicability of the BMP Plans submitted to the City of Somerset will not require supporting engineering design calculations. However, if questions pertaining to the nature of BMP implementation should arise, the design engineer may be called upon to provide detailed analysis that will support the inclusion, frequency, extent or omission of the practice in question.

Some of the examples shown in this document represent projects which, under state or federal laws, may require permits or design by a registered design professional. This manual, the source references and professional integrity should be seen as three legs providing a stable foundation for the community's project BMPs.

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Section 1

INTRODUCTION

1.1 Background and Purpose

The Clean Water Act (CWA) was passed in 1972 to help protect and restore the waters in our Nation's streams, rivers, and lakes. In the early 1990s, Phase I of the National Pollutant Discharge Elimination System (NPDES), under authority of the CWA, was passed to regulate stormwater management in large urban areas. Phase II regulations were developed and passed near the turn of the century requiring medium-sized cities meeting a certain population density and other criteria to develop stormwater initiatives to address pollution associated with urban runoff. In March of 2003, the City of Somerset, and numerous other "Phase II Cities and Counties" submitted permit applications to the Kentucky Division of Water outlining a 5-year plan for addressing the Phase II requirements.

The thought behind the Phase II program is that urban runoff is a chief cause of stream impairment, and that urban runoff can be managed in large part by effectively addressing a few key areas. These areas include educating and involving the public on the impacts of urban runoff and how the public can help, managing the storm sewer infrastructure and addressing illicit discharges (discharge of pollution / polluted runoff), implementing local regulations, developing best management practices (BMPs) for construction and post-construction, and practicing environmentally sensitive and responsible municipal operations.

This manual presents a brief introduction to stormwater BMPs and was developed to support Phase II efforts in addressing Construction Site Runoff as required by the City's Phase II permit. The following types of BMPs are addressed: Site Planning and Design Practices (SPD); Erosion Prevention Practices (EPP); Sediment Management Practices (SMP); Good Housekeeping Practices (GHP); BMPs for Residential and Homeowners (RHP) and post-construction BMP for stormwater collection prevention (SPP). Stormwater Pollution Treatment Practices (PTP). The manual describes how BMPs can be selected, and contains a series of fact sheets for each type of BMP to be used in the area. Additionally, a number of the BMPs address municipal operations and residential issues and can be used for sharing information with the public.

The intent of the Stormwater BMP Manual is to provide guidance on BMP selection, design, and implementation to plan submitters, reviewers, construction site operators, and site inspectors. There is special emphasis on Erosion Prevention and Sedimentation Control (EPSC) during construction and recommendations to homeowners to help provide and extend benefits of these BMPs beyond construction. There are also guidance materials for activities at commercial and industrial facilities.

The fact sheets are categorized, focused, and concise so that they may be used as quick references for design, inspection, and maintenance guidance. In this way, the fact sheets are designed to be stand-alone documents that may be distributed to facilitate discussion about design and/or implementation of the management practice. Many of the practices are considered structural practices in that they involve construction. However, several of the BMPs cover non-structural practices where normal activities are performed in a different manner with stormwater quality in mind.

1.2 List of Definitions, Abbreviations and Acronyms

1.2.1 Definitions

Best Management	A measure that is implemented to protect water quality and reduce the Practice (BMP) potential for pollution associated with stormwater runoff.
Blue Line Streams	Streams that are represented on the United States Department of the Interior Geological Survey 1:24,000 quadrangle maps.
Channel	A natural or constructed/manmade watercourse with definite bed and banks to confine and conduct continuously or periodically flowing water. Channel flow is that water which is flowing within the limits of the defined channel.
Clearing	Any activity that removes vegetative surface cover.
Clean Water Act (CWA)	Federal Regulation that prohibits the discharge of pollutants to Waters of the United States unless said discharge is in accordance with an NPDES permit.
Critical Area	A site difficult to stabilize due to exposed subsoil, steep slope, extent of exposure, or other conditions.
Critical Watershed	A watershed that has a FEMA Zone “A”, “AE”, or “X” within the site or a location of historical flooding of roads or structures.
Detention	The temporary delay of storm runoff prior to discharge into receiving waters.
Developer	Any individual, firm, corporation, association, partnership, or trust involved in commencing proceedings to affect development of land for developers or others.
Drainage Basin	A part of the surface of the earth that is occupied by and provides surface water runoff into a stormwater management system, which consists of a surface stream or a body of impounded surface water together with all tributary surface streams and bodies of impounded surface water.
Drainage Way	Any channel that conveys surface runoff throughout the site.
Drainage/Dry Well	A bored, drilled, driven, dug, or naturally occurring shaft or hole with a depth greater than the largest surface dimension; used to drain surface fluid, primarily stormwater runoff, into a subsurface formation.
Ephemeral Stream	A stream or part of a stream that flows only in direct response to precipitation or snowmelt. Its channel is above the water table at all times.
Erosion	The wearing away of land surface by the action of wind, water, gravity, ice, or any combination of those forces.

Erosion Prevention Sediment Control Plan (EPSC)	A set of plans prepared by or under the direction of a licensed professional engineer detailing the specific measures and sequencing to be used to control sediment and erosion on a development site during and after construction.
Excavation	Any portion of land surface or area from which earth has been removed or will be removed; the depth below original ground surface to remaining surface.
Existing Grade	The slope or elevation of existing ground surface prior to cutting or filling.
Fill	Portion of land surface or area to which soil, rock, or other materials have been or will be added; height above original ground surface after the material has been or will be added.
Finished Grade	The final slope or elevation of the ground surface after cutting or filling.
Flood Plain	The relatively flat or lowland area adjoining a river, stream, watercourse, lake, or other body of standing water which has been or may be covered temporarily by floodwater. For purposes of this ordinance, the flood plain is defined as the area encompassed by a 100-year storm having a one percent chance of being equaled or exceeded in any given year.
Grading	Any stripping, cutting, filling, or stockpiling of earth or land, including the land in its cut or filled condition, to create new grades.
Impervious Surface	A term applied to any ground or structural surface that water cannot penetrate or through which water penetrates with great difficulty.
KDOW General Permit (KGP)	An agreement between the regulating authority and the Permittee which specifies conservation practices that shall be implemented in the construction of activities specified in the terms and conditions of the general permit.
Land Disturbance	The purposeful act of clearing, grubbing, excavating, or grading; disrupting ground surface by or for construction activities, including construction access/roads, staging, and storage sites producing significant areas of exposed soil and soil piles.
National Pollutant Discharge Elimination System (NPDES)	EPA's program to control the discharge of pollutants to waters of the United States. NPDES is a part of the Federal CWA, which requires point and non-point source dischargers to obtain permits. These permits are referred to as NPDES permits.
Notice of Intent (NOI)	A formal notice to the EPA or a state agency having delegated NPDES authority that a construction project seeking coverage under a General Permit is about to begin.
Notice of Termination (NOT)	A formal notice to KDOW having delegated NPDES authority that construction project is complete and seeking release for the EPSC and the State General Permit.

Perimeter Control	A barrier that prevents sediment from leaving a site by filtering sediment-laden runoff or diverting it to a sediment trap or basin.
Permit Phasing	Clearing a parcel of land in distinct phases, with the stabilization of each phase completed before the clearing of the next commences.
Permittee	Shall mean the "Person Responsible for the Land Disturbing Activity".
Public Storm Drain	Drain system provided by and maintained by the City of Somerset, that is designed to help maintain stormwater runoff; it also provides inlets for water to travel to holding areas attempting to remove excessive water from streets and other areas.
Sediment	Solid material, both mineral and organic, that in suspension is being transported or has been moved from its site of origin by air, water, or gravity as a product of erosion.
Sediment Control	Measures that prevent eroded sediment from leaving the site.
Site	A parcel of land or a contiguous combination thereof, where grading work is performed as a single unified operation subject to erosion of sedimentation as a result of cutting, filling, grading, or other disturbance of the soil.
Site Development	A permit issued by the City of Somerset for the construction or Permit alteration of ground improvements and structures for the control of erosion, runoff, and grading.
Stabilization	The use of practices that prevent exposed soil from eroding.
Start of Construction	The first land-disturbing activity associated with a development, including land preparation such as clearing, grading, and filling; installation of streets and walkways; excavation for basements, footings, piers, or foundations; erection of temporary forms; and installation of accessory buildings such as garages.
Stormwater Management Plan (SWMP)	A plan which is based on hydrologic and hydraulic calculations to determine flood stage and required improvement to minimize impacts by development.
Stormwater Pollution Prevention Plan (SWPPP)	A plan required by stormwater regulations or permits that includes site map(s), an identification of construction/ contractor activities that could cause pollutants in the stormwater, and a description of measures or practices to control these pollutants. The SWPPP is part of the "BMP Plan" used in the KYDOW General Permit.
Temporary Protection	Short-term stabilization of erosive or sediment producing areas.
Utility General Permit	Agreement between the MS4 Municipality and the local Utilities, stating that Phase II regulations shall be applied and implemented.

Vegetative Protection	Stabilization of erosive or sediment producing areas by covering the soil with any of the following materials: permanent seeding for long-term vegetative cover, short-term seeding for temporary vegetative cover, sodding, producing areas covered with a turf of perennial sod-forming grass, tree planting, or other planting.
Watercourse	Any body of water including, but not limited to lakes, ponds, rivers, streams, and bodies of water delineated by the City of Somerset.
Waterway	A channel that directs surface runoff to a watercourse or to the public storm drain.

1.2.2 Abbreviations and Acronyms

ADT	Average Daily Traffic
ARAP	Aquatic Resource Alteration Permit
BFM	Bonded Fiber Matrix
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
BS	Bank Stabilization
BZ	Buffer Zones
CB	Continuous Berms
CD	Check Dams
CL	Channel Lining
COS	Chemical Oxygen Demand
CRS	Construction Road Stabilization
DB	Detention Basin
DO	Dissolved Oxygen
EPA	Environmental Protection Agency
EPP	Erosion Prevention Practices
EPSC	Erosion Prevention and Sediment Control
G	Geotextiles
GHP	Good Housekeeping Practices
HAZWOPER	Hazardous Waste Operations and Emergency Response
KDOW	Kentucky Division of Water
KDWM	Kentucky Division of Waste Management
KUB	Kentucky Utilities Board
M	Mulching
MS4	Municipal Separate Storm Sewer System
MSD	Marine Sanitation Device
MSDS	Material Safety Data Sheet
N and M	Nets and Mats
NPDES	National Pollution Discharge Elimination System
OSDS	On-Site Disposal System
OSHA	Occupational Safety and Health Administration
PCB	Polychlorinated Biphenyl
PE	Professional Engineer
PPE	Personal Protective Equipment
PS	Permanent Seeding

RH	Residential Homeowners
RR	Rip-rap
SBCCI	Southern Building Code Congress International, Inc.
SCE	Stabilized Construction Entrance
SEDCAD	Software for Design of Stormwater, Erosion, and Sediment Control Systems
SF	Silt Fence
SF-LD	Light Duty Silt Fence
SF-HD	Heavy Duty Silt Fence
SMP	Sediment Management Practices
SO	Sodding
SPCC	Spill Prevention Control and Countermeasure
SPD	Site Planning and Design Practices
SR	Surface Roughening
ST	Sediment Traps
SWPPP	Storm Water Pollution Prevention Plan
T	Terracing
TIP	Temporary Inlet Protection
TMDL	Total Maximum Daily Load
TOP	Temporary Outlet Protection
TS	Temporary Seeding
TS	Top Soiling
TW	Tire Washing
USACE	United States Army Corps of Engineers

1.3 Construction Site Management for Stormwater Quality

1.3.1 Erosion and Sediment Control Regulations

Soil erosion is the process by which soil particles are removed from land surfaces by wind, water or gravity. Natural erosion generally occurs at slow rates. However, the rate of erosion increases when land is cleared or altered and left disturbed. Erosion rates will increase when flow rates and velocities discharged from a site exceed the erosive range. Short-term stormwater quality management predominately focuses on erosion prevention and sedimentation control (EPSC) for construction sites. However, for some fully developed sites EPSC can also be a concern.

Clearing and grubbing activities during construction remove vegetation and disrupt the structure of the soil surface, leaving the soil susceptible to rainfall erosion, stream and channel erosion, and wind erosion if left untreated. Ultimately, the material suspended by erosion settles during sedimentation in downstream reaches. This can lead to increased maintenance needs and flooding problems.

1.3.1.1 Water Erosion

The rainfall erosion process begins when raindrops impact the soil surface and dislodge minute soil particles. These soil particles then become suspended in the water droplet. The sediment-laden water droplets accumulate on the soil surface until a sufficient quantity has developed to begin flowing under the forces of gravity.

The initial flow of sediment-laden water generally consists of a thin, slow-moving sheet, known as sheet flow. While sheet flow is generally not highly erosive on its own, it does begin the transport of previously suspended sediment. Due to irregularities in the soil surface and uneven topography, sheet flow will usually begin to concentrate into rivulets, where the flow picks up velocity, and erosive energy increases as a result of gravitational forces.

The increasing erosive energy of water flowing in rivulets will cut small grooves, or rills, in the soil surface. Rill erosion of the soil surface tends to concentrate more flows, which then flow faster and gain erosive energy as a result of gravitational forces. In turn, the rills become deeper and larger, and join adjacent rills. Typically, rills run parallel with the slope and each other, are small enough to be stepped across, and are generally enlarged by direct erosion of the rill's sides and bottom by the action of flowing water.

The communion of several adjacent rills, or sufficient enlargement of a single rill, begins gully erosion. Gully erosion of the soil surface tends to concentrate more flows, which then flow faster and gain erosive energy as a result of gravity. Typically, gullies run parallel with the slope, may have one or more lateral branches, and are enlarged by four key actions. First, gullies often have a "head cut" at the upstream end which progresses its way upstream as water flowing into the gully erodes the lip of the head. This mechanism is similar to a waterfall working its way upstream. Second, the flow in a gully tends to under cut the banks. Once sufficiently under cut, the banks collapse into the gully where the loosened soil is then washed away. Third, when banks collapse into the gully, flowing water is diverted around the temporary blockage of soil. This temporary blockage increases velocities along one or both banks, which results in increased bank erosion. Fourth, the concentration of flows in the gully can result in scour of the gully floor until a stable slope is obtained.

1.3.1.2 Stream and Channel Erosion

One or more of the following factors that disrupt the delicate balance required for stable streams and channels generally precipitate erosion within streams and channels.

1. Disturbing the banks of streams and channels is often required during construction. Once vegetation or other bank protection measures are disturbed, flows may begin to erode the unprotected soil.

2. Disturbing the flow within a stream or channel is often necessary to facilitate construction activities. However, this should only be allowed when traversing banks such as with a temporary stream crossing, culvert installation, bridge construction, etc. By diverting flows within the channel, velocities are increased in some areas to compensate for decreases in other areas. The increases in velocity may exceed those normally experienced by the channel, resulting in bank erosion and bottom scour.

3. Increasing the quantity and rate of flow to streams and channels often results from construction activities and construction of facilities that increase the quantity and rate of runoff as well as how runoff is conveyed to the discharge point. The increased quantity and rate of flow can cause bank erosion and bottom scour.

1.3.1.3 Wind Erosion

Dust is defined as solid particles or particulate matter small enough to remain suspended in the air for a period of time and large enough to eventually settle out of the air. Dust from a construction site originates as inorganic particulate matter from rock and soil surfaces and material storage piles. The majority of dust generated and emitted into the air at a construction site is related to earth moving, demolition, construction traffic on unpaved surfaces, and wind over disturbed soil surfaces.

1.3.1.4 Factors Influencing Erosion

There are five primary factors that influence erosion: soil characteristics, vegetative cover, topography, climate, and rainfall.

1. Soil characteristics that determine the Erodibility of the soil include particle size, particle gradation, organic content, soil structure, and soil permeability. Soil characteristics affect soil stability and infiltration capacity. The less permeable the soil, the higher the likelihood for increased runoff and erosion. Soils with a high percentage of silt and clays are generally the most erodible.

   The soil characteristics play a different role for channel flow. The tractive-force or shear stresses developed by flowing water over the channel banks and bottom can cause the soil particles to move and become suspended into the runoff. The "permissible shear" stress indicates the stress that the channel banks and bottom can sustain without compromising stability. Protecting the channel bottom and banks with a variety of "soft/green" or "hard" armoring increases the permissible shear stress in the channel.

2. Vegetative cover plays an important role in controlling erosion by shielding the soil surface from the impacts of falling rain and slowing the velocity of runoff. This permits greater infiltration, maintains the soil's capacity to absorb water, and holds soil particles in place. Vegetative root structures create a favorable soil structure, improving its stability and permeability.

3. Topography, including slope length and steepness, are key elements in determining the volume and velocity of runoff. As slope length, and /or steepness increases, so do the rate of runoff and the erosion potential.

4. Climate is a key factor that influences erosion. High rainfall areas and areas with freeze/thaw cycles have significant effects on soil stability and structure.

5. Wet weather frequency, intensity, and duration are fundamental factors in determining the amounts of erosion produced. When storms are frequent, intense, or of long duration, erosion risks are high. In Indiana, the erosion risk period is typically highest in the wet season (typically December through May) which coincides with the period of minimal vegetative cover.

1.3.2 Other Stormwater Pollutants and Impacts

Sediment from erosion is the pollutant most frequently associated with construction activities. However, other pollutants of concern include nutrients, metals, pesticides, oil and grease, fuels, other toxic chemicals, and miscellaneous wastes. These pollutants originate from a variety of activities including paving operations, demolition, materials storage, equipment fueling, and other daily activities necessary for project construction or site (commercial or industrial) management. By taking an activities inventory, the contractor/operator can identify potential pollutant sources and then select appropriate BMPs to address these sources. Appropriate BMPs are usually specific to the construction activity or site (commercial or industrial) management activity.

1.3.2.1 Nutrients

Phosphorous and nitrogen from fertilizers, pesticides, construction chemicals, and solid waste are often generated by site activities. These nutrients can result in excessive or accelerated growth of vegetation or algae resulting in impaired use of water in lakes and other sources of water supply through taste and odor problems. Excess algae can also deplete dissolved oxygen levels, resulting in fish kills. Collectively, the problems associated with excessive levels of nutrients in a receiving water are referred to as *eutrophication* impacts.

1.3.2.2 Oxygen Demanding Substances

Lower dissolved oxygen (DO) levels are often the cause of fish kills in streams and reservoirs. The degree of DO depletion is measured by the biochemical oxygen demand (BOD) test that expresses the amount of easily oxidized organic matter present in water. The chemical oxygen demand (COD) test measures all the oxidizable matter present in urban runoff. BOD is caused by the decomposition of organic matter in stormwater that depletes DO. Other non-organic materials in the water can intensify DO depletion.

1.3.2.3 Metals

Many artificial surfaces (e.g., galvanized metal, paint, or preserved wood) contain metals that can enter stormwater as the surfaces corrode, flake, dissolve, decay, or leach. However, significant portions of metals in urban runoff are from cars and trucks. Over half the trace metal load carried in stormwater is associated with sediments to which these eroded metals attach. Heavy metals are of concern because they are toxic to aquatic organisms, can be bioaccumulative, and have the potential to contaminate drinking water supplies.

1.3.2.4 Pesticides

Herbicides, insecticides and rodenticides (collectively termed *pesticides*), are commonly used on construction sites, lawns, parks, golf courses, etc. Unnecessary, excessive, or improper application of these pesticides may result in direct water contamination, indirect water pollution by aerosol drift, or erosion of treated soil and subsequent transport into surface waters.

1.3.2.5 Oil, Grease and Fuels

These products are widely used and can be spilled/leaked/dumped on the ground where they can wash into waterways. Sources include leakage during normal vehicle use, hydraulic line failure, spills during fueling, and inappropriate disposal of drained fluids. These products can cause harm to plant and animal life.

1.3.2.6 Other Toxic Chemicals

Often synthetic organic compounds (adhesives, cleaners, sealants, solvents, etc.) are widely applied and may be improperly stored and disposed. Accidental spills and leakage or deliberate dumping of these chemicals onto the ground or into storm drains causes environmental harm in receiving waters.

1.3.2.7 Miscellaneous Wastes

Miscellaneous wastes include wash water from concrete mixers, paints and painting equipment cleaning activities, solid organic wastes resulting from trees and shrubs removed during land clearing, wood and paper materials derived from packaging of building products, food containers, such as paper, aluminum, and metal cans, industrial or heavy commercial process wash/cooling water, vehicle washing, dewatering operations, other commercial or industrial wastes and sanitary wastes. The discharge of these wastes can lead to unsightly and polluted receiving waters.

1.4 BMP Selection Process

1.4.1 BMP Objectives

Each construction project is unique. Therefore, an understanding of the pollution risks of the construction activity is essential for selecting and implementing BMPs. Defining these risks requires review of the characteristics of the site and the nature of the construction, information which should be assembled for the construction plans. Once these pollution risks are defined, BMP objectives are developed, and BMPs selected. The BMP objectives for construction projects are as follows:

1. Practice Good Housekeeping: Perform activities in a manner which keeps potential pollutants from either draining or being transported off-site by managing pollutant sources and modifying construction activities.

2. Contain Waste: Dispose of all construction waste in designated areas, and keep stormwater from flowing on to or off of these areas.

3. Minimize Disturbed Areas: Only clear land which will be actively under construction in the near term (e.g., within the next 3-4 months), minimize new land disturbance during the rainy season, and do not clear or disturb sensitive areas (e.g., steep slopes, buffers and natural watercourses) and other areas where site improvements will not be constructed.

4. Stabilize Disturbed Areas: Provide temporary stabilization of disturbed soils whenever active construction is not occurring on a portion of the site. Provide permanent stabilization during finish grade and landscape the site.

5. Protect Slopes and Channels: Outside of approved grading plan area, avoid disturbing steep or unstable slopes. Safely convey runoff from the top of the slope, and stabilize disturbed slopes as quickly as possible. Avoid disturbing natural channels. Stabilize temporary and permanent channel crossings as quickly as possible, and ensure that increases in runoff velocity caused by the project do not erode the channel.

6. Control Site Perimeter: Upstream runoff should be diverted around or safely conveyed through the construction project. Such diversions must not cause downstream property damage. Runoff from the project site should be free of excessive sediment and other constituents.

7. Control Internal Erosion: Detain sediment laden waters from disturbed, active areas within the site to minimize the risk that sediment will have the opportunity to leave the site.

Site characteristics and contractor activities affect the potential for both erosion and contamination by other constituents used on the construction site. Before defining BMP objectives, you should carefully consider:

1. Site conditions that affect erosion and sedimentation, including:

    a. Soil type, including underlying soil strata that are likely to be exposed to stormwater.
    b. Natural terrain and slope.
    c. Final slopes and grades.
    d. Location of concentrated flows, storm drains, and streams.
    e. Existing vegetation and ground cover.

2. Climatic factors, which include:

    a. Seasonal rainfall patterns.
    b. Appropriate design storm.
        i. Quantity of rainfall.
        ii. Intensity of rainfall.
        iii. Duration of rainfall.

3. Type of construction activity.
4. Construction schedules, construction sequencing and phasing of construction.
5. Size of construction project and area to be graded.
6. Location of the construction activity relative to adjacent uses and public improvements.
7. Cost-effectiveness considerations.
8. Types of construction materials and potential pollutants that are present or will be brought onsite.
9. Floodplain, floodway, and buffer requirements.

1.4.2 BMP Categories

Once the BMP objectives are defined, it is necessary to identify the category of BMPs that is best suited to meet each objective.

To determine where to place categories of BMPs, a map of the project site can be prepared with sufficient topographic detail to show existing and proposed drainage patterns and existing and proposed permanent stormwater control structures. The project site map should identify the following:

1. Locations where stormwater enters and exits the site. Include both sheet and channel flow for the existing and final grading contours.

2. Identify locations subject to high rates of erosion such as steep slopes and unlined channels. Long, steep slopes over 100 feet in length are considered as areas of moderate to high erosion potential.

3. Categorize slopes as:

    a. Low Erosion Potential (0 to 5 percent slope)

   b. Moderate Erosion Potential (5 to 10 percent slope)
   c. High Erosion Potential (slope greater than 10 percent)

4. Identify wetlands, springs, sinkholes, floodplains, floodways, sensitive areas or buffers which must not be disturbed, as well as other areas where site improvements will not be constructed. Establish clearing limits around these areas to prevent disturbance by the construction activity.

5. Identify the boundaries of tributary areas for each outfall location. Then calculate the approximate area of each tributary area.

6. Define areas where various contractor activities have a likely risk of causing a runoff or pollutant discharge.

With this site map in hand, categories of BMPs can be selected and located. It is more cost-effective to prevent erosion/pollution than to remove sediment/pollutants, and erosion prevention is achieved most cost-effectively by planning before construction begins and phasing construction activities.

BMPs that can achieve more than one BMP objective should be taken into account when selecting BMPs to achieve maximum cost-effectiveness. For instance, it is not always necessary to install extensive sediment trapping controls during construction. In fact, sediment trapping should be used only as a short-term measure for active construction areas, and replaced by permanent stabilization measures as soon as possible. However, it should be noted that perimeter/outfall control in the form of permanent detention ponds should be built first and used as temporary sediment control by placing a filter on the outlet. After construction is complete and tributary area is stabilized, the permanent outlet configuration can be reestablished.

1.4.3 Selecting BMPs for Construction Site Management (Sections SPD, EPP, SMP)

Certain contractor activities may cause pollution if not properly managed. Not all of the BMPs will apply to every construction site. However, all of the suggested BMPs should be considered, and those which are appropriate for the project at hand should be selected. Considerations for selecting BMPs for contractor activities include the following:

1. Is it expected to rain? BMPs may be different on rainy days vs. dry days, winter vs. summer, etc. For instance, a material storage area may be covered with a tarp during the rainy season, but not in the summer. However, it should be noted that plans should be made for some amount of rain even if it is not expected to generate a flooding event.

2. How much of a material is used? Less intensive BMP implementation may be necessary if a “small” amount of pollutant containing material is used (however, remember that different materials pollute in different amounts).

3. How much water is used onsite? The more water used and wastewater generated, the more likely that pollutants transported by this water will reach the stormwater system or be transported off-site. Washing out one concrete truck on a flat area of the site may be sufficient (as long as the concrete is safely removed later), but a pit should be constructed if a number of trucks will be washed out at the same site.

4. What are the site conditions? BMPs selected will differ depending on whether the activity is conducted on a slope or flat ground, near a stormwater structure or watercourse, etc. Anticipating problems and conducting activities away from certain sensitive areas will reduce the cost and inconvenience of performing BMPs.

5. **What about accidents?** Pre-establishing a BMP for each conceivable pollutant discharge may be very costly and significantly disrupt construction. As a rule of thumb, establish controls for common (daily or weekly) activities and be prepared to respond quickly to accidents. Define the difference; not everything can be called an accident and may be classified as negligent disregard of proper practices.

Therefore, keep in mind that the BMPs for contractor activities are suggested practices which may or may not apply in every case. Construction personnel should be instructed to develop additional or alternative BMPs which are more cost-effective for a particular project. The best BMP is a construction work force aware of the pollution potential of their activities and committed to a clean worksite.

Effective EPSC management first keeps the soil protected (e.g. minimizes disturbed areas) as long as possible by erosion prevention (EP) and second, directs runoff from disturbed areas to locations where suspended soil materials can be removed prior to discharge from the site by sediment control (SC). The use of source control BMPs to control erosion before its starts is the preferred method of long-term sediment control. However, on active construction areas, there may not be sufficient time for EP BMPs to become established to the point at which they are fully effective before the onset of erosive events. In these situations, SC BMPs can provide a more immediate level of protection by removing suspended sediment from flows before being transported. However, the best protection on active construction sites is generally obtained through simultaneous application of both EP BMPs and SC BMPs. This combination of controls is effective because it prevents most erosion before it starts and has the ability to capture sediments that become suspended before the transporting flows leave the construction site.

BMPs for erosion prevention and sediment control are selected to meet the BMP objectives based on specific site conditions, construction activities, and cost-effectiveness. Different BMPs may be needed at different times during construction since construction activities are constantly changing site conditions.

The following general items are provided to aid in preparing the project plans and choosing appropriate erosion and sediment control BMPs.

Minimize Disturbed Areas

The first step for selecting BMPs is to compare the project layout and schedule with onsite management measures that, where appropriate, can limit the exposure of the project site to erosion and sedimentation. Scheduling and planning considerations are the least expensive way to limit the need for EPSC controls. Consider the following BMPs:

1. Do not disturb any portion of the site unless an improvement is to be constructed there.

2. The staging and timing of construction can minimize the size of exposed areas and the length of time the areas are exposed and subject to erosion.

3. The staging of grading operations should limit the amount of areas exposed to erosion at any one time. Only the areas that are actively involved in cut and fill operations or are otherwise being graded should be exposed. Exposed areas should be stabilized as soon as grading is complete in that area.

4. Retain existing vegetation and ground cover where feasible, especially along watercourses and along the downstream perimeter of the site.

5. Do not clear any portion of the site until active construction begins.

6. Construct outfall detention or perimeter sedimentation control (with filter weirs/berms and temporary sedimentation control barriers first).

7. Quickly complete construction on each portion of the site.

8. Install cover landscaping and other improvements that permanently stabilize each part of the site immediately after the land has been graded to its final contour.

9. Minimize the amount of denuded areas and any new grading activities during the wet months of December through May.

10. Construct permanent stormwater control facilities (e.g., detention basins) early in the project and use for sediment trapping, slope stabilization, velocity reduction, etc. during the construction period.

Stabilize Disturbed Areas

The purpose of site stabilization BMPs is to prevent erosion by covering disturbed soil. This covering may be vegetative, chemical, or physical. Any exposed soil is subject to erosion—either by rainfall striking the ground, runoff flowing over the soil, wind blowing across the soil, and vehicles driving on the soil. Thus all exposed soils should be stabilized except where active construction is in progress. Locations on a construction site which are particularly subject to erosion and should be stabilized as soon as possible include:

1. Slopes
2. Highly erosive soils
3. Construction entrances
4. Stream channels
5. Soil stockpiles

1.4.3.1 Site Perimeter

1. Disturbed areas and slopes that drain toward adjacent properties, storm drain inlets or receiving waters should be protected with temporary linear barriers (continuous berms, silt fences, sand bags, rolls, etc.) to reduce or prevent sediment discharge while construction in the area is active. In addition, the contractor should be prepared to stabilize those soils with EP measures prior to the onset of rain.

2. When grading has been completed, the areas should be protected with EP controls such as mulching, seeding, planting, or emulsifiers. The combination of EP measures and SC measures should remain in place until the area is permanently stabilized.

3. Significant offsite flows (especially concentrated flows) that drain onto disturbed areas or slopes should be controlled through use of continuous berms, earth dikes, drainage swales, and lined ditches that will allow for controlled passage or containment of flows.

4. Concentrated flows that are discharged off of the site should be controlled through outlet protection and velocity dissipation devices in order to prevent erosion of downstream areas.

5. Perimeter controls should be placed everywhere runoff enters or leaves the site. They are usually installed just before clearing, grubbing and rough grading begin. Perimeter controls for all but the smallest projects will become overloaded by both runoff and sediment. Additional controls within the interior of the construction site should supplement perimeter controls once rough grading is complete.

1.4.3.2 Internal Swales and Ditches

1. More often, flows are directed toward internal swales, curbs, and ditches. Until the permanent facilities are constructed, temporary stormwater facilities will be subjected to erosion from concentrated flows.

2. These facilities should be stabilized through temporary check dams, geotextile mats, and under extreme erosive conditions by lining with concrete.

3. Long or steep slopes should be terraced at regular intervals (per local requirements). Terraces will slow down the runoff and provide a place for small amounts of sediment to settle out.

4. Slope benches may be constructed with either ditches along them or back-sloped at a gentle angle toward the hill. These benches and ditches intercept runoff before it can reach an erosive velocity and divert it to a stable outlet.

5. Overland flow velocities can be reduced by creating a rough surface for runoff to cross (e.g. tall grass).

1.4.3.3 Internal Erosion

Once all other erosion and sediment control BMPs have been exhausted, excessive sediment should be removed from the stormwater both within and along the perimeter of the project site. The appropriate controls work on the same principle: the velocity of sediment-laden runoff is slowed by temporary barriers or traps which pond the stormwater to allow sediments to settle out. Appropriate strategies for implementing sedimentation controls include:

1. Direct sediment-laden stormwater to temporary sediment traps.

2. Locate sediment basins and traps at low points below disturbed areas.

3. Protect all existing or newly-installed storm drainage structures from sediment clogging by providing inlet protection for area drains and curb inlets.

4. Construct temporary sediment traps or ponds at the stormwater outfall(s) for the site.

5. Excavate permanent stormwater detention ponds early in the project, use them as sedimentation ponds during construction, remove accumulated sediment, and landscape the ponds when the upstream drainage area is stabilized.

6. Use temporary sediment barriers such as:

    a. Continuous Berms

b. Silt Fences
c. Sand Bag Barriers
d. Brush or Rock Filter

These barriers should only be used in areas where sheet flow runoff occurs. They are less effective or ineffective if the runoff is concentrated into rill or gully flow.

1.4.3.4 Stormwater Inlets and Outfalls

1. Stormwater inlets, including drop inlets, and pipe inlets, should be protected from sediment intrusion if the area draining to the inlet has been disturbed.

2. Stormwater inlet protection can utilize sand bags, sediment traps, or other similar devices.

3. Internal outfalls must also be protected to reduce scour from high velocity flows leaving pipes or other drainage facilities.

1.4.4 BMPs for Good House Keeping (Section GHP)

Most permanent BMPs will be proposed by the developer early in the planning stage of a project. For most projects, there will be no single BMP which addresses all the long-term stormwater quality problems. Instead, a multi-level strategy will be worked out with the City of Somerset which incorporates source controls, a series of onsite treatment controls, and community-wide treatment controls.

In most cases permanent BMPs can be implemented most effectively when they can be integrated into other aspects of the project design. This requires that conceptual planning consider stormwater controls as integral to site design rather than as an adder after design. The following should be considered early in the design process.

1. Is a detention/retention facility required for flood control? Often, facilities are required to maintain peak runoff at predevelopment levels to reduce downstream conveyance system damage and other costs associated with flooding. Most permanent BMPs can be incorporated into flood control detention/retention facilities with modest design refinements and limited increases in land area and cost.

2. Planned open space which will be relatively flat (e.g., final grade slopes less than 5 percent) may be merged with stormwater quality/quantity facilities. Such integrated, multi-use areas may achieve several objectives at a modest cost.

3. Infiltration BMPs may serve as groundwater recharge facilities, detention/retention areas may be created in landscaped areas of the project, and vegetated swales/filters may be used as roadside or parking lot median vegetated areas.

1.4.5 BMPs for Residential and Homeowners (Section RHP)

Citizens of Somerset also hold a stake in the maintenance and improvement of water quality in the community. If residents and property owners take measures to minimize their impact in their surrounding environment, pollution can be greatly reduced.

Residential and Homeowner BMPs describe methods that individuals can use and employ throughout their community to make ditches, streams and receiving waters safe. The pollutants that they discharge (most of the time unknowingly) can be reduced simply through education. Information on the "dos and don'ts" of chemical treatments (fertilizers, herbicides, insecticides, etc.) and disposal of other hazardous wastes (soapy water from vehicle washing or disposal of petroleum based products into stormwater appurtenances such as catch basins) are just two examples of how to improve the water quality in a community. The City of Somerset should raise awareness of these BMPs of homeowners and residents via billings or community outreach programs and schools.

1.4.6 BMPs for Post-Construction Practices (Sections SPP and PTP)

The City of Somerset has continued to promote and encourage growth and development throughout its history. As development throughout the City continues, the characteristics of its topography and hydrology have shifted from those of a rural community to those of a more urbanized city. This has affected the way land is managed and consequently, stormwater drainage.

As more areas are developed for industrial and commercial needs, the service requirements to support those enterprises increase. Residential, commercial, industrial and transportation development disturb and alter drainage patterns resultant from wet weather runoff and increase pollution within the City's streams and waters and beyond its boundaries. In an effort to manage the demands of development, the City is managing ways and means to improve stormwater quality. To do so, the City of Somerset has created Post-Construction Best Management Practices to educate, train and enforce how development and redevelopment of the land is managed, thereby improving water quality.

1.4.6.1 Background Information

The amendment of the Clean Water Act of 1987 placed more emphasis on non-point source pollution and stormwater quality. One measure was the expansion of the National Pollutant Discharge Elimination System (NPDES) permit program to focus on non-point source pollution in large and small municipalities. These communities were required to implement stormwater quality programs by creating structural and non-structural controls, BMP guidelines for inspections, enforcement, monitoring and public education. Phase I communities began development and implementation of their programs in 1993. Louisville, KY is one such community. Since 1999, the NPDES permit program has been extended to smaller municipalities such as Somerset. These cities are called Phase II communities, and are required to adhere to the following six minimum control measures:

- Public Education and outreach
- Public Participation/Involvement
- Illicit Discharge Detection and Elimination
- Construction Site Runoff Controls
- Post-construction Runoff Controls
- Pollution Prevention and Good Housekeeping

As part of the requirements of the NPDES permit, Somerset has developed its Post-construction Stormwater Management Program.

In February 2005, the City approved a Stormwater Management Ordinance. This ordinance provides direction for design and performance criteria for developers and design engineers, and empowers this BMP Manual to provide the detail and standards of those practices for post-construction stormwater quality. It also provides information regarding who will be responsible for approving and enforcing those practices found in this manual.

1.4.6.2 Goals of the Program

The goals of the post-construction runoff management program are as follows:

1. Provide protection of the short-term and long-term public health, safety, and general welfare by:

    - Providing for regulation and management of Somerset's stormwater system, including public and private facilities within Somerset's jurisdiction.
    - Protecting, and preserving stormwater quality and fish and wildlife habitat within Somerset.
    - Protecting those downstream from stormwater quality impairment.

2. Comply with state and federal stormwater regulations developed pursuant to the Clean Water Act Amendments of 1987 and subsequent amendments. The objectives of these regulations include the following:

    - Managing the quality of stormwater discharged to the MS4 by controlling the contribution of pollutants associated with residential, commercial and industrial activity.
    - Controlling stormwater pollution caused by the suspension and transport of soils and other sediments.
    - Aiding in maintaining a stable tax base by providing for the sound use and development of flood-prone areas in such a manner as to maximize beneficial use without increasing flood hazard potential or diminishing the quality of the community's stormwater resources.
    - Minimizing damage to public facilities and utilities such as water and gas mains, electric, telephone and sewer lines, streets and bridges.
    - Ensuring the use of the public and private stormwater management systems that will not result in excessive maintenance costs.
    - Encouraging the use of natural and aesthetically-pleasing designs that optimize the preservation of natural areas.
    - Guiding the construction of stormwater management facilities by developing comprehensive master plans and guidance that address stormwater quantity and quality.
    - Encouraging the preservation of floodplains, floodways and open spaces to protect and benefit the community's quality of life and natural resources.

1.4.6.3 Types of Pollutants and Impacts

The most noticeable impact of development to a watershed is the accumulation of pollutants from the atmosphere, from automobiles, or carried by wind from adjacent areas onto newly formed impervious areas. These pollutants are washed off and concentrated in stormwater runoff. These pollutants consist of nutrients, suspended solids, organic carbon, bacteria, hydrocarbons, trace metals such as cadmium, copper, lead and zinc, pesticides, chlorides and other deleterious materials found in trash cans. Table 1-1 is a summary of pollutants typically found in urban stormwater runoff.

Table 1.1 Typical Pollutant Concentrations Found in Urban Stormwater

Typical Pollutants found in Stormwater Runoff	Units (2)	Avg Concentration (1)
Total Suspended Solids	mg/l	80
Total Phosphorous	mg/l	0.30
Total Nitrogen	mg/l	2.0
Total Organic Carbon	mg/l	12.7
Fecal Coliform Bacteria	MPN/100 ml	3600
E. coli Bacteria	MPN/100 ml	1450
Petroleum Hydrocarbons	mg/l	3.5
Cadmium	μg/l	2
Copper	μg/l	10
Lead	μg/l	18
Zinc	μg/l	140
Chlorides (winter only)	mg/l	230
Insecticides	μg/l	0.1 to 2.0
Herbicides	μg/l	1 to 5.0

(1) These concentrations represents mean or median storm concentrations measured at typical sites and may be greater during individual storms. Also note that mean or median runoff concentrations for stormwater hotspots are up to 10 times higher than those shown in this table.

(2) Units: mg/l – milligrams per liter; μg/l – micrograms/liter; MPN – Most Probable Number.

Data Source: *2000 Maryland Stormwater Design Manual*

1.4.6.4 Other Impacts by Development

Development can negatively impact a watershed in other ways. Paved areas that once absorbed precipitation no longer contribute to recharging groundwater. Aquifers help recharge local waterways.

The increased stormwater runoff becomes a powerful force in altering the shape of downstream waterways. Urban channel streams receive runoff more quickly and experience bankfull and sub-bankfull flow more dramatically and frequently. This can cause the stream to widen and deepen and contribute to a loss of aquatic life due to higher temperatures (stormwater discharging off of hot asphalt) and loss of habitat.

1.4.6.5 Post-Construction Stormwater Management's Ties to Land Use

The BMPs found within this manual have unique applications and limitations. There will be cases where existing land use or topography dictate the suitability and effectiveness of a practice, especially for those that require extensive land commitments by the City or developer, or may not be practical in a densely populated area. Large green spaces such as parks are potential sites for the larger practices and can be incorporated into a regional BMP policy, whereas residential areas may use other suitable practices such as infiltration trenches and grassed swales.

Gas stations and automotive maintenance shops, downtown development, and industrial parking lots are also referred to as “hot spots” and may be able to use oil/grit separators, filter strips or sand filters that can be located under existing structures so long as access for maintenance is provided.

Commercial strip areas may require source controls unless land is available for larger practices. Pollutant loading from these areas tend to be higher than residential on a land unit basis. A regional treatment design and policy should be considered so that land use is optimized and practice maintenance is simplified and minimized for all parties concerned.

1.4.6.6 Treatment Approaches

Somerset’s approach to stormwater management addresses two concerns: stormwater quantity and stormwater quality. Stormwater management can use two types of approaches to help the receiving water meet its designated use: performance based and prescriptive.

The performance-based approach sets a specific goal to reach, such as removal of 80% of suspended solids. The prescriptive approach defines requirements of pretreatment or the distance or size a BMP must be to provide treatment to polluted runoff. These requirements are provided within each BMP in Section 4 of this Manual.

1.4.7 Stormwater Quantitative Design Criteria

Stormwater management practices are designed so that the peak flow discharge rates of a post-developed area match the pre-developed flow rates.

The EPA describes *first flush* as the pollutants that are washed off of an exposed area during a wet weather event and its subsequent runoff process. Typically, the initial concentration of the run off will be more polluted than the stormwater that runs off later.

By controlling or capturing first flush pollutants with best management practices, the opportunities and chances of improving water quality are increased, thereby allowing subsequent runoff to be diverted to the stormwater system without as much need for residue containment as with the first flush.

The WEF Manual of Practice No. 23, *Urban Runoff Quality Management,* shows that the mean storm precipitation depth for a 6 hour event is 0.60 inches. This value should be used in subsequent equations in designing stormwater facilities and practices.

1.4.8 Stormwater Quality Design Criteria

Somerset’s stormwater quality design measures are based on the *Unified Stormwater Sizing Criteria* developed by the Maryland Department of the Environment. The goals of following these procedures are to meet pollutant removal standards, maintain groundwater recharge wherever possible, reduce channel erosion, prevent overbank flooding and pass extreme floods.

1.4.8.1 Water Quality Volume

The Water Quality Volume (WQv) is storage required to capture and treat stormwater runoff from 90% of the average annual rainfall. The following equation shows that this value is equal to the product of precipitation, volumetric runoff coefficient and site area, divided by twelve.

Equation 1.1 states:

$$WQv = [(P)(Rv)(A)]/12 \qquad \text{(Equation 1.1)}$$

Where,

P is the average rainfall in inches, (in the case of Somerset 50.8 inches);
Rv is the volumetric runoff coefficient, which is:

$$Rv = 0.05 + 0.009(I)$$

where I is the percent impervious cover; and
A is the area in acres

1.4.8.2 Recharge Volume

Recharge volume is defined by Equation 1.2, which states:

$$\mathrm{Re}\,v = [(S)(Rv)(A)]/12 \qquad \text{(Equation1.2)}$$

Where,

S is the Soils Specific Recharge Factor, which is found in the following table;

Hydrologic Soil Group	Soil Specific Recharge Factor *(S)*
A	0.38
B	0.26
C	0.13
D	0.07

Rv is the volumetric runoff coefficient, which is:

$$Rv = 0.05 + 0.009(I)$$

where I is the percent impervious cover; and
A is the area in acres.

A simplified variation of Equation 2.2 uses the value Ai, the measured impervious cover, to directly calculate Re*v*. It reads:

$$\mathrm{Re}\,v = (S)(Ai)$$

Since Somerset's topography includes karst features, check with the City Engineer to determine if a Recharge Volume is required for a project area.

1.4.8.3 Channel Protection Storage Volume

The channel protection storage volume is the quantity of water that should be detained to protect Somerset's drainage channels from erosion. The rationale for providing this protection is that runoff will be stored and released in a more gradual manner during lower flows. The method of determining the Cpv is based on the Design Procedures for Stormwater Management Extended Detention Structures

The steps are as follows:

- Compute the time of concentration (t_c) and the one-year post development runoff depth (Q_a) in inches
- Compute the initial abstraction (I_a = 100/CN – 2) and the ratio I_a/P where P is the one-year rainfall depth
- With t_c and I_a/P, find the unit peak factor (q_v) from a SCS Graph of 24-hour Type II Storm Distribution. Then compute the one-year post-development peak discharge ($q_t = q_u A Q_a$, where A is the drainage area in square miles).
    - If q_i is ≤ 2.0 cfs, the CP_v is not required. Provide for water quality volume (WQ_v) and recharge volume (Re_v) as necessary.
- With q_u, find the ratio of outflow to inflow (q_o/q_i) for T=24 hours from the Unit Discharge Graphic.
- Compute the peak outflow discharge $q_v = q_o/q_i \times q_i$.
- With q_o/q_i, compute the ratio of storage to runoff volume (V_s/V_r).

  $V_s/V_r = 0.683 - 1.43\,(q_o/q_i) + 1.64\,(q_o/q_i)^2 - 0.804\,(q_o/q_i)^3$
- Compute the extended detention storage volume $V_s = (s/V_r) \times V_r$ (note: $V_r = Q_a$);

  Convert V_s to acre-feet by $V_s/12 \times A$, where V_s is in inches and A is in acres

- Compute the required orifice area (A_o) for extended detention design:

$$A_o = \frac{q_o}{C\sqrt{2gho}} = \frac{q_o}{4.81\sqrt{4.81ho}}$$

Where h_o is the maximum storage depth associated with V_s.

- Determine the required maximum orifice diameter (d_o) $d_o = \sqrt{4A_o / \pi}$

A d_o less than 3.0" is subject to Somerset approval and is not recommended unless an internal control for orifice protection is used.

1.4.8.4 Overbank Flood Protection Volume

The overbank flood protection volume, Q_p, is used to prevent an increase in the frequency and magnitude of out-of-bank flooding that is resultant of development. The City of Somerset requires that a 10-year, 24-hour storm be used to calculate the Q_p.

1.4.8.5 Extreme Flood Volume

The extreme flood volume is a measure used to prevent flood damage from a large wet weather event, to maintain the boundaries of pre-development 100-year Federal Emergency Management Agency (FEMA) and/or locally designated floodplain, and to protect the physical integrity of the structural BMPs.

The designer needs to calculates the required storage to attenuate the post-construction 100-year, 24-hour peak discharge.

1.4.9 Waterway Buffers

Areas of new development and redevelopment shall include a 25- to 50-foot undisturbed no-build buffer zone that is measured from top of bank on both sides for the entire length of blue-line streams identified in the most recent USGS Quadrangle maps within the City of Somerset. Buffers are vegetated areas, including trees and shrubs which exist or are established to protect a stream system, lake, or reservoir area. These buffers also apply to other sensitive areas such as springs, wetlands and sinkholes.

A waterway buffer must be applied to all waterways serving more than 25.0 acres of tributary area. No new construction of any building or structure shall be permitted in the buffer.

The waterway buffer is defined as the area contained within a boundary established 25-feet beyond the floodplain boundary as defined by FEMA or the City of Somerset, which ever is larger.

For areas without a defined floodplain, the waterway buffer shall be defined on a case-by-case basis by the City of Somerset.

The waterway buffer and floodplain may be used for application of water quality devices. This may only be permitted provided EPSC, water quality, and cut-fill policies are adequately addressed. Detention/retention volumes in the floodplain may count as fill if applied in a manner where floodplain storage is lost.

1.4.10 Long-Term Maintenance and Operation Agreement and Inspections

It is important that post-construction BMPs are properly maintained for the life of the practice. It is therefore important that the owner of the property with the practice enter into an agreement with the City that clearly defines the responsibilities and requirements of each party to ensure that the BMP is properly maintained and operates unimpeded.

Some of the elements included in the long-term maintenance agreement include a required annual operation and maintenance report advising the City of how well the practice is performing, a provision allowing the City access to the practice at all times, and a statement that the practice's O&M management is bound to all future owners and that the agreement is transferred with the deed of record. The City of Somerset has *Long-Term Maintenance and Operation Agreement* forms, that can be found on the city's stormwater webpage under "Ordinance".

1.4.11 Enforcement

The City of Somerset has a responsibility to the public and the legal authority to enforce the maintenance and operation of a best management practice. There may be times that the City will require quick and immediate corrective measures to maintain a safe, healthy environment for areas upstream, downstream and/or surrounding the

BMP. The *Long-Term Maintenance and Operation Agreement* grants the City the right to access the practice at any time.

1.5 EPSC Permitting

1.5.1 Requirements

All land-disturbing activities, including site development and redevelopment, which disturb one or more acres of soil or are part of a common plan of sale or development that disturbs one or more acres of soil are required to obtain an Erosion Protection and Sediment Control (EPSC) permit before breaking ground. The submittal for the permit includes a permit application, EPSC plan for the site as described in the Stormwater Management Ordinance (2005-02), and a plan review fee.

1.5.2 Enforcement

The City of Somerset has a responsibility to the public and the legal authority to enforce the EPSC permit. The Stormwater Management Ordinance grants the City the right to access the site at any time.

When required, enforcement proceedings will be initiated by the issuance of a stop-work order by an administrative official. The stop-work order or citation will be delivered to the address listed on the EPSC permit and posted at the site. The permittee must cease activity or comply with the EPSC permit within 5 days of the posting of the order, or the permit may be revoked. If the permit is revoked, the permittee must bring the site back into compliance with the permit; else a new permit must be obtained before work may begin again. The permittee may also be subject to fines of up to $10,000 per day, per violation.

There may be times that the City will require quick and immediate corrective measures to maintain a safe, healthy environment for areas upstream, downstream and/or surrounding the site. In this situation, the City may correct the matter immediately and bill the cost of the work to the permittee.

1.6 How to Use this Manual

On the opposite page, there is a sample BMP Fact Sheet. This sample helps illustrate and explain the components that make up a fact sheet. Please note that some of the metrics used for the EPP and SMP section were not applicable to other sections and as such are not included.

On the pages following the example please find a summary of the BMPs described in this manual. The summary tables should make it easy for the reader to quickly reference information such as symbols, cost and pollutants targeted by these BMPs.

1

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Sediment Management Practices (SMPs)

3 SMP-01

Activity: Check Dams 2

4

PLANNING CONSIDERATIONS:

Design Life:

Acreage Needed: Minimal

Estimated Unit Cost: Low

Monthly Maintenance:

5

6

7

CD

Target Pollutants 8

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description This section provides a general overview of the BMP activity and introduces common niches where it can be applied.

Suitable Applications Suitable applications direct the user to the general design limitations and site compatibility for the BMP activity. This section targets situations where the BMP activity could be most effective, and points out situations where the activity should not me implemented.

Approach The approach is a suggested plan of action for implementing the BMP activity. This includes specific planning considerations respective to the type of materials, construction planning, and suggests BMPs to install in series in order to maximize benefits.

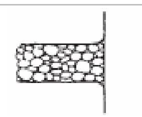
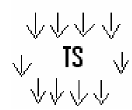
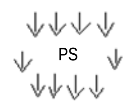
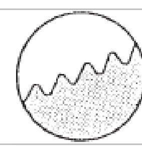
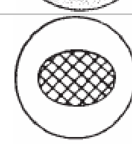
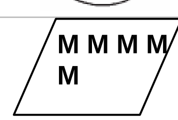
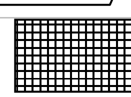
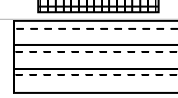
Installation Procedures This section provides guidance to design considerations when constructing the BMP, and often references a sample drawing.

Maintenance Although maintenance is often needed after a significant rain event, this section gives detailed guidance to users for the frequency of maintenance specific to each BMP design. Here, the user can find recommended maintenance techniques, frequency of in-active inspection checks, and key areas to maintain in order to maximize the design life of the BMP.

Inspection Checklist The inspection checklist includes key areas for inspectors to check in order to maintain the BMP throughout its design life. This may include design parameters, structural check-ups, or structural inspection after significant rain events.

Legend

1. Logo of City
2. BMP Activity Title
3. BMP Activity No.
4. Planning Considerations:
   - Design Life – a quantitative measurement of the BMP's effective life given that proper maintenance procedures are followed
   - Acreage needed – general description of land required for BMP
   - Estimated Unit Cost – general costs are categorized by Low, Medium, High
   - Monthly Maintenance – approximate frequency of maintenance
5. Typical Photo – photos are included as examples only, and are not meant for use in structural design
6. Suggested BMP symbol to place on ESPC drawings or design plans
7. Suggested BMP planning symbol to place on conceptual drawings or illustrations
8. Target Pollutants Table – likely pollutants to be removed by BMP practice

Section 3: Construction Site Management Practices for Stormwater Quality Symbology			
BMP	**Manual Description**	**Symbology**	
3.2 Erosion Prevention Practices - Fact Sheets			
EPP-01	Tire Washing Facility		TW
EPP-02	Construction Road Stabilization		CRS
EPP-03	Stabilized Construction Entrance		SCE
EPP-04	Buffer Zones		BZ
EPP-05	Temporary Seeding		TS
EPP-06	Permanent Seeding		PS
EPP-07	Sodding		SO
EPP-08	Surface Roughening		SR
EPP-09	Top Soiling		TS
EPP-10	Mulching		M
EPP-11	Nets and Mats		N M
EPP-12	Geotextiles		G

Section 3: Construction Site Management Practices for Stormwater Quality Symbology			
BMP	**Manual Description**	**Symbology**	
EPP-13	Terracing	T	T
EPP-14	Soil Binders		
3.3 Sediment Management Practices - Fact Sheets			
SMP-01	Check Dams		CD
SMP-02	Silt Fence		SF
SMP-03	Brush or Rock Filters and Continuous Berms	CB	CB
SMP-04	Sediment Traps		ST
SMP-05	Temporary Sediment / Detention Basin		DB
SMP-06	Bank Stabilization	S S	BS
SMP-07	Rip-rap	RR	RR
SMP-08	Channel Linings	CL	CL
SMP-09	Temporary Diversions, Drains, and Swales	TD TD	TD
SMP-10	Filter Strips	FS	FS
SMP-11	Temporary Inlet Protection		TIP
SMP-12	Temporary Outlet Protection		TOP

Section 3: Construction Site Management Practices for Stormwater Quality Symbology		
BMP	**Manual Description**	**Symbology**
SMP-13	Slope Drains	SD **SD**

Section 3: Construction Site Management Practices for Stormwater Quality Estimated Unit Costs		
BMP	**Manual Description**	**Cost**
	3.1 Site Planning and Design Practices - Fact Sheets	
	SPD-01 Protecting Sensitive Features	
SPD-01.1	Stream Corridor (Instream Activities)	High
SPD-01.2	Wetlands (Conservation/Permitting)	High
SPD-01.3	Steep Slopes and Highly Erodible Lands	Medium
SPD-01.4	Karst (Avoid; Prohibit Infiltration BMPs)	Medium
	SPD-02 Minimizing Impervious Surfaces	
SPD-02.1	Parking Lot Design	Low
SPD-02.2	Street Design	Low
SPD-02.3	Cul-de-sac Design	Low
SPD-02.4	Permeable Pavements	Low
SPD-02.5	Open-Space Preservation	Low
SPD-02.6	Construction Phasing	Low
	SPD-03 Vegetative Practices	
SPD-03.1	Vegetative Buffers	Low
SPD-03.2	Disturbed Area Stabilization (Temporary Seeding)	Low
SPD-03.3	Disturbed Area Stabilization (Permanent Seeding)	Low
SPD-03.4	Disturbed Area Stabilization (Mulch)	Low
SPD-03.5	Disturbed Area Stabilization (Sodding)	Low
SPD-03.6	Erosion Control Mats/Blankets	Medium
	SPD-04 Land Use Practices	
SPD-04.1	Covenants	High
SPD-04.2	Setbacks and Buffers	High
SPD-04.3	Conservation Easements	High
	3.2 Erosion Prevention Practices - Fact Sheets	
EPP-01	Tire Washing Facility	Medium
EPP-02	Construction Road Stabilization	Medium
EPP-03	Stabilized Construction Entrance	Low
EPP-04	Buffer Zones	Low
EPP-05	Temporary Seeding	Low

Section 3: Construction Site Management Practices for Stormwater Quality Estimated Unit Costs		
BMP	**Manual Description**	**Cost**
EPP-06	Permanent Seeding	Low
EPP-07	Sodding	Low
EPP-08	Surface Roughening	Medium
EPP-09	Top Soiling	Medium
EPP-10	Mulching	Low
EPP-11	Nets and Mats	Low
EPP-12	Geotextiles	Low
EPP-13	Terracing	Medium
EPP-14	Soil Binders	
	3.3 Sediment Management Practices - Fact Sheets	
SMP-01	Check Dams	Low
SMP-02	Silt Fence	Low
SMP-03	Brush or Rock Filters and Continuous Berms	Medium
SMP-04	Sediment Traps	Low
SMP-05	Temporary Sediment / Detention Basin	Medium
SMP-06	Bank Stabilization	Medium
SMP-07	Rip-rap	Medium
SMP-08	Channel Linings	Medium
SMP-09	Temporary Diversions, Drains, and Swales	Medium
SMP-10	Filter Strips	Low
SMP-11	Temporary Inlet Protection	Low
SMP-12	Temporary Outlet Protection	Low
	3.4 Good Housekeeping Practices - Fact Sheets	
GHP-01	Dewatering Operations	Medium
GHP-02	Paving Operations	Low
GHP-03	Structure Construction and Painting	Low
GHP-04	Material Delivery, Storage and Use	Low
GHP-05	Spill Prevention and Control	Low
GHP-06	Solid Waste Management	Low
GHP-07	Hazardous Waste Management	Low
GHP-08	Contaminated Soil Management	High
GHP-09	Concrete Waste Management	Low
GHP-10	Sanitary/Septic Waste Management	Low
GHP-11	Vehicle and Equipment Cleaning	Low
GHP-12	Vehicle and Equipment Fueling	Low
GHP-13	Vehicle and Equipment Maintenance	Low
GHP-14	Employee/Subcontractor Training	Low
GHP-15	Pesticides, Herbicides and Fertilizer Use	Low
GHP-16	Dust Control and Tracking	Low
GHP-17	Maintenance of Collection Facilities and Appurtenances	Low

Section 3: Construction Site Management Practices for Stormwater Quality Estimated Unit Costs		
BMP	**Manual Description**	**Cost**
GHP-18	Preservation and Maintenance of Exiting Vegetation	Low
GHP-19	System Flushing	Low
	3.5 Residential and Homeowners - Fact Sheets	
RH-01	Non-Stormwater Discharge to Storm Drains	Medium
RH-02	Vehicle Washing	Low
RH-03	Vehicle Maintenance and Repairs	Low
RH-04	Landscape Irrigation and Lawn Watering	Low
RH-05	Pesticides and Fertilizers	Low
RH-06	Household Hazardous Waste	Low
RH-07	Sanitary Sewer Laterals and Septic Tanks	Low
RH-08	Pet and Animal Waste	Low
RH-09	Slope and Streambank Stabilization	Low
RH-10	Swimming Pools and Spas	Low
RH-11	Boats	Low
RH-12	Tips for Wet Basements and Crawl Spaces	Low
	4.1 Post-Construction –Non-structural Fact Sheets	
SPP-01	Alum Injection	
SPP-02	On-Lot Treatment	
SPP-03	Urban Forestry	
SPP-04	Infrastructure Planning	
SPP-05	Narrower Residential Streets	
SPP-06	Curb and Gutter Elimination	
SPP-07	Alternative Pavers	
	4.2 Post-Construction – Structural Fact Sheets	
PTP-01	Sand and Organic Filters	
PTP-02	Dry Detention Pond	
PTP-03	Wet Detention Pond	
PTP-04	Infiltration Trenches/Basins	
PTP-05	Constructed Stormwater Wetlands	
PTP-06	Bioretention	
PTP-07	In-line Storage Inlets	

Section 2: Construction Site Management Practices for Stormwater Quality
Target Pollutant Removal Efficiencies

Significant ♦ Partial ◈ Low or Unknown ◇

BMP	Manual Description	Sediment	Heavy Metals	Nutrients	Oxygen Demanding Substances	Toxics	Oils / Grease	Bacteria / Viruses	Floatable Materials	Construction Waste
3.1 Site Planning and Design Practices - Fact Sheets										
SPD-01 Protecting Sensitive Features										
SPD-01.1	Stream Corridor (Instream Activities)	♦	♦	◇	◇	◇	◇	♦	◇	◇
SPD-01.2	Wetlands (Conservation/Permitting)	♦	◇	◇	◇	◇	◇	◇	◇	◇
SPD-01.3	Steep Slopes and Highly Erodible Lands	♦	◇	◇	◇	◇	◇	◇	◇	◇
SPD-01.4	Karst (Avoid; Prohibit Infiltration BMPs)	♦	◇	◇	◇	◇	◇	◇	◇	◇
SPD-02 Minimizing Impervious Surfaces										
SPD-02.1	Parking Lot Design	◈	◈	◈	◈	◇	◈	◇	◈	◇
SPD-02.2	Street Design	♦	◇	◇	◇	◇	◇	◇	◇	◇
SPD-02.3	Cul-de-sac Design	◈	◈	◇	◈	◇	◇	◇	◇	◇
SPD-02.4	Permeable Pavements	◈	◈	◇	◈	◇	◇	◇	◇	◇
SPD-02.5	Open-Space Preservation	♦	◇	◇	◇	◇	◇	◇	◇	◇
SPD-02.6	Construction Phasing	♦	◇	◇	◇	◇	◇	◇	◇	◇
SPD-03 Vegetative Practices										
SPD-03.1	Vegetative Buffers	♦	◇	◇	◇	◇	◇	◇	◇	◇
SPD-03.2	Disturbed Area Stabilization (Temporary Seeding)	♦	◇	◇	◇	◇	◇	◇	◇	◇
SPD-03.3	Disturbed Area Stabilization (Permanent Seeding)	♦	◇	◇	◇	◇	◇	◇	◇	◇
SPD-03.4	Disturbed Area Stabilization (Mulch)	♦	◇	◇	◇	◇	◇	◇	◇	◇
SPD-03.5	Disturbed Area Stabilization (Sodding)	♦	◇	◇	◇	◇	◇	◇	◇	◇
SPD-03.6	Erosion Control Mats/Blankets	♦	◇	◇	◇	◇	◇	◇	◇	◇

Section 2: Construction Site Management Practices for Stormwater Quality Target Pollutant Removal Efficiencies										
	Significant ♦		Partial ◈		Low or Unknown ◊					
BMP	**Manual Description**	**Sediment**	**Heavy Metals**	**Nutrients**	**Oxygen Demanding Substances**	**Toxics**	**Oils / Grease**	**Bacteria / Viruses**	**Floatable Materials**	**Construction Waste**
SPD-04 Land Use Practices										
SPD-04.1	Covenants	♦	◊	◊	◊	◊	◊	◊	◊	◊
SPD-04.2	Setbacks and Buffers	♦	◊	◊	◊	◊	◊	◊	◊	◊
SPD-04.3	Conservation Easements	♦	◊	◊	◊	◊	◊	◊	◊	◊
3.2 Erosion Prevention Practices - Fact Sheets										
EPP-01	Tire Washing Facility	♦	◊	◊	◊	◊	◊	◊	◊	◊
EPP-02	Construction Road Stabilization	♦	◊	◊	◊	◊	◊	◊	◈	◊
EPP-03	Stabilized Construction Entrance	◈	◊	◈	◊	◈	◈	◊	◊	◊
EPP-04	Buffer Zones	♦	♦	♦	♦	◊	♦	◊	◈	◊
EPP-05	Temporary Seeding	♦	◊	◈	◊	◈	◊	◊	◊	◊
EPP-06	Permanent Seeding	♦	◊	◈	◊	◈	◊	◊	◊	◊
EPP-07	Sodding	♦	◊	◈	◊	◈	◊	◊	◊	◊
EPP-08	Surface Roughening	♦	◊	◊	◊	◊	◊	◊	◊	◊
EPP-09	Top Soiling	♦	♦	♦	♦	◊	♦	◊	◈	◊
EPP-10	Mulching	♦	◊	◈	◊	◊	◊	◊	◊	◊
EPP-11	Nets and Mats	♦	◊	◊	◊	◊	◊	◊	◊	◊
EPP-12	Geotextiles	♦	◊	◊	◊	◊	◊	◊	◊	◊
EPP-13	Terracing	♦	◊	◊	◊	◊	◊	◊	◊	◊
EPP-14	Soil Binders									
3.3 Sediment Management Practices - Fact Sheets										
SMP-01	Check Dams	♦	◊	◊	◊	◊	◊	◊	◊	◊
SMP-02	Silt Fence	♦	◊	◊	◊	◊	◊	◊	◊	◊

Section 2: Construction Site Management Practices for Stormwater Quality
Target Pollutant Removal Efficiencies

Significant ♦ Partial ◈ Low or Unknown ◇

BMP	Manual Description	Sediment	Heavy Metals	Nutrients	Oxygen Demanding Substances	Toxics	Oils / Grease	Bacteria / Viruses	Floatable Materials	Construction Waste
SMP-03	Brush or Rock Filters and Continuous Berms	♦	◇	◇	◇	◇	◇	◇	◇	◇
SMP-04	Sediment Traps	♦	◇	◇	◇	◇	◇	◇	♦	◇
SMP-05	Temporary Sediment / Detention Basin	♦	◇	◇	◇	◇	◇	◇	◇	◇
SMP-06	Bank Stabilization	♦	◇	◈	◇	◇	◇	◇	◇	◇
SMP-07	Rip-rap	♦	◇	◇	◇	◇	◇	◇	◇	◇
SMP-08	Channel Linings	♦	♦	♦	◇	◇	◈	◇	◈	◇
SMP-09	Temporary Diversions, Drains, and Swales	♦	♦	♦	◇	◇	♦	◇	◈	◇
SMP-10	Filter Strips	◈	◈	◈	◈	◈	◈	◇	◈	◇
SMP-11	Temporary Inlet Protection	♦	◇	◇	◇	◇	◇	◇	◈	◇
SMP-12	Temporary Outlet Protection	♦	◇	◇	◇	◇	◇	◇	◇	◇
3.4 Good Housekeeping Practices - Fact Sheets										
GHP-01	Dewatering Operations	♦	◇	◇	◇	◈	◇	◇	◇	◇
GHP-02	Paving Operations	◈	◇	◇	◇	◈	◈	◇	◇	◇
GHP-03	Structure Construction and Painting	♦	◇	◇	◇	◇	◇	◇	◇	◇
GHP-04	Material Delivery, Storage and Use	◈	◇	◈	◇	◈	◈	◇	◈	◇
GHP-05	Spill Prevention and Control	◇	◇	◇	◇	◈	◈	◇	◇	◇
GHP-06	Solid Waste Management	◈	◇	◇	◇	◇	◇	◇	♦	♦
GHP-07	Hazardous Waste Management	◇	◇	◇	◇	◈	◇	◇	◇	◇
GHP-08	Contaminated Soil Management	◈	◇	◇	◇	♦	◇	◇	◇	◇
GHP-09	Concrete Waste Management	◇	◇	◇	◇	◇	◇	◇	◇	◈
GHP-10	Sanitary/Septic Waste Management	◇	◇	◇	◇	◇	◇	◇	◇	◈
GHP-11	Vehicle and Equipment Cleaning	◇	◇	◇	◇	◈	◈	◇	◇	◇
GHP-12	Vehicle and Equipment Fueling	◇	◇	◇	◇	◈	◈	◇	◇	◇

Section 2: Construction Site Management Practices for Stormwater Quality
Target Pollutant Removal Efficiencies

Significant ♦ Partial ◈ Low or Unknown ◇

BMP	Manual Description	Sediment	Heavy Metals	Nutrients	Oxygen Demanding Substances	Toxics	Oils / Grease	Bacteria / Viruses	Floatable Materials	Construction Waste
GHP-13	Vehicle and Equipment Maintenance	◇	◇	◇	◇	◈	◈	◇	◇	◇
GHP-14	Employee/Subcontractor Training	◇	◇	◇	◇	◇	◇	◇	◇	◇
GHP-15	Pesticides, Herbicides and Fertilizer Use	◇	◇	♦	♦	♦	◇	◇	◇	◇
GHP-16	Dust Control and Tracking	♦	◇	◇	◇	◈	◈	◇	◇	◇
GHP-17	Maintenance of Collection Facilities and Appurtenances	♦	♦	◇	♦	◇	♦	♦	♦	◇
GHP-18	Preservation and Maintenance of Exiting Vegetation	♦	◇	♦	♦	◇	◇	◇	♦	◇
GHP-19	System Flushing	♦	◇	◇	◇	◇	◇	◇	◇	◇
3.5 Residential and Homeowners - Fact Sheets										
RH-01	Non-Stormwater Discharge to Storm Drains	♦	♦	♦	♦	♦	♦	♦	♦	◈
RH-02	Vehicle Washing	◈	◈	◈	◈	◈	◈	◇	◇	◇
RH-03	Vehicle Maintenance and Repairs	◈	♦	◇	◈	♦	♦	◇	◇	◇
RH-04	Landscape Irrigation and Lawn Watering	◇	◇	♦	◈	♦	◇	◇	◇	◇
RH-05	Pesticides and Fertilizers	◇	◈	♦	♦	♦	◇	◇	◇	◇
RH-06	Household Hazardous Waste	◇	♦	◇	◈	♦	♦	◇	◇	◇
RH-07	Sanitary Sewer Laterals and Septic Tanks	◇	◇	♦	♦	◇	◇	♦	◇	◇
RH-08	Pet and Animal Waste	◇	◇	♦	◈	◇	◇	♦	◇	◇
RH-09	Slope and Streambank Stabilization	♦	◇	♦	◇	◇	◇	◇	◈	◇
RH-10	Swimming Pools and Spas	◇	◇	◇	♦	♦	◇	◇	◇	◇
RH-11	Boats	◇	◈	♦	♦	◈	◈	♦	♦	◇
RH-12	Tips for Wet Basements and Crawl Spaces	♦	♦	♦	♦	♦	♦	♦	♦	

Section 2

EROSION PREVENTION AND SEDIMENT CONTROL PLAN

2.1 Requirements

The City of Somerset, KY will require an Erosion Prevention and Sediment Control (EPSC) Plan for most types of development construction. When preparing the EPSC Plan, the design engineer and/or developer should determine the best practices to protect active construction sites by selecting source control and sediment containment practices. In doing so, most erosion problems can be avoided and sediment containment issues can be addressed prior to construction disturbances.

Site characteristics such as soil types, topography, slopes, and geography, and construction methods should be thoroughly reviewed when selecting BMPs to implement throughout the life of the project. The design team should be mindful of how the site is changing throughout the project so that BMPs can be repaired, modified or replaced with a more suitable practice.

For more information regarding the required elements of an EPSC Plan, refer to **"Stormwater Permit Application"** on the city's Stormwater webpage.

2.2 Minimize Disturbed Areas

Some important decisions must be made prior to BMP selections for a proposed construction site.

Construction planning and sequencing are the least expensive methods to reduce and control erosion and sediment. The following points should be considered when to minimize disturbed areas:

1. Do not disturb areas of the construction site that are not scheduled for improvements and keep existing vegetation, even if it is scheduled to be removed, for as long as possible.

2. Carefully schedule and phase construction. Avoid grading during wet months (December through May). Use temporary cover measures (seed or mulch) whenever construction is halted for an extended period.

3. Phase site grading to limit the amount and time of an area's exposure. Exposed areas should be stabilized immediately following the completion of grading.

4. Plan and implement permanent structures throughout the earlier phases of the project. This will maximize the practice's usefulness and help with erosion prevention and sediment containment.

5. Install landscaping fixture upon the completion of any phase and prior to moving on to the next phase.

Any exposed soil is subject to erosion and sediment transport, even by a single rain drop. Designers and contractors should make every effort to stabilize the following susceptible areas at a construction site prior to and throughout construction:

- Slopes
- Highly erosive soils
- Construction entrances and exits
- Stream channels
- Soil stockpiles

2.3 Site Perimeter Controls

The contractor must set site perimeter controls to protect areas downstream from erosion, sediment and flooding problems.

Area of Concern	Site Perimeter Control
Disturbed areas or slopes that drain toward adjacent properties	Continuous berms, silt fences, sandbags
Stabilizing area after grading has been completed	Mulching, seeding, planting, emulsifiers, or a combination of two or more
Off site flows that enter the constructions site	Continuous berms, earth dikes, drainage swales and lined ditches
Concentrated flows that leave the construction site	Outlet control measures that will dissipate velocities

Additional controls within the interior of construction site should supplement perimeter controls once rough grading is complete.

2.4 Internal Erosion and Drainage Design

Once the perimeter controls have been selected, the issue of internal erosion and drainage controls must be addressed. Internal practices are typically more time consuming and labor intensive since they will be used in close proximity of construction activities. They are required early in the project until permanent practices can be implemented.

Some of the internal erosion and drainage design practices to be used include:

- Check dams, geotextile mats, and under extreme circumstances concrete channel lining.
- Terracing at regular intervals.
- Slope benches or ditches.
- Surface roughening or temporary seeding.

2.5 Maintenance and Inspection

Constant inspection and maintenance of the selected practices are critical towards the success of preventing erosion and sediment transport. Maintaining a daily or weekly checklist of practices to inspect for deficiencies of those practices are critical to the success of preventing erosion and sediment displacement.

A good way to ensure that all practices will be properly utilized is for the erosion prevention and sediment control inspector and general contractor to arrange a pre-construction meeting with the City Engineer. This meeting should take place after the Notice to Proceed, but prior to the mobilization of equipment.

One of the most critical aspects of maintaining the construction site's BMPs is to have a plan on when sediment should be removed from the utilized practices, and where should it be placed. The BMPs in this manual often suggest when sediment should be removed from structures, but the contractor should demonstrate sound judgment in maintaining the structures more frequently if necessary.

A sound inspection and maintenance strategy should include the following:

1. Verify that sediment-laden stormwater is directed to temporary sediment traps or basins. Verify that sediment basins and traps are at low points below disturbed areas.

2. Protect all existing or newly installed storm drainage structures from sediment clogging by providing inlet protection for area drains and curb inlets. Stormwater inlet protection can utilize sand bags, sediment traps, or other similar devices.

3. Excavate permanent stormwater detention ponds early in the project, use them as sedimentation ponds during construction, remove accumulated sediment, and landscape the ponds when the upstream drainage area is stabilized.

4. Inspect temporary sediment barriers such as silt fences, rock filters, and continuous berms before and after every rainfall. These barriers should only be used in areas where sheet flow runoff occurs. They are ineffective if the runoff is concentrated into rill or gully flow.

5. Internal outfalls must also be protected to reduce scour from high velocity flows leaving pipes or other drainage facilities.

2.6 EPSC Preparation Guidance

The EPSC Plan will consist of a site plan sheet at a scale suitable for illustrating the elements that will prevent erosion and control sediment, and a set of directions in narrative form within the contract documents. The Owner of the development or project will be responsible for preparing the EPSC Plan. Whether it is the Owner, designer or a subcontractor to develop the plans, the matter is left up to the Owner.

The plans will illustrate which practices shall be used and their placement within the project. The narrative will explain decisions concerning erosion prevention and sediment control, and when required, show why those measures were selected, either by calculations or sound engineering judgment. This will allow the reviewer to make informed decisions on the efficiency and practicality of the BMPs selected.

The level of detail shown on the drawings depends on the magnitude of the project. For single lots, a sketch may be all that is required. However for larger developments, such as a shopping center or industrial park, a plan sheet at an appropriate scale shall be submitted to the City for review. In addition, multiple sheets may be required to adequately reflect the various project phases.

Here is a list of typical notes that should be added to every EPSC plan, large and small.

1. As a minimum, all erosion and sediment control practices will be constructed and maintained according to the standards located in the City of Somerset's BMP Manual, Stormwater Ordinances and policies as required by state and federal laws.

2. A copy of the approved Erosion Prevention and Sediment Control Plans shall be maintained at the project site at all times. This copy shall be presented to the City of Somerset's representatives upon request.

3. Prior to commencing land-disturbing activities in any area not on the approved erosion and sediment control plan, the contractor shall submit a supplementary erosion control plan to the City of Somerset for review and approval.

4. All erosion and sediment control measures are to be placed prior to or as the first step in clearing and grading. The contractor is responsible for any additional erosion prevention and sediment control measures necessary to prevent erosion and sedimentation as determined by the City of Somerset.

5. During dewatering operations water must be pumped through an approved filtering device. The City of Somerset may suspend dewatering operations if pollution is observed.

6. The contractor shall inspect all erosion prevention and sediment control devices at least once a week and within 24 hours of the end of 0.5 inch or larger rain event. The contractor shall perform any repairs or maintenance immediately in order to ensure effective erosion and sediment control.

7. The contractor shall maintain a record of all inspections and maintenance activities at the project site. This record shall be made available to the City of Somerset upon request.

2.7 Erosion Prevention and Sediment Control Plan

Requirements of the Erosion Prevention and Sediment Control Plan (EPSC) are shown in the "Stormwater Permit Application" on the city's Stormwater webpage.

Section 3

CONSTRUCTION SITE MANAGEMENT PRACTICES FOR STORMWATER QUALITY

This section contains fact sheets for the following BMP categories:

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Site Planning and Design Practices (SPDs)

SPD-01.1

Activity: Stream Corridors

PLANNING CONSIDERATIONS:

Design Life:
Permanent

Acreage Needed:
Width is defined by local ordinances

Possible Permits:
KDOW
Check local ordinances

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ♦ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ♦
Oil& Grease ♦ Bacteria & Viruses ◊ Floatable Materials ♦ Construction Waste ♦

Description

Sensitive areas such as stream corridors (waterways and riparian land) are subject to special protection due to their unique characteristics. These waterways provide habitat for fish, aquatic plants, and bottom dwelling organisms. Modifications to these inhabitants destroys physical features essential to a good habitat including: stable streambanks and bottom substrates, pools and riffles, meanders and spawning areas.

The vegetative habitat surrounding riparian land adjacent to stream banks filters pollutants from storms and floods and provides habitats for a variety of amphibians, aquatic birds and mammals. These creatures and their functions are impaired when development occurs within the corridor or riparian. Development causes more flooding to the area as well as meandering of natural streams.

To combat the developmental construction to the corridor or riparian, filter strips or forested buffers should be created or preserved along the banks of streams. Another method of preservation to corridors and riparian is the presence of vegetation along shorelines of ponds, lakes and wetlands. This aids in preventing erosion caused by wave action.

Benefits

- Improves the quality of water resources by removing or ameliorating the effects of pollutants in runoff.
- Streamside trees and bushy vegetation reduce erosion during flood events.
- Root system of trees control streambank erosion.
- Leaves from streambank trees lower water temperatures thereby improving fish habitat.
- Living and dead vegetation provide nutrients to support wildlife habitat.
- Improved fish and wildlife habitation provides recreational benefits to the community such as fishing, birding, canoeing and swimming where allowed.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Site Planning and Design Practices (SPDs)

SPD-01.2

Activity: Wetland Preservation

PLANNING CONSIDERATIONS:

Design Life:
Permanent

Acreage Needed:
Check Local Ordinances

Possible Permits:
KDOW
Check local ordinances

Target Pollutants

Significant ♦ | Partial ⟐ | Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊ Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

Wetlands impart an aesthetically pleasing aspect to the environment while providing a unique habitat for plant and wildlife, including sensitive and endangered species. Wetlands also add value to flood storage, groundwater recharge and pollutant-filtering functions.

There are some wetlands that avoidance is recommended. These wetlands are very difficult to replace and are moderate to high-quality in nature. Sites where scattered and small low-quality wetlands are readily replaceable, mitigation is recommended to enhance the wetlands' function and reduce potential constraints to development.

Benefits

Wetland preservation benefits both the public and the individual property owner. Property owners or developers who preserve wetlands:

- May enjoy tax benefits.
- Finish projects more easily by avoiding some regulatory requirements of other BMPs.
- Complete projects at lower costs.
- Gain satisfaction for protecting a valuable natural resource.

Other benefits include:

- Improved water quality for the community.
- Storage during flooding events.

	Somerset, Kentucky **Stormwater Best Management Practices (BMPs)** **Site Planning and Design Practices (SPDs)**	SPD-01.3
	Activity: Steep Slopes and Highly Erodible Lands	

PLANNING CONSIDERATIONS:

Design Life:
Permanent

Acreage Needed:
N/A

Possible Permits:
KDOW
Check local ordinances

Target Pollutants

Significant ♦	Partial ⬗	Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

Steep slopes are characterized as any slope exceeding 10% which is measured by 1 foot of vertical drop per 10 feet of horizontal distance. Yet the variation on surface soil can make this definition debatable. The erodibility of surface soil can make flatter slopes fall under this classification if it is highly erodible. Additionally the geology is another aspect that determines the suitable steepness of a slope.

The instability of slopes due to development causes destruction to the vegetative state, root systems and soil structures. The increase in flow velocity introduced by construction exposes steep slopes to destructive and unsightly erosion, bare slopes, difficulties in re-vegetation, sediment deposition, and raises concerns for safety.

The minimization of the area and time of disturbance to the natural terrain should be a top priority with developers as construction takes place on a site. The protection of the site, vegetation, and all other inhabitants living in this constructed area should be protected and stabilized during development.

BMP Application

The following BMPs may be used to aid in reducing the erosive nature of Steep Slopes:

- EPP-11 Nets and Mats
- EPP-12 Geotextiles
- EPP-13 Terracing

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Site Planning and Design Practices (SPDs)

SPD-01.4

Activity: Karst Topography

PLANNING CONSIDERATIONS:

Design Life:
Permanent

Acreage Needed:
N/A

Possible Permits:
KDOW
Check local ordinances

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

The effects of polluted stormwater runoff can be problematic to a karst system. The introduction of sediment or pollutant-laden runoff percolates into the karst system and rapidly increases can cause degradation of the water quality.

Depending on the karst system rock type, some systems may be more susceptible to the development of conditions than others.

Some suggested practices are as follows:

Approach

1. Drain surface water away from karst features
2. Provide treatment to surface water prior to its entry into karst features or walls
3. Utilize minimal disturbance in location where karst features exist.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Site Planning and Design Practices (SPDs)

SPD-02.1

Activity: Parking Lot Design

PLANNING CONSIDERATIONS:

Design Life:
Permanent, or life of development

Acreage Needed:
None

Estimated Unit Cost:
Low

Monthly Maintenance:
N/A

Target Pollutants		
Significant ♦	Partial ◈	Low or Unknown ◇

Sediment ◈ Heavy Metals ◈ Nutrients ◈ Oxygen Demanding Substances ◇ Toxic Materials ◇
Oil& Grease ◈ Bacteria & Viruses ◇ Floatable Materials ◈ Construction Waste ◇

Description

To reduce the amount of runoff volume in parking lot designs, infiltration swales and vegetation incorporation to reduce paved surfaces may occur. These two alternatives would provide water quality benefits to the parking lot design.

Reduced paved surfaces increases the amount of sediment-laden runoff that can be filtered through vegetation and settlement provided by swales. Vegetation acts as a sponge where runoff is concerned. Leaves, stems and branches intercept rainwater which then evaporates. Depending on the type of vegetation, some may even encourage infiltration (deep-rooted prairie plants).

While vegetation increases the amount of sediment-laden runoff captured and evaporated, swales enable sediment to settle out producing a cleaner runoff for the environment.

Suitable Applications

- To compensate overly generous parking ration requirements.
- Lots desiring minimum stall dimensions.
- To use the most space-efficient stall configuration for a site.
- Reduce amount of surface sediment laden runoff.

Approach

Pavement reduction can be established in five ways:

1. Variances to Municipal Codes.
2. Reducing stall dimensions.
3. Promoting shared parking lots.
4. Reconfiguring parking stall patterns, orientations.
5. Grass islands.

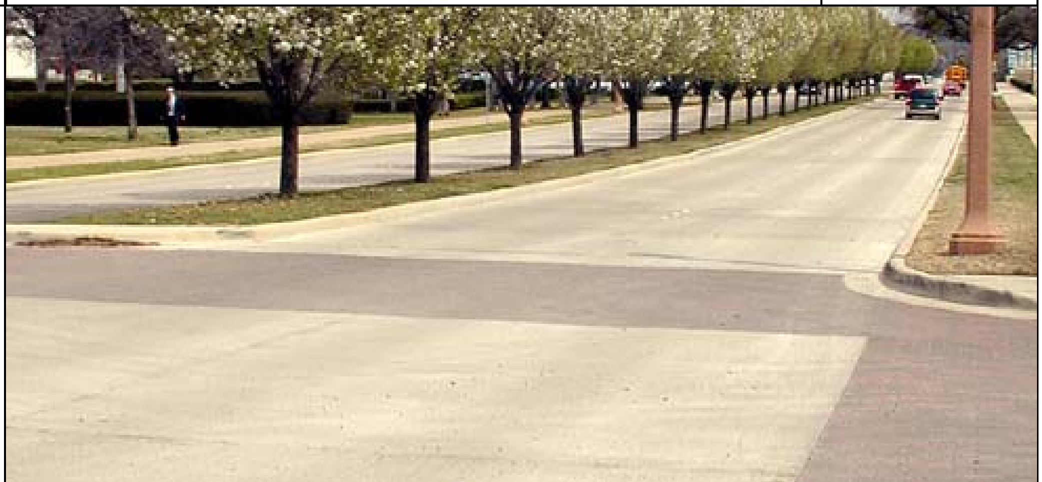
Activity: Parking Lot Design	SPD-02.1

Approach (cont'd)	Site runoff can be reduced in two ways: 1. Consider green lots 2. Use of permeable pavers
Caution	Check zoning requirements prior in implementing BMP.
Maintenance	➢ Planted areas must be weeded monthly during the first two to three years. After initial years, once or twice a growing season will be sufficient. ➢ Water regularly during dry spells. ➢ Irrigation should be two inches per week maximum. ➢ Push street snow away from swales during winter seasons to avoid road sand accumulation.
Inspection Checklist	❑ Plants are watered regularly during dry weather. ❑ Weeds are under control.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Site Planning and Design Practices (SPDs)

SPD-02.2

Activity: Street Design – Private Drives and Roads



PLANNING CONSIDERATIONS:

Design Life:
Permanent

Acreage Needed:
As required by ordinances

Estimated Unit Cost:
Low

Monthly Maintenance:
N/A

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ♢

Sediment ♦ Heavy Metals ♢ Nutrients ♢ Oxygen Demanding Substances ♢ Toxic Materials ♢
Oil& Grease ♢ Bacteria & Viruses ♢ Floatable Materials ♢ Construction Waste ♢

Description

The design of a street will determine the effects of stormwater runoff. This gives a developer numerous opportunities to reduce impervious areas and aid in the reduction of runoff and management requirements associated with runoff. Natural drainage patterns should be preserved whenever possible during street design planning. This ensures that maximum stormwater filtration and infiltration can take place.

Suitable Applications

- Siting of streets.
- Design width.
- Street drainage.

Approach

- *Siting of Streets*
  Siting the street is an important consideration when planning the layout of a new street network or the siting of a road. To maximize stormwater filtration and infiltration, municipalities should aim to preserve natural drainage patterns whenever possible and avoid locating streets (and other impervious surfaces) in low areas or on highly permeable soils.
- *Design Width*
  Streets should be designed with the minimum pavement width that will support the area's traffic volume; on street parking needs; and emergency, maintenance and service vehicles.
- *Street Drainage*
  Curbless road design, such as the so-called "rural residential section" encourages infiltration via roadside swales. On low-traffic streets without curbs, grass shoulders can serve as an occasional parking lane, allowing a narrower paved area.

Activity: Street Design	SPD-02.2

Advantages

- Thoughtful siting and design of streets improves stormwater control "at the source", which means less runoff requiring management, reduced stormwater infrastructure, and a smaller impact on downstream water bodies.
- Reducing paving lowers development and maintenance costs.
- Forgoing curb-and-gutter in favor of a rural residential section is a cost savings.
- Rural-section streets can incorporate attractive "rain garden" plantings in low areas adjacent to the roadway, when soil permits.
- Narrower streets tend to slow traffic and create a more pedestrian-friendly environment.
- Reducing pavement lessens the urban heat island effect - the increase in air temperature that occurs when highly developed areas are exposed to the sun.

Limitations

- Local ordinances may preclude narrowed or curbless street design.
- The city's desire to design roads to accommodate future growth may impede innovations.
- Roadside swales are difficult to accommodate in single family residential developments with net densities above 8 units per acre.
- Good drainage for road subgrade must be provided when using roadside infiltration methods.
- Soil and topography may limit street siting opportunities.

Construction Requirements

- Take care not to compact adjacent, permeable soils during road construction.
- Protect swales and other infiltrations areas from sediment influx during construction, or remove sediment after construction is complete.

Maintenance

- Swales planted with perennials grasses and wildflowers rather than turf grass must be weeded at least monthly during the first two to three years. After that, weeding once or twice a growing season may suffice.
- Swales will need periodic sediment removal to maintain volume and filtering ability.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Site Planning and Design Practices (SPDs)

SPD-02.3

Activity: Cul-de-sac Design

PLANNING CONSIDERATIONS:

Design Life:
Permanent

Acreage Needed:
Minimal

Estimated Unit Cost:
Low

Monthly Maintenance:
N/A

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ◈ Heavy Metals ◊ Nutrients ◈ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

Impervious areas can be significantly decreased with the cul-de-sac design in subdivisions. The smallest possible radius to this area ensures that stormwater runoff has less impact on downstream water bodies.

Other combating methods of runoff acceptance in a cul-de-sac stem from the application of flat apron curbs, islands to accept runoff from surrounding area and T-shaped turnarounds.

Suitable Applications

- Small subdivisions having 10 or fewer homes can benefit from the T-shaped turnaround.
- Highly developed areas desiring a solution to the urban heat island effect.

Advantages

- Cul-de-sac designs like those suggested here result in less management of stormwater runoff and reducing the impact on downstream water bodies.
- Planted cul-de-sac islands are attractive amenities.
- Less paving can lower development costs.
- Reducing pavement lessens the urban heat island effect-the increase in air temperature that can occur when highly developed areas are exposed to the sun.
- Reducing pavement can help reduce the increased runoff temperature commonly associated with impervious cover.

Activity: Cul-de-sac Design	SPD-02.3

Limitations	➢ City ordinances may not accommodate small radii cul-de-sacs, due to accommodations for emergency vehicles. ➢ Hammerhead turnarounds require vehicles to make a three-point-turn to exit. ➢ Planted islands require more maintenance than paving during the first two to three years. ➢ Difficulty in emergency vehicles ability to turn around.
Installation Procedures	➢ Avoid compacting soil in center island, till soil to a 2 foot depth. ➢ Select vegetation that thrives on high rainfall and drought.
Design Criteria	➢ Widen rear pavements in cul-de-sacs to ensure easier turning, especially for emergency vehicles. ➢ Islands should be maintained and vegetation planted for the appropriate soil type. ➢ Include an unpaved, depressed island, using whatever radius will allow an appropriate road width.
Construction Criteria	➢ During paving, care should be taken to avoid compacting soil in center island. Should compaction occur, it may be necessary to rip or till soils to a depth of 2 ft. ➢ Choose plants that will thrive when rainfall is high, and survive droughts without watering.
Maintenance	➢ Cul-de-sac island planting areas must be weeded monthly during the first two to three years. After that, weeding once or twice a growing season may suffice for maintenance.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Site Planning and Design Practices (SPDs)

SPD-02.4

Activity: Permeable Pavements

PLANNING CONSIDERATIONS:

Design Life:
Permanent

Acreage Needed:
Minimal

Estimated Unit Cost:
Low

Annual Maintenance:
N/A

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ♢

Sediment ◈ Heavy Metals ♢ Nutrients ◈ Oxygen Demanding Substances ♢ Toxic Materials ♢
Oil& Grease ♢ Bacteria & Viruses ♢ Floatable Materials ♢ Construction Waste ♢

Description

Infiltration and the reduction of runoff are a result of turf paving. The decrease arises from modular paving blocks or grids, cast-in-place concrete grids and soil enhancement technologies. Healthy grass growth as well as foot and vehicular traffic occur as a result of the site's increased load bearing capacity.

Suitable Applications

- Areas desiring roadside right-of-ways
- Emergency access lanes.
- Delivery access routes.
- Overflow parking areas.

Approach

- Modular Paving Blocks and Grids
  Modular paving blocks or grass pavers consist of concrete or plastic interlocking units that provide structural stability while a series of gaps planted with turf grass allow for infiltration. Some blocks may also be filled with gravel and left unplanted. Depending on the use and soil type, a sand setting bed and gravel sub base is often added underneath to help further infiltration and prevent settling.
- Cast-in-Place Concrete Systems
  Monolithic concrete pavements incorporate gaps that are filled with topsoil and grass for a free-draining "pavement" with the structural capacity to handle most heavy vehicle loads. The surface is similar to that of modular concrete paving blocks.
- Soil Enhancements
  The soil-amendment technology employs synthetic mesh elements blended with a sandy growing medium, resulting in a natural turf surface and an engineered load-bearing root zone. Appropriate for summer overflow parking, golf courses, recreational fields and areas where the aesthetic appeal of uninterrupted grass is important.

Approach (cont'd)

- Porous Pavement
  Porous pavements may be used in lieu of conventional pavement on parking areas and areas with light traffic, provided that the grades, subsoils, drainage characteristics, and groundwater conditions are suitable. Slopes should be flat or very gentle. Soils should have field-verified permeability rates of greater than 0.5 inches per hour, and there should be a 4-foot minimum clearance from the bottom of the system to bedrock or the water table.

Advantages

- Turf pavers reduce or eliminate other stormwater management techniques by reducing runoff.
- Applied in combination with other BMPs, pollutant removal and stormwater management can be further improved.
- There may be a construction cost savings due to reduced curb-and-gutter requirements.
- Turf pavers are appropriate for driveways, walkways and overflow parking areas where handicapped access is not required or provided elsewhere.
- Turf helps soften the look of an area and make it more pleasant for pedestrians.
- Soil-enhanced turf systems are advantageous for sports and recreation fields as they resist compaction, thus increasing infiltration, and provide a soft playing surface.
- The mesh elements stabilize soil without reducing its permeability. The elements combat compaction, as they flex under pressure and "cultivate" the surrounding soils.
- Snow melts faster on a porous surface because of rapid drainage below the snow surface.
- Porous pavement can help to reduce the increased runoff temperature commonly associated with impervious cover.

Limitations

- For reasons of durability and maintenance, turf pavers are not recommended for high-traffic areas.
- Turf paving systems limit wheelchair access.
- Snow removal can be difficult, as plow blades can remove vegetation and catch the edge of the blocks, damaging the surface.
- Salt and sand in runoff from adjacent impervious pavement can damage turf and clog gaps in the blocks.
- Construction costs for turf paving may be higher than conventional pavements. Maintenance costs are generally higher.
- Clay soils will limit infiltration.
- Since turf paving encourages infiltration, it should not be applied on stormwater hotspots, places where land use or activities generate highly contaminated runoff, due to potential for groundwater contamination.

Activity: Permeable Pavements (Turf Pavers)	SPD-02.4

Design Criteria

- Infiltration rates are affected by soil types and should be considered when designing turf areas.
- Soil type also affects the sub base depth.
- Fill voids with sand or sandy loam planting base (adhere to manufacturer's recommendations).
- Plant with "park grade" turf grasses which are more drought tolerant than "elite grade" grasses.

Construction Requirements

- Modular and Cast-in-Place Concrete Systems

  Cells may be planted in one of three ways:

  1. Fill with a porous backfill mix (some products require sharp sand), scrape or back rake the entire surface to expose pattern. Broadcast seed or hydroseed and then top dress and fertilize as required.
  2. Fill and scrape or back rake as above, then lay 5/8-inch sod on the assembled pavers. Water the sod, then use a hand water roller or power-driven roller to compress the sod and root system completely into the cells.
  3. Do not fill the cells with any type of soil mixture. Lay 1-inch sod on the assembled pavers. Water the sod and compress as above.

- Soil Enhancements

  Sand or a proprietary growing medium is blended with a specific proportion of mesh elements using a mechanical shovel. A 20 kg sample of mixed material will contain 55.4-66.7 g of mesh elements (or approximately 44 lb. mesh for 5 cubic yards of sand mix). Manufacturer will supply precise proportions.

  For some proprietary systems, materials are sourced locally and the patent-holder acts as project manager for the installation, using specially designed machines.

  Grass cover is established using pre-germinated seed, washed turf or conventional seed.
  Nonessential traffic should be kept off the area until grass is well-established.

- Porous Pavement

  Excavate and grade with light equipment with tracks or oversized tires to prevent soil compaction

  As needed, divert storm water runoff away from planned pavement area before and during construction.

  A typical porous pavement cross-section consists of the following layers:

  1. porous asphalt course, 2-4 inches
  2. filter aggregate course
  3. reservoir course of 1.5-3 inches
  4. filter fabric

Inspection Checklist

- ☐ Turf method matches soil type.
- ☐ Turf is maintained to accommodate traffic patterns.

Activity: Open-Space Preservation

PLANNING CONSIDERATIONS:

Design Life:
Permanent

Acreage Needed:
Minimal

Estimated Unit Cost:
Low

Annual Maintenance:
N/A

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

An open-space preservation or conservation program involves a combination of methods merging long-range planning with an opportunistic action approach. Those methods include: outright purchase of land at full or "bargain-sale" prices; establishment of permanent Conservation Restrictions through gift or purchase; exercise of the local first refusal right; limited development purchases; and others.

Suitable Applications

When prime open space in a community becomes available the opportunity to create blocks or greenbelts of local conservation land should be taken advantage of by the community.

Planning Considerations

- Land preserved through acquisition, deed restriction, or other methods should be representative of each major land or habitat type within the town, and should be joined to form connecting corridors wherever possible.
- A multi-faceted local approach to the preservation of open space requires the support of the community, willingness to work with local or regional land trusts, the existence of a working open space plan, and the maintenance of a healthy conservation fund.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Site Planning and Design Practices (SPDs)

SPD-02.6

Activity: Construction Phasing

PLANNING CONSIDERATIONS:

Design Life:
N/A

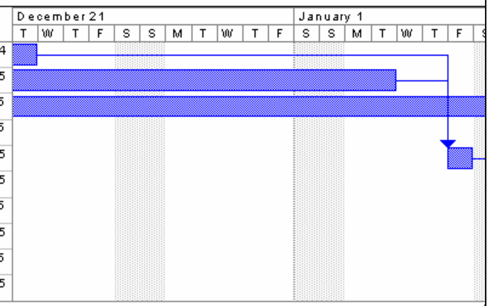
Acreage Needed:
None

Estimated Unit Cost:
N/A

Monthly Maintenance:
N/A

Construction Phasing

Task Name	Duration	Start	Finish
FM Feasibility Review	7 days	Mon 12/13/04	Tue 12/21/04
Finalize Construction Dwgs	17 days	Mon 12/13/04	Tue 1/4/05
Prepare Permit Submitals	23 days	Mon 12/13/04	Wed 1/12/05
Permit and Encroachment Approvals	45 days	Thu 1/13/05	Wed 3/16/05
Send Out Bid Package	1 day	Fri 1/7/05	Fri 1/7/05
Pre-Bid Meeting	1 day	Fri 1/14/05	Fri 1/14/05
Bid Due Date	1 day	Mon 1/31/05	Mon 1/31/05
Contractor Selection	5 days	Tue 2/1/05	Mon 2/7/05
Commissioner Approval	1 day	Mon 2/21/05	Mon 2/21/05
Start Construction	1 day	Thu 3/17/05	Thu 3/17/05



Target Pollutants

Significant ♦	Partial	Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

A work schedule that coordinates the sequence of land-disturbing activities with the installation of erosion and sedimentation control practices.

A construction sequence schedule is a specified work schedule that coordinates the timing of land-disturbing activities and the installation of erosion protection and sedimentation-control measures.

Approach

- To reduce on-site erosion and off-site sedimentation from land-disturbing activities by installing EPSC practices in accordance with a planned schedule.
- Reduce on-site erosion and off-site sedimentation by performing land-disturbing activities and installing EPSC practices in accordance with a planned schedule.
- Preserving the natural vegetation on-site to the maximum extent practicable will minimize the impacts of development on stormwater runoff. Preferably 65% or more of the development site should be protected from the purposes of retaining or enhancing existing forest cover and preserving wetlands and stream corridors.

Activity: Construction Phasing	SPD-02.6

Suitable Applications

Purpose of the construction sequence schedule is to address the EPSC plan in an efficient and effective manner. Appropriate sequencing of construction activities can be a cost-effective way to help accomplish this goal. The plan can be open to changes that would be discussed at the erosion control project meetings.

The generalized construction activities shown in the following Table SPD 02.6-01, do not usually occur in a specified linear sequence, and schedules will vary due to weather and other unpredictable factors. However, the proposed construction sequence should be indicated in the EPSC plan.

Maintenance

- Follow the construction sequence throughout project development.
- When changes in construction activities are needed, amend the sequence schedule in advance to maintain management control.
- Vegetation and trees should not be removed from the natural growth retention area, except for approved timber harvest activities and the removal of dangerous diseased trees.

Table SPD-02.6-1
SEQUENCING TABLE

	CONSTRUCTION ACTIVITY	SCHEDULE CONSIDERATION
1	Identify and label protection areas (e.g. buffer zones, filter strips, trees)	Site delineation should be completed before construction begins
2	Construction access. Construction entrance, construction routes, equipment parking areas and cutting of vegetation (necessary perimeter controls.	First land-disturbing activity. - Establish protected areas and designated resources for protection. Stabilize bare areas immediately with gravel and temporary vegetation as construction takes place.
3	Sediment traps and barriers. Basin traps, sediment fences, and outlet protection	Install principal basins after construction site is accessed. Install additional traps and barriers as needed during grading
4	Runoff control. Diversions, silt fence, perimeter dikes, and outlet protection.	Install key practices after principal sediment traps and before land grading. Install additional runoff control measures during grading.
5	Runoff conveyance system. Stabilize stream banks, storm drains, channels, inlet and outlet protection, and slope drains.	Where necessary, stabilize stream banks as early as possible. Install principal runoff conveyance system with runoff-control measures. Install remainder of system after grading.
6	Grubbing and grading. Site preparation: cutting, filling and grading, sediment traps, barriers, diversions, drains, surface roughening.	Begin major grubbing and grading after principal sediment and key runoff control measures are installed. Clear borrow and disposal areas only as needed. Install additional control measures as grading progresses.
7	Surface stabilization: temporary and permanent seeding, mulching, sodding, and installing riprap.	Apply temporary or permanent stabilization measures immediately on all disturbed areas where work is delayed or complete.
8	Building construction: buildings, utilities, paving	Install necessary erosion and sedimentation control practices as work takes place.
9	Landscaping and final stabilization: topsoiling, planting trees and shrubs, permanent seeding, mulching, sodding, installing riprap.	Last construction phase - Stabilize all open areas including borrow and spoil areas. Remove and stabilize all temporary control measures.
10	Maintenance	Maintenance inspections should be performed weekly, and maintenance repairs should be made immediately after periods of rainfall.

	Somerset, Kentucky **Stormwater Best Management Practices (BMPs)** **Site Planning and Design Practices (SPDs)**	SPD-03.1
	Activity: Vegetative Buffers	

PLANNING CONSIDERATIONS:

Design Life:
1 yr

Acreage Needed:
Minimal

Estimated Unit Cost:
Low

Monthly Maintenance:
60% of Installation

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

Vegetative buffers consists of an undisturbed vegetation barrier that has been enhanced or restored surrounding an area of disturbance or bordering streams, ponds, wetlands and lakes. This planning BMP filters runoff, reduces storm runoff velocities, protects channel banks, provides flood protection and a number of other enhancing traits.

Suitable Applications

- Areas desiring enhancement to wildlife inhabitant.
- Areas needing temperature regulation and replenishment of wildlife victuals.

Installation Procedures

- Planting can consists of bare root seeding.
- Container grown seeding, grown plants and balled and burlapped plants.
- Soil preparation and maintenance are essential for the establishment of planted vegetation.
- Standard permanent erosion control grasses and legumes may be used in denuded areas for quick stabilization.

Maintenance

- Areas closest to the stream should be maintained with minimum impact.
- Watering required during periods of drought as well as during the initial year; watering may be necessary in all buffer areas planted or seeded for enhancement.
- It is imperative that the structure of the vegetated stream buffer be maintained.
- If the buffer has been planted, it is suggested that the area be monitored to determine if plant material must be replaced. Provisions for the protection of new plantings from destruction or damage from beavers or other damaging pests should be incorporated into the plan.

Design Criteria

- Buffer width should be selected to permit the zone to perform its intended purpose.
- Slope, hydrology, width and structure shall be considered.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Site Planning and Design Practices (SPDs)

SPD-03.2

Activity: Disturbed Stabilization (Temporary Seeding)

PLANNING CONSIDERATIONS:

Design Life: 1 yr

Acreage Needed: Minimal

Estimated Unit Cost: Low

Monthly Maintenance: 60% of Installation

Target Pollutants		
Significant ♦	Partial ◈	Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

For seasonal protection and areas with fast growing species the establishment of temporary seeding is desired to reduce storm water runoff velocity, maintain sheet flow, protect the soil surface from erosion, to promote infiltration of runoff into the soil, improve wildlife habitat, aesthetics and soil condition for permanent planting.

Suitable Applications

- Coordinate with permanent measures (See EPP-06) to assure economical and effective stabilization.
- Used as companion crops until permanent seeding is established.

Maintenance

- Inspection of area made before anticipated rain events and within 24 hours after the end of a storm event of 0.5 inches or greater.
- Maintenance should be corrected prior to the next known storm event or within 7 days after identification of the previous significant wet weather event.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Site Planning and Design Practices (SPDs)

SPD-03.3

Activity: Disturbed Area Stabilization (Permanent Seeding)

PLANNING CONSIDERATIONS:

Design Life:
1 yr

Acreage Needed:
Minimal

Estimated Unit Cost:
Low

Monthly Maintenance:
60% of Installation

Target Pollutants

Significant ♦	Partial ◈	Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

Final stabilization occurs when perennial vegetation is introduced to construction areas. This stabilization occurs as a result of planting trees, shrubs, vines, grasses or legumes on exposed areas. The result of this aesthetic overture reduces stormwater runoff velocity, maintains sheet flow, protects soil surface from erosion, promotes infiltration of runoff into the soil and improves wildlife habitat. Permanent stabilization also acts as a protective cover for cuts, fills, and other denuded areas that will not be regarded.

Suitable Applications

- Areas where topsoil was never stripped.
- Topsoil has been returned and incorporated into the soil surface.
- See EPP-06, Permanent Seeding for more information.

Installation Procedures

- Grade and shape slope unless hydraulic seeding has taken place.
- Divert erosion causing concentrations of water to safe outlets.
- Plants should be selected based on characteristics specific to soil conditions, site, planned and maintenance of the area, method of planting, etc.
- Topsoil should be friable and loamy, free of debris with a uniform application of 5 inches recommended.
- Seedbed preparations: When conventional seeding is to be used, topsoil should be applied to any are where the disturbance results in subsoil being the final grade surface.

Broadcast Planting

1. Seedbed preparation may not be required where hydraulic seeding equipment is to be used.
2. Tillage, at a minimum, shall adequately loosen the soil to a depth of 4 to 6 in.; alleviate compaction; incorporate topsoil, lime, and fertilizer; smooth and firm the soil; allow for the proper placement of seed, sprigs, or plants; and allow for the anchoring of plants; and allow for the anchoring of straw or hay mulch if a crimper is to be used.
3. Tillage may be done with any suitable equipment
4. Tillage should be done parallel to the contour where feasible
5. On slopes too steep for the safe operation of tillage equipment, the soil surface shall be pitted or trenched across the slope with appropriate hand tools to provide consecutive beds, 6 to 8 in. apart, in which seed may lodge and germinate. Hydraulic seeding may also be used.

Individual Plants

1. Where individual plants are to be set, the soil shall be prepared by excavating holes, opening furrows, or dibble planting.
2. For nursery stock plants, holes shall be large enough to accommodate roots without crowding.
3. Where pine seedlings are to be planted, use a subsoiler under the row to a depth of 36 in. on the contour four to six months prior to planting. Subsoiling should be done when the soil is dry, preferably in August or September.
4. Trees should not be planted in power line right-a-ways or under power lines.

Inoculants

1. All legume seeds shall be inoculated with appropriate nitrogen fixing bacteria. The inoculants shall be pure culture prepared specifically for the seed species and used within the dates on the container.
2. A mixing medium recommended by the manufacturer shall be used to bind the inoculants to the seed. For conventional seeding, twice the amount of inoculants recommended by the manufacturer. For hydraulic seeding, four times the amount of inoculant recommended by the manufacturer shall be used.
3. All inoculant seed shall be protected from the sun and high temperatures and shall be planted the same day inoculated. No inoculated seed shall remain in the hydroseeder longer than one hour.

Installation Procedures (cont'd)

Planting

1. Hydraulic Seeding: Mix the seed (inoculant if needed), fertilizer, and wood cellulose or wood pulp fiber mulch with water and apply in a slurry uniformly over the area to be treated. Apply within one hour after the mixture is made.
2. Conventional Seeding: Seeding will be done on a freshly prepared seedbed. For broadcast planting, use a cultipacker seeder, drill, rotary seeder, other mechanical seeder, or hand seeding to distribute the seed uniformly over the area to be treated. Cover the seed lightly with $^1/_8$ to ¼ in. of soil for small seed and ½ to 1 in. for large seed when using a cultipacker or other suitable equipment.
3. No-Till Seeding: No-till seeding is permissible into annual cover crops when planting is done following maturity of the cover crop or if the temporary cover stand is sparse enough to allow adequate growth of the permanent (perennial) species. No-till seeding shall be done with appropriate no-till seeding equipment. The seed must be uniformly distributed and planted at the proper depth.
4. Individual Planting: Shrubs, vines and sprigs may be planted with appropriate planters or hand tools. Pine trees shall be planted manually in the subsoil furrow. Each plant shall be sent in a manner that will avoid crowding the root.

Nursery stock plants shall be planted at the same depth or slightly deeper than they grew at the nursery. The tips of the vines and sprigs must be at slightly above the ground surface.

Where individual holes are dug, an appropriate amount of fertilizer shall be placed in the bottom of the hole, two in. of soil shall be added, and the plant shall be set in the hole and the hole filled.

Applying Mulching

Mulch is required for all permanent vegetation applications. Mulch applied to seeded areas shall achieve 75% soil cover. Select the mulching material from the following and apply as indicated.

1. When using temporary erosion control blankets or block sod, mulch is not required.
2. Dry straw or dry hay of good quality and free of weed seeds can be used. Dry straw shall be applied at the rate of 2 tons per acre. Dry hay shall be applied at a rate of 2 ½ tons per acre. *Sericea lespedeza* hay containing mature seed shall be applied at a rate of three tins per acre.
3. Straw or hay mulch will be spread uniformly within 24 hours after seeding and/or planting. The mulch may be spread by blower type spreading equipment, other spreading equipment, or by hand.
4. Wood cellulose mulch or wood pulp fiber shall be used with hydraulic seeding. It shall be applied at the rate of 500 pounds per acre. Dry straw or dry hay shall be applied (at the rate indicated above) after hydraulic seeding.
5. One thousand pounds per acre of wood pulp fiber, which includes a tackifier, shall be used with hydraulic seeding on slopes ¾:1 or steeper.
6. Wood cellulose and wood pulp fibers shall not contain germination or growth inhibiting factors. They shall be evenly dispersed when agitated in water. The fibers shall contain a dye to aid in uniform application during seeding.

Installation Procedures (cont'd)

Anchoring Mulch

1. Emulsified asphalt can be (a) sprayed uniformly onto the mulch as it is ejected from the blower machine or (b) sprayed on the mulch immediately following mulch application when straw or hay is spread by methods other than special blower equipment. The combination of asphalt emulsion and water shall consist if a homogeneous mixture satisfactory for spraying. The mixture shall consist of 100 gallons of water per ton of mulch. Care shall be taken at all times to protect state waters, the public, adjacent property, pavements, curbs, sidewalks, and all other structures from asphalt discoloration.
2. Hay and straw mulch may be pressed into the soil immediately after the mulch is spread. A special "crimper" or disk harrow with the disks set straight may be used. Serrated disks are preferred, and should be 20 in. or more in diameter and 8 to 12 in. apart. The edges f the disks shall be dull enough to press the mulch into the ground without cutting it, leaving much of it in an erect position. Mulch shall not be plowed into the soil.
3. Synthetic tackifiers or binders may be applied in conjunction with or immediately after the mulch is spread. Synthetic tackifiers should be mixed and applied according to manufacturer's specifications.

Irrigation

Irrigation will be applied at a rate that will not cause runoff.

Maintenance

- Inspect seeding and mulch regularly.
- Any washout areas should be repaired immediately.
- Maintenance needs that have been identified should be repaired before the next storm event or within seven days of identification.

Inspection Checklist

- [ ] Inspect all applications and make appropriate repairs.

Activity: Disturbed Area Stabilization (Mulch)

PLANNING CONSIDERATIONS:

Design Life:
1 yr

Acreage Needed:
Minimal

Estimated Unit Cost:
Low

Monthly Maintenance:
N/A

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

Mulch is used to promote vegetation during vegetative stabilization practices to reduce stormwater runoff and erosion, conserve moisture, promote germination of seed, prevent surface compaction or crusting, protect seed from birds, modify soil temperature and increase biological activities in the soil.

Suitable Applications

- Cleared areas where seed may not promote an erosion-retardant cover.
- Protection of seed from birds.
- Reduction of soil surface temperature is desired.

Design Criteria

- Select mulching material depending on desired soil coverage.
- Anchor mulch immediately after application.
- Refer to EPP-10 Mulching for more information regarding design and installation of this BMP.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Site Planning and Design Practices (SPDs)

SPD-03.5

Activity: Disturbed Area Stabilization (Sodding)

PLANNING CONSIDERATIONS:

Design Life:
Permanent

Acreage Needed:
As required

Estimated Unit Cost:
Low

Monthly Maintenance:
30% of Installation

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

Areas needing immediate vegetative cover such as grass swales, drop inlets, and waterways with intermittent flow use sod brought from other locations. This BMP is referred to as Disturbed Area Stabilization. The stabilization establishes immediate ground cover, reduces stormwater runoff, protects soil surface from erosion, reduces damage from sediment and runoff to downstream areas as well as improves aesthetics.

Design Criteria

- Sod selected material should be certified.
- Sod grown in the area is preferred.
- Sod should be machine cut and contain ¾" (+ or – ¼ inch) of soil.
- Cuts should be installed within 36 hours of digging.
- Avoid planting when subject to frost heave, or hot weather if irrigating is not available.
- Refer to EPP-07 Sodding, for more information on its applications, installation, and maintenance.

	Somerset, Kentucky **Stormwater Best Management Practices (BMPs)** **Site Planning and Design Practices (SPDs)**	SPD-03.6
	Activity: Erosion Control Mats/Blankets	

PLANNING CONSIDERATIONS:

Design Life:
1-2 years

Acreage Needed:
Varies

Estimated Unit Cost:
Medium

Monthly Maintenance:
N/A

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

In areas where erosion hazards are high, matting and blankets can be applied. This protective blanket or stabilization mat aids in establishing temporary or permanent vegetation on steep slopes, channels or stream banks. The presence of this BMP prevents erosion of the soil surface or seed, promotes seed germination, protects young vegetation and prevents the dispersion of seed or mulch.

Suitable Applications

- All concentrated flow areas with slopes steeper than 2.5:1, with a height of 10 ft. or greater and cuts and fills within stream buffers.
- Temporary blankets should be (at a minimum) used to stabilize concentrated flow areas.
- Vegetative lining is desired in stormwater conveyance channels where velocity is projected to be between 5 and 10 ft. per second.

Design Criteria

- Care must be taken to choose the type of blanket or matting appropriate for each project.
- Rolled erosion control blankets are made of plastic netting intertwined with natural organic or manmade mulch.
- Jute mesh is a typical homogeneous design that can act alone as a stabilization blanket.

Activity: Erosion Control Mats/Blankets	SPD-03.6

Approach

- **Straw Blanket** consist of weed free straw with a $^5/_{16}$ x $^5/_{16}$ top side and a minimum thickness of 3/8 in. and minimum dry weight of 0.5 lbs per square yard.
- **Excelsior blankets** are curled wood excelsior formed into a blanket with 1 ½ x 3 in. mesh sides and a minimum thickness of ¼ in. with a 0.8 dry weight lbs per square yard.
- **Coconut blankets** consist of 100% coconut fiber with a ¼ thickness, a minimum dry. weight of 0.5 lbs per square yard and a $^5/_8$ x $^5/_8$ in. maximum mesh .
- **Wood fiber blankets** consist of reprocessed wood fiber with a maximum mesh size of 5/8 x ¾ in. and a 0.35 lbs per square yard minimum dry weight.
- **Jute mesh** consist of woven root fiber or yarn with regularly spaced openings between strands and a 1.0 lbs per square yard dry weight for basic slope applications.

Installation Procedures

- Shape and grade site.
- Prepare a friable seedbed free from clods and rocks.
- Temporary blankets should be installed vertically from the top of the slope to bottom.
- For shallower slopes (less than 2:1) with height twice as much as the width, and a maximum height of 16 feet, the blanket may be applied horizontally. Concentrated flow area blankets should be placed in the direction of water flow.
- Entrench blanket beyond the top and bottom of the slope and at any horizontal joint a minimum of 6 in.
- Permanent matting begins installation at the bottom of the slope and works towards the top while being centered in the middle of the channel.
- Shingle upstream layer over downstream layer overlapping 3 ft.
- Temporary blankets should be anchored with staples per manufacturing directions.
- Manufacturer's recommendations should be followed when choosing products.
- All preliminary seeding and soil amendments should be done prior to installation of temporary blankets.
- Permanent matting areas should be brought to final grade before installation of matting. After installation and backfilling of topsoil, seeding and mulch should be applied.

Maintenance

- Inspect erosion control matting before (if anticipated) and within 24 hours following rainfall events to check for movement of topsoil, mulch or erosion. Continue checking until vegetation is firmly established.
- Inspect blankets or mats at least every 14 days.
- Repair or replace netting that has been washed out, broken, eroded, and/or needing surface repair, re-seeding, re-sodding, re-mulching or topsoil replacement.

Inspection Checklist

- ☐ Inspection completed before a storm event.
- ☐ Inspection completed within 24 hours after the end of a storm event of 0.5 inches or greater.
- ☐ Erosion control mats are properly tucked.
- ☐ Damaged areas have been repaired.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Site Planning and Design Practices (SPDs)

SPD-04.1

Activity: Covenants

PLANNING CONSIDERATIONS:

Design Life:
Permanent

Acreage Needed:
N/A

Estimated Unit Cost:
High

Monthly Maintenance:
N/A

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

Conservation covenants are voluntary, legally binding agreements between a landowner and the State or Local Government which are designed to provide permanent protection for areas or species that have conservation value. The covenant is registered on the title of the land and travels with the title to future landowners. Once a covenant is in place it can only be modified or revoked with the agreement of the landowner and the relevant state or local agency.

A management agreement is usually provided with a covenant and will detail how the conservation values are to be managed. Some activities such as grazing and firewood collection may be allowed within a conservation covenant. For those activities that are allowed, the details of how they will be undertaken are outlined in detail within the management plan. Both documents are drafted in consultation with the landowner.

The aim of conservation covenants is to ensure that land use is compatible with the natural values of that area. A conservation covenant will apply to all or most of the native vegetation on a property. However, a landowner may also choose to exclude parts of their property from the covenant for example to allow for building a house in the future.

Participation in a conservation covenant is entirely voluntary and the details of the covenant and management agreement are agreed only with the cooperation and consent of the landowner.

Description (cont'd)

Management Agreements

Management agreements are agreements between a landowner and the State Government that are not registered on the land title. Management agreements set out required management practices to protect the nature conservation values.

Benefits of Covenanting Land

There are many benefits gained by having a conservation covenant on your land, they include:

- Rate rebates in some areas or districts.
- Exemption from land tax.
- Having a conservation covenant helps if you are applying for grants for environmental work.
- By maintaining remnant native vegetation you benefit from erosion and salinity protection; and you provide shade and shelter for livestock; and protect wetlands, catchments and water quality.

Activity: Setbacks and Buffers

PLANNING CONSIDERATIONS:

Design Life:
Permanent

Acreage Needed:
Varies

Estimated Unit Cost:
High

Monthly Maintenance:
N/A

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

A *setback* is the area between intensive development (i.e., buildings, parking lots, roads) and a protected area, such as a wetland. Setbacks are necessary for:

- Controlling the peripheral effects of development
- Protecting developments
- Providing access for maintenance

For example, a highway or parking lot built directly on the edge of a high-quality wetland may adversely affect water quality and wildlife habitat from pollutant runoff or spray and traffic noise. Setback requirements for structures, particularly adjacent to streams, reflect the fact that streams naturally meander or expand over time. Placing structures in the natural path of a meandering stream virtually guarantees that expensive stabilization measures will be needed in the future as the stream approaches building foundations, threatening their collapse.

Only limited activities are recommended for approval in a setback. The types of activities include minor improvements, such as walkways, foot bridges, and observation decks; roadways necessary for crossing a water body; maintenance and repair of existing roads and utilities; and the establishment of landscaped lawns or parks. In general, major modifications to the land surface should be avoided in setbacks.

Description (cont'd)

Limiting activities in a *floodway* to appropriate uses is similar to a setback requirement. A floodway is the part of the floodplain, centered on the stream, which will convey most of the flow during a high water event. Appropriate uses exclude most buildings and structures. However, other uses that are allowed may adversely affect water quality and habitat. These include:

- Parking lots
- Roadways parallel to the waterbody
- Garages and storage sheds
- Treatment plants and pumping facilities

Within a setback, a *buffer strip* is the transitional vegetated area closest to the waterbody or wetland. The purposes of a buffer are to:

- Minimize erosion
- Stabilize the stream bank or lakeshore
- Filter runoff pollutants from adjacent developments
- Preserve fish and wildlife habitat
- Screen manmade structures and preserve aesthetic values
- Provide access for maintenance or trails

Buffers reflect that natural aquatic systems may not function well in isolation and that a gradual continuum exists from natural riparian or wetland systems to upland. Ideally, a buffer should be maintained or planted in native riparian vegetation to maximize pollutant filtering, soil stabilization, and habitat functions.

	Somerset, Kentucky **Stormwater Best Management Practices (BMPs)** **Site Planning and Design Practices (SPDs)**	SPD-04.3
	Activity: Conservation Easements	

PLANNING CONSIDERATIONS:

Design Life:
Permanent

Acreage Needed:
Varies

Estimated Unit Cost:
High

Monthly Maintenance:
N/A

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

Another useful tool for protecting sensitive areas is a conservation easement. A conservation easement incorporates legal provisions into a property deed that limits the use of the property. Conservation easements allow for the continued private ownership of the land but restrict land uses to current uses or to nondamaging activities. The legal concession may be donated by or purchased from the owner. The land owner also may be compensated by reduced property taxes on the land in the easement.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Erosion Prevention Practices (EPPs)

EPP-01

Activity: Tire Washing Facility (TW)

TW

PLANNING CONSIDERATIONS:

Design Life:
1 yr

Acreage Needed:
Minimal

Estimated Unit Cost:
Medium

Annual Maintenance:
Negligible

Target Pollutants

Significant ♦	Partial ◈	Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

As a result of vehicular ingress and egress to the construction site, the facility would remove mud and dirt from vehicle tires and the undercarriage to prevent materials from depositing onto public roads. This application can be used in conjunction with the stabilized construction entrance, EPP-03.

Suitable Applications

- Temporary construction traffic, phased construction projects and off-site road access.
- Typically used for large construction sites.

Approach

- Incorporate with the stabilized construction entrance, EPP-03.
- Construct wash rack on level ground when possible, on a pad of course aggregate.
- Design tire rack to withstand anticipated traffic loads and drain to a detention pond or swale. A typical wash rack has been shown in the standard details. However, wash rack design may consist of other materials or configuration as long as it provides the intended function.
- If a swale is required, then it shall provide sufficient grade, width, and depth to carry runoff.
- The swale shall carry runoff from the wash area to a sediment-trapping device such as a check dam.
- All employees, contractors, subcontractors, and others that leave the site with mud caked tires and/or undercarriages shall use construction entrance.

Activity: Tire Washing Facility (TW)	EPP-01

Installation Procedures for Tire Washing Facility

- A geotextile underliner must be placed under the entire length and width of the stabilized entrance, but not under the wash rack.
- Place a layer of KTC No. 1 or No. 2 stone across the full width of the exit and construct on level ground with a minimum thickness of 6-inches.
- The length of the stabilized entrance shall be as required based on the application, unless approved otherwise by the City Engineer.
- The width of the pad shall be a minimum of 12-feet, unless approved otherwise by the City Engineer.
- If a swale is required, then it shall meet specific requirements needed to carry the wash runoff to a sediment-trapping device.

Maintenance

- Remove accumulated sediment to maintain system performance, in the wash rack and/or sediment trap.
- Inspect at the end of each shift or workday for damage and repair as needed.
- Remove any mud tracked onto adjacent roadway by sweeping or scraping as necessary.

Inspection Checklist

- [ ] Vehicles are leaving the site through designated construction exit(s).
- [ ] Mud, dust or dirt is removed prior to exit onto the adjacent road.
- [ ] The construction exit is sufficiently maintained to prevent mud, dirt, fines and dust from being tracked off-site.
- [ ] Stones under wash rack have been maintained and free of deleterious materials.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Erosion Prevention Practices (EPPs)

EPP-02

Activity: Construction Road Stabilization (CRS)

— CRS — CRS —

CRS

PLANNING CONSIDERATIONS:

Design Life:
2 yrs

Acreage Needed:
Variable

Estimated Unit Cost:
Medium

Monthly Maintenance:
Negligible

Target Pollutants

Significant ♦ Partial ⟐ Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ⟐ Construction Waste ◊

Description

Construction vehicles frequently use access roads, subdivision roads, parking areas and other on-site transportation routes that are not accessible to the public. Construction specifications and drawings should demonstrate methods and practices to stabilize these routes to reduce erosion between the time of initial grading and final stabilization.

Suitable Applications

- Temporary construction traffic routes, phased construction projects and off-site road access.
- Detour roads for local or temporary construction traffic.
- Construction during wet weather.
- Construction roads utilizing a temporary stream crossing must be indicated and approved.

Approach

- Road should follow topographic contours to reduce erosion of the roadway.
- Gravel roads should be of sufficient thickness to support construction traffic.
- Chemical stabilizers or water are usually required on gravel or dirt roads to prevent dust. No additional costs for dust control on construction roads should be required above that needed to meet local air quality requirements.

Activity: Construction Road Stabilization	EPP-02

Design Considerations for Construction Road Stabilization

- All existing vegetation (trees, bushes, ground cover) shall be retained as long as feasibly practicable to reduce the exposure of disturbed grounds. Removal of vegetation should be phased in concurrence with relative construction activities within the vicinity.
- The implementation of this BMP depends largely on climate and weather conditions. Alternative routes should be established to incorporate these measures to account for conditions such as dry areas, wet conditions and other circumstances that would inhabit a safe and stable route for construction traffic. Permanent roads and parking areas should be paved as soon as possible after grading. The early application of gravel or chemical stabilization may solve potential erosion and stability problems where construction will be phased. Temporary gravel roadways should be considered during the wet weather seasons and on slopes greater than 5 percent.
- When gravel roads are needed, a minimum 6-in. course of 2 to 3-in. crushed rock, gravel base, or crushed surfacing base course should be applied immediately after grading or the completion of utility installation within the right-of-way. Chemical stabilization may also be used upon compacted native sub-grade. These chemical controls should be applied per the manufacturer's directions.
- Roadways should be carefully graded to drain transversely. Provide drainage swales on each side of the roadway in the case of a crowned section, or one side in the case of super-elevated section. Simple gravel berms without a trench can also be used.
- Installed inlets should be protected to prevent sediment-laden water from entering the storm sewer system.

Temporary Roads and Parking Areas

- Grade
  - The gradient and vertical-horizontal alignment should be designed according to the intended traffic patterns.
  - Grades for temporary roads should not exceed 10% for lengths less than 200 LF.
  - Frequent grade changes can reduce erosion and improve sediment control.
  - Grades for parking areas should not exceed 4%.
- Width
  - The radius for temporary roads should not be less than 35-feet for standard construction vehicles, and 50-feet for tractor trailers.
  - Temporary road widths should not be less than 14-feet for one-way traffic, 20-feet for two-way traffic.
  - Temporary roads should include two shoulders with a minimum width of two feet on each side.
- Side Slopes
  - All cuts and/or fills should be graded at a slope of 2:1 whenever possible.
  - A slope of 3:1 should be used whenever machined mowing will be used to maintain ground cover.
- Drainage
  - The design and capacity of all drainage structures should be consistent with sound engineering principles and suitable for the type of road that will be eventually permanent.
  - Structures should withstand flows from a 25-year, 24-hour storm event.

Activity: Construction Road Stabilization | EPP-02

Design Considerations (cont'd)

- Stabilization
  - Install a 6-inch layer of coarse aggregate immediately after grading or utility installation within the right-of-way.
  - For added stability, a geotextile should be installed beneath the base stone.
  - All adjacent drainage swales, cuts, and fills shall be properly seeded or sodded.
- Permanent Roads and Parking Areas
  - Permanent roads and parking areas should be designed to the codes and standards of the local authority and the Kentucky Transportation Cabinet.
  - Permanent roads should have an initial base coarse of gravel immediately after site grading.

Maintenance

- Periodically apply additional aggregate on gravel roads.
- Active dirt construction roads are commonly watered three or more times per day during the dry season.
- Remove silt and debris from road side ditches and swales to prevent clogging or damming.
- Inspect weekly, and after each rain event and repair any eroded areas immediately.

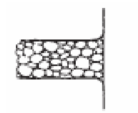
Inspection Checklist

- ❑ Gravel roads are preventing mud and dirt from leaving project area.
- ❑ Dirt and gravel roads do not show signs of erosion, including but not limited to, rill and gully erosion.
- ❑ All stream crossings are maintained as mandated by the appropriate general or individual permit.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Erosion Prevention Practices (EPPs)

EPP-03

Activity: Stabilized Construction Entrance (SCE)



SCE

PLANNING CONSIDERATIONS:

Design Life:
1 yr

Acreage Needed:
Minimal

Estimated Unit Cost:
Low

Monthly Maintenance:
60% of Installation

Target Pollutants

Significant ♦   Partial ◈   Low or Unknown ◊

Sediment ◈   Heavy Metals ◊   Nutrients ◈   Oxygen Demanding Substances ◊   Toxic Materials ◈
Oil& Grease ◈   Bacteria & Viruses ◊   Floatable Materials ◊   Construction Waste ◊

Description

The construction entrance practice receives all incoming and outgoing traffic of the construction site. By stabilizing the construction entrance there will be a significant reduction in the amount of sediment to and from public right-of-ways, streets, alleys, sidewalks or parking areas. The construction entrance practice is a stabilized pad of aggregate underlain with filter cloth located at any point where traffic will be entering or leaving. This management practice is likely to create a significant reduction in sediment, nutrients, toxic materials, and oil and grease.

Suitable Applications

- All points of construction ingress and egress.
- Unpaved areas where sediment tracking occurs from site onto paved or public roads.

Approach

- Construct on level ground where possible.
- Stones should be sized as to remove mud from tires from the construction site.
- Provide ample turning radii as part of entrance.
- Should be used in conjunction with street sweeping on adjacent public right-of-way.
- Limit egress to the designated construction exit(s) by installing perimeter fencing.
- Wash rack may be included to increase efficiency of removing dirt from tires.

Installation Procedures

- A Geotextile underliner must be used under the entire length and width of the stabilized entrance.
- Construct sediment barriers, such as check dams, to prevent sediment from entering into the storm water sewer system, ditch, or waterway.
- Construct entrance with KTC No. 1 or No. 2 stone. Do not use #57s, 410 “traffic bound”, or DGA – for entrance / exit pads leading to paved roads.
- The length of the stabilized entrance shall be as required based on the application, unless approved otherwise by the City Engineer.

Activity: Stabilized Construction Entrance	EPP-03

Maintenance

- Inspect weekly and after each rainfall.
- Periodically requires addition of stones for top; add gravel material when soil sub grade becomes visible.
- Remove all mud or sediment deposited on paved roadways as necessary.
- Stir aggregate with back-hoe on a weekly basis or as required based on construction activity.

Inspection Checklist

- [ ] Entrance/exits are exclusively used by all traffic.
- [ ] Construction exit is sufficiently maintained to prevent mud, dirt, and dust from being tracked off-site, and stone has been stirred with back-hoe.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Erosion Prevention Practices (EPPs)

EPP-04

Activity: Buffer Zones (BZ)

BZ

BZ

PLANNING CONSIDERATIONS:

Design Life:
Permanent

Acreage Needed:
Minimal

Estimated Unit Cost:
Low

Monthly Maintenance:
60% of Installation

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ♦ Nutrients ♦ Oxygen Demanding Substances ♦ Toxic Materials ◊
Oil& Grease ♦ Bacteria & Viruses ◊ Floatable Materials ◈ Construction Waste ◊

Description

Buffer zones allow the utilization of vegetation to protect soils from erosion as well as reduce the velocity of runoff. This BMP allows the removal of sediment through filtering and settling. This management practice is likely to create a significant reduction in sediment by reducing erosion and retaining plant vegetation along waterways.

Suitable Applications

- There are two types of buffer strips: General Buffers and Vegetated Riparian Buffers.
  - *General Buffers*: A strip of original, undisturbed land adjacent to the disturbed site provides a general buffer.
  - *Vegetated Riparian Buffers*: Buffers that provide protection to adjacent streams by filtering overland flow of sediments and strengthening bank stabilization. These buffers are also useful by cooling streams to promote plant and fish habitation and providing food for the surrounding wildlife.
- Utilization or reinforcement of existing vegetation is preferred. However, where improvements are required; sodding, plugging, use of stockpiled vegetation or seeding is acceptable.
- Sodding is appropriate if it is part of the no construction activity area that contained turf prior to construction, or for any graded or cleared areas that might erode and where a robust plant cover is needed immediately.
- Plantings for buffer reestablishment and enhancement can consist of bare root seedlings, container grown seedlings, container grown plants and balled and burlapped plants. Standard permanent erosion control grasses and legumes may be used in denuded areas for quick stabilization.
- Soil preparation and maintenance are essential for the establishment of planted vegetation.

Activity: Buffer Zones	EPP-04

Approach

General Buffers

- A sufficient width should be selected to promote plantings' growth and to serve as a filter of overland flow entering the zone.

Vegetated Riparian Buffers

- Prior to structuring the zone, careful consideration should be given to its intent and purpose and how it should be enhanced to meet the requirements of the buffer zone. Stream characteristics such as width, slope, depth and the topography of the surrounding vicinity should be considered.
- Stream buffers must at least include the floodway plus 50 feet perpendicular to the floodway. If a floodway has not been determined, the buffer must be at least 25 feet perpendicular from each side of the stream bank, creek, or unnamed waterway, under "bank-full" conditions.
- Stream buffers are typically 50 feet wide for flat lying areas.
- A buffer should be increased 2 feet in width for every 1% of slope perpendicular to the centerline of the stream.
- If existing vegetation is disturbed or removed, a new multipurpose buffer should be created using the three following zones:
    - Zone 1 – the first 20-feet adjacent to the stream should include trees and shrubs spaced 6-10 feet apart to provide stabilization of the bank deep into the soil.
    - Zone 2 – The next 10-feet should consist of managed forest for chemical absorption and wildlife habitat.
    - Zone 3 – the upper 20-feet should be comprised of grasses for sediment and chemical capture as well as noise reduction.

Maintenance

- Inspect sod installations weekly and after significant storm events, until the turf is established, and routinely thereafter.
- Maintenance shall consist of mowing, weeding, and ensuring that the irrigation system is operating properly and as designed to sustain growth.
- Inspect buffer strips weekly and after significant storm events until vegetation is established, and routinely thereafter. Repair eroded or damaged areas as needed to maintain original purpose and effectiveness of the buffer strip.
- Provisions to maintain and protect new plantings from native wildlife should be incorporated with the design documents and drawings.

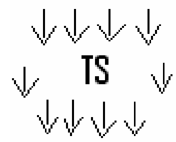
Inspection Checklist

- ☐ Sod is properly maintained and watered.
- ☐ Buffer strips are properly maintained.
- ☐ Plantings are sufficiently protecting from wildlife.
- ☐ Significant rainstorm events have not deteriorated buffer zone.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Erosion Prevention Practices (EPPs)

EPP-05

Activity: Temporary Seeding



TS

PLANNING CONSIDERATIONS:

Design Life:
1 yr

Acreage Needed:
As Needed

Estimated Unit Cost:
Low

Annual Maintenance:
20% of Capital Costs

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◈ Oxygen Demanding Substances ◊ Toxic Materials ◈
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

Temporary seeding is used as a means of providing stabilization subject to erosion. This management practice is likely to create a significant reduction in sediment loss and a partial reduction in nutrients and toxic materials.

Temporary seeding may also prevent costly maintenance operations on other erosion control systems and improve the visual resources of the construction area.

Suitable Applications

- Apply to areas that are left in rough grade condition, and will not be disturbed for 21 days or more.

Approach

- <u>Conventional Seeding</u>
  Common methods of application include: disc, cultivator, broadcasting, and no-till drilling.
- <u>Hydroseeding</u>
  Hydroseeding uses a mixture of mulch, seed, and tactifier which is sprayed over a disturbed area for coverage.

Activity: Temporary Seeding	EPP-05

Installation/ Applications

Seed bed Preparation

- Prepare area to be seeded.
- Apply seed, fertilizer, and lime as required
- Apply mulch as specified in EPP-10.
- Grade as needed to permit the use of conventional equipment for seedbed preparation, fertilization and seeding.
- Apply to bare or denuded areas, soil stockpiles, if they will not be used for more than 21 consecutive days.
- Soil material should be capable of supporting permanent vegetation and have at least 25% silt and clay to sufficiently hold moisture during establishment.
- In compacted areas, soil should be loosened to a depth of 6-8 inches.
- Protect areas against seed wash-out using surface roughening diversions or terraces.
- Soil should be analyzed for fertilizer and lime requirements.

Conventional Seeding

- Work lime and fertilizer into the soil with disk harrow, springtooth harrow or like equipment to a depth of 2 inches.
- Apply seeding uniformly with a cyclone or drill. Seed no deeper than ¼" to ½".
- Weather conditions should be taken into account when seeding areas. Seeding should not take place during adverse weather conditions.

Hydroseeding

A practice of applying a hydraulic spray that seeds, fertilizes and tacks in a single step.

- Prepare a homogenous mixture in a slurry tank: Seed (inoculated if needed), fertilizer, wood cellulose or wood pulp fiber mulch, and water. (Ordinary mulch is not suitable for hydroseeding).
- Apply within one hour after mixture is prepared. The application rate should be approximately 35 lbs per 1000 sq ft.
- Spray in two, orthogonal directions (i.e. north/south and east/west) for an even distribution of the hydroseed mixture.
- A straw mulch can be applied after hydroseeding at a rate of 100 lbs per 1000 sq. ft.

The chart below displays the recommended rates for temporary seeding.

Seeding Rates

March 1 to October 31	Per 1000 SF	Per Acre
Oats	3 lbs	120 lbs
Perennial Ryegrass	1 lbs	40 lbs
Tall Fescue	1 lbs	40 lbs
Wheat	1 lbs	40 lbs
Annual Rye	3 lbs	120 lbs
November 1 to February 28	**Per 1000 SF**	**Per Acre**
Annual Rye	3 lbs	120 lbs
Wheat	3 lbs	120 lbs
Perennial Ryegrass	1 lbs	40 lbs
Tall Fescue	3 lbs	120 lbs

Source: Kentucky ESPC Field Guide

Activity: Temporary Seeding	EPP-05

Maintenance	➢ Inspect frequently during the first six weeks following planting to assure that appropriate moisture levels are maintained and determine if stands are uniform and dense. ➢ Water until grass is thoroughly established, especially during dry, hot seasons or adverse conditions. ➢ Check for damage caused by equipment or heavy rains. Damaged areas should be repaired, fertilized, seeded, and mulched. Tack or tie down mulch as necessary.
Inspection Checklist	☐ Area is watered daily until stabilization has taken place. ☐ After stabilization, water as needed. ☐ Heavy equipment has not been used within area. ☐ Washout areas have been repaired. ☐ Vegetative coverage is (check one): ☐ 20-40% ☐ 40-60% ☐ 60-80% ☐ 80-100%

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Erosion Prevention Practices (EPPs)

EPP-06

Activity: Permanent Seeding (PS)

PS

PS

PLANNING CONSIDERATIONS:

Design Life:
Permanent

Acreage Needed:
As Needed

Estimated Unit Cost:
Low

Annual Maintenance:
20% of Capital Costs

Target Pollutants		
Significant ♦	Partial ◊	Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

Permanent seeding establishes a permanent ground cover over disturbed areas. This practice can greatly reduce erosion from a disturbed area.

Suitable Applications

- Permanent seeding can be used to reduce sediment runoff from disturbed areas during construction.
- Permanent seeding can reduce air born pollutants arising from construction disturbances.

Approach

- Conventional Seeding
  Common methods of application include: disc, cultivator, broadcasting, and no-till drilling.
- Hydroseeding
  Hydroseeding uses a mixture of mulch, seed, and tactifier which is sprayed over a disturbed area for coverage.
- Permanent seeding shall be applied to disturbed areas within 14 days of final grading unless Temporary Seeding - EPP-05, is to be used in the interim.
- This practice can be used in conjunction with other BMPs to reduce erosion during and after construction.

Activity: Permanent Seeding	EPP-06

Installation Procedures

Conventional Method

- Soil material should be capable of supporting permanent vegetation and have at least 25 % silt and clay to sufficiently hold moisture during establishment.
- In compacted areas, soil should be loosened to a depth of 6-8 inches.
- The area shall be protected from excess runoff as necessary with diversions or berms.
- Plant species shall be selected on the basis of quick germination, growth, and time of year to be seeded.
- Fertilizer, lime, seedbed preparation, seed coverage, mulch, and irrigation shall be used as necessary to promote early establishment.
- Weather conditions should be taken into account when seeding areas. Seeding should not take place during or under pending adverse weather conditions.

Seeding

- Soil should be analyzed for fertilizer and lime requirements.
- Prepare seedbed with agricultural ground limestone, at a rate of 1 ton per acre, or as determined by soil testing.
- Use a 10-10-10 fertilizer shall be applied at a rate of 800 lbs per acre, or as determined by soil testing.
- Work lime and fertilizer into the soil with disk harrow, springthooth harrow or like equipment to a depth of 4 inches.
- Protect areas against seed wash-out using surface roughening diversions or terraces.
- See Table EPP-06-01, Suggested Seeding Rates, on the following page.
- Apply mulch as specified in EPP-10.

Hydroseeding

A practice of applying a hydraulic spray that seeds, fertilizes and tacks in a single step.

- Prepare a homogenous mixture in a slurry tank: Seed (inoculated if needed), fertilizer, wood cellulose or wood pulp fiber mulch, and water. (Ordinary mulch is not suitable for hydroseeding).
- Apply within one hour after mixture is prepared. The application rate should be approximately 35 lbs per 1000 sq ft.
- Spray in two, orthogonal directions (i.e. north/south and east/west) for an even distribution of the hydroseed mixture.
- A straw mulch can be applied after hydroseeding at a rate of 100 lbs per 1000 sq. ft.

Maintenance

- Water soil until the grass is firmly established, especially if seedlings are made late in the planting season.
- Inspect all seeded areas for failures and make necessary repairs.
- If stand is inadequate (less than 80% coverage) overseed, fertilize, using half of the original rates.
- If stand is more than 60% damaged, reestablish following original seedbed preparation methods, seeding and mulching recommendation and apply lime and fertilizer as needed according to a new soil test.

Activity: Permanent Seeding	EPP-06

Inspection Checklist

- ❑ Area is watered daily until stabilization has taken place.
- ❑ Area has been maintained (watered, repaired) since stabilization.
- ❑ Heavy equipment has not been used within area.
- ❑ Eroded areas have been regarded and re-established.

Table EPP-06-01
Suggested Seeding Rates

Recommended Seed Blend for Kentucky		
Seed Species and Mixtures	**Seeding Rate / Acre**	**Per 1000 sq. ft.**
Seed and seed mixtures for relatively flat or slightly sloping areas		
Perennial ryegrass	25 to 35 lbs.	1 lb.
+ tall fescue	15 to 30 lbs.	1 lb.
Tall fescue	40 to 50 lbs.	1.5 lbs.
+ ladino or white clover	1 to 2 lbs.	2 oz.
Steep slopes, banks, cuts, and other low maintenance areas (not mowed)		
Smooth bromegrass	25 to 35 lbs.	1 lb.
+ red clover	10 to 20 lbs.	0.5 lb.
Tall fescue	40 to 50 lbs.	1 lb.
+ white or ladino clover	1 to 2 lbs.	2 oz.
Orchardgrass	20 to 30 lbs.	1 lb.
+ red clover	10 to 20 lbs.	0.5 lb.
+ ladino clover	1 to 2 lbs.	2 oz.
Crownvetch	10 to 12 lbs.	0.25 lb.
+ tall fescue	20 to 30 lbs.	1 lb.
Lawns and other high traffic or high maintenance areas (mowed)		
Bluegrass	105 to 140 lbs.	3 lbs.
Perennial ryegrass (turf)	45 to 60 lbs.	2 lbs.
+ bluegrass	70 to 90 lbs.	2.5 lbs.
Tall fescue (turf type)	130 to 170 lbs.	4 lbs.
+ bluegrass	20 to 30 lbs.	1 lb.
Ditches and other areas of concentrated water flows		
Perennial ryegrass	100 to 150 lbs.	3 lbs.
+ white of ladino clover	1 to 2 lbs.	2 oz.
Kentucky bluegrass	20 lbs.	0.5 lb.
+ smooth bromegrass	10 lbs.	0.25 lb.
+ switchgrass	3 lbs.	2 oz.
+ timothy	4 lbs.	0.25 lb.
+ perennial ryegrass	10 lbs.	0.25 lb.
+ white of ladino clover	1 to 2 lbs.	2 oz.
Tall fescue	100 to 150 lbs.	3 lbs.
+ ladino or white clover	1 to 2 lbs.	2 oz.
Tall fescue	100 to 150 lbs.	3 lbs.
+ perennial ryegrass	15 to 20 lbs.	0.5 lb.
+ Kentucky bluegrass	15 to 20 lbs.	0.5 lb.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Erosion Prevention Practices (EPPs)

EPP-07

Activity: Sodding (SO)

PLANNING CONSIDERATIONS:

Design Life:
Permanent

Acreage Needed:
As required

Estimated Unit Cost:
Medium

Monthly Maintenance:
30% of installation

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◈ Oxygen Demanding Substances ◊ Toxic Materials ◈
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

Sodding is a method used to quickly establish permanent grass stands. This practice can prove very effective in quickly stabilizing critical, erosion-prone areas.

Suitable Applications

- Ditches or channels carrying intermittent flow.
- Areas around drop inlets in grass swales.
- Residential or commercial lawns that would be aesthetically enhanced sodding.
- Other critical areas not previously described.

Approach

- Establish permanent grass stands quickly.
- Prevent erosion by stabilizing formerly denuded areas.
- Reduce the amount of air borne sediment, dust and mud leaving the project site.
- Stabilize channels where concentrated overland flow occurs.

Installation Procedures

Site Preparation

- Soil material should be capable of supporting permanent vegetation and have at least 25 % silt and clay to sufficiently hold moisture during establishment.
- In compacted areas, soil should be loosened to a depth of 6-8 inches.
- Stockpile unwanted topsoil to be used in other areas at the construction site.
- Grade and prepare the area for conventional construction equipment to be used for preparing the sod bed.

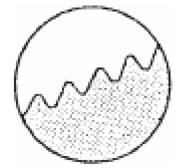
Activity: Sodding	EPP-07

Installation Procedures (cont'd)	*Sod Bed Preparation* ➢ Soil should be analyzed for fertilizer and lime requirements. ➢ Use a 10-10-10 fertilizer shall be applied at a rate of 1,000 lbs per acre, or as determined by soil testing. ➢ Work lime and fertilizer into the soil with disk harrow, springthooth harrow or like equipment to a depth of 4 inches. ➢ Clear vicinity of deleterious materials and stones greater than 4" in diameter prior to laying sod. ➢ Loosen the top one-inch of soil prior to saying the sod pieces. *Handling* ➢ Sod should be kept moist and covered during transport and preparation. ➢ Sod should be free of noxious and secondary weeds and secured from good, thick growing stands. ➢ Sod should be mowed to a height between 2-4 inches. *Placement* ➢ Do not place sod in freezing conditions (ambient temperatures less than 32^o F.) ➢ Sod shall be placed and pressed together such that it will be continuous. ➢ The outer edges of the sod placed along curbing or side walks shall be sufficiently deep so that the surface water will flow over onto the top of the sod. ➢ In swales and ditches, lay sod strips perpendicularly to the centerline of the channel. ➢ In steep channels, wood stakes should be used to secure the sod strips. ➢ On slopes 3:1 or steeper, the sod shall be rolled or tamped, then secured with chicken wire or jute mesh over the sod for protection over critical areas. The stakes should secure the sod and the net and be spaced no further than 18" apart. The size of the stakes shall be approximately ½" x ¾" x 12". The netting or mesh shall be stapled on the side of each stake within two inches of the top of the stake. The stake would then be driven flush with the top of the sod. ➢ The sod shall be tamped or rolled after placement and then watered.
Maintenance	➢ Sod should be kept moist for at least the first three weeks, until properly rooted. ➢ Sod areas where original placement does not establish or take root. ➢ Do not mow for the first three weeks. ➢ Once mowing begins, cutting height should be 3" or greater. ➢ Fertilize and mow grasses once established.
Inspection Checklist	❑ Sodded areas are properly watered and maintained. ❑ Heavy construction equipment has been prohibited from crossing sodded areas. ❑ Sodded areas are mowed once established.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Erosion Prevention Practices (EPPs)

EPP-08

Activity: Surface Roughening (SR)



SR

PLANNING CONSIDERATIONS:

Design Life:
1 yr

Acreage Needed:
Minimal

Estimated Unit Cost:
Medium

Monthly Maintenance:
10% of Installation

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

This BMP corrects the affects of runoff velocities, sediment trapping and sheet flow length by constructing small furrows across a slope, and utilizing construction equipment to track soil surface. The primary function of surface roughening is to temporarily stabilize a slope until it can receive permanent vegetation.

Suitable Applications

- All exposed construction slopes.
- Exposed soils where seeding, planting, and mulching will benefit from surface roughening.
- Areas that have the potential for erosion of clay (smooth, hard surfaces), silt or sand sized particles.

Approach

Roughening methods include:

- Terracing, (see EPP-13)
- Fill Slope Roughening
- Grooving
- Roughening with tracked machinery

Factors to be considered in choosing a method are

- Slope steepness
- Mowing requirements
- Soil type

Activity: Surface Roughening	EPP-08

Installation Procedures

Fill Slope Roughening

- Place fill slopes with a gradient steeper than 3:1 (H:V) in lifts not to exceed 8 in., and make sure each lift is properly compacted.
- The face of the slope should consist of loose, uncompacted fill 4 in. to 6 in. deep.
- Use grooving, furrowing, or tracking to roughen the face of the slopes, if necessary.
- Apply seed, fertilizer and mulch then track or punch in the mulch. See Permanent Seeding (EPP-06), Temporary Seeding (EPP-05), and Mulching (EPP-10) BMPs.
- Do not blade or scrape the final slope face.

Grooving - Cuts, Fills, and Graded Areas

- Slopes that will be maintained by mowing should be no steeper than 3:1 (H:V).
- To roughen these areas, create shallow grooves by normal tilling, disking, harrowing, or use a cultipacker-seeder. Make the final pass of any such tillage on the contour.
- Make grooves formed by such implements close together, less than 10 in. apart and 3 in. deep.
- Excessive roughness is undesirable where mowing is planned.
- Practice should be used on slopes no longer than 200 feet.

Furrowing

- Slope no greater than 3:1 (H:V)
- Use equipment to cut a 6" deep furrow while placing cut material below furrow
- Cut furrows along the contour and at a minimum spacing of 50'.
- Practice should not be used on slope longer than 200 feet.

Roughening with Tracked Machinery

- Limit roughening with tracked machinery to soils with a sandy textural component to avoid undue compaction of the soil surface.
- Operate tracked machinery up and down the slope to leave horizontal depressions in the soil, running with the contours of the slope. Do not back blade during the final grading operation.
- Seed and mulch roughened areas to obtain optimum seed germination and growth.

Maintenance

- Periodically check the seeded or planted slopes for rills and washes, particularly after significant storm events, greater than 0.5 in.
- Fill these areas slightly above the original grade, then reseed and mulch as soon as possible.

Inspection Checklist

- ☐ Surface roughened areas inspected after recent wet weather events.
- ☐ Rills and washed areas have been re-roughened and re-seeded.
- ☐ Practice is maintained and properly functioning; other practices are not required.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Erosion Prevention Practices (EPPs)

EPP-09

Activity: Top Soiling (TS)

TS

PLANNING CONSIDERATIONS:

Design Life:
Permanent

Acreage Needed:
Varies

Estimated Unit Cost:
Medium

Monthly Maintenance:
10% of Capital Cost

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◇

Sediment ♦ Heavy Metals ♦ Nutrients ♦ Oxygen Demanding Substances ♦ Toxic Materials ◇
Oil& Grease ♦ Bacteria & Viruses ◇ Floatable Materials ◈ Construction Waste ◇

Description

Topsoil is used to enhance the final product of a construction site area. This act is done to support temporary and permanent seeding, as well as aiding in erosion control methods. By implementing this BMP, a reduction in construction waste and some reduction in sediment will occur.

Suitable Applications

- Where construction activities expose subsoil layers that may not be able to support vegetative growth.
- Areas where reusing and preserving topsoil increases the success rate of new vegetation.

Approach

- Compost used on site as a recycled aspect of construction clearing.
- Verify proper placement of down slope sediment control practices prior to removing topsoil.
- Strip topsoil only from those areas that will be disturbed by excavation, filling, road building, or compaction by equipment. Normally, 4 to 6 inches are stripped for topsoil use.
- Position topsoil stockpiles where they will not erode, block drainage, or interfere with site work.
- Before topsoil is applied to the site, disk the subsoil to insure topsoil bonding. Apply a minimum of 4 inches of topsoil evenly.
- If site is excavated down to rock, such as sandstone or shale, 8 to 12 inches of topsoil is recommended for good plant growth.

Activity: Top Soiling	EPP-09

Installation Procedures	➢	Strip topsoil 4 to 6 in. from areas to be disturbed by excavation, filling, road building or compaction by equipment and preserve for later use.
	➢	Disk the subsoil to insure topsoil bonding before applying to site. Applying a minimum of 4 in. of topsoil evenly.
	➢	Apply seeding & mulch or sod after final grading.
Maintenance	➢	Maintain areas where vegetation has been re-established to remedy erosion and damage or vegetation failure by frequently checking the newly applied topsoil.
Inspection Checklist	❑	Effective management practices such as netting, temporary seeding, mulch and other traditional methods are used to ensure correct storage of the soil. If these practices are not available, other equivalent practices are to be enforced.
	❑	Appropriate layer of topsoil has been established.
	❑	Storage piles do not interfere with site drainage.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Erosion Prevention Practices (EPPs)

EPP-10

Activity: Mulching (M)

PLANNING CONSIDERATIONS:

Design Life:
6-12 Months

Acreage Needed:
None

Estimated Unit Cost:
Low

Monthly Maintenance:
60% of Installation

M M M
M M

M

Target Pollutants

Significant ♦	Partial ◈	Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◈ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

To secure temporary or permanently seeded areas, mulching is used as a stabilizer. There are several types of mulches to be utilized, some of which include organic materials, straw, wood chips, and bark or other wood fibers. This management practice has the possibility to significantly reduce sediment and partial reduction of nutrients.

Suitable Applications

- Temporary stabilization of freshly seeded and planted areas, sometimes during periods of unsuitable vegetative growth.
- Temporary stabilization of areas that cannot be seeded or planted (e.g., insufficient rain, steep slope, non-growth season).
- Areas which have been permanently seeded to assist in retaining moisture, and to hold seeding.
- On areas to increase the survival of temporary and/or permanent vegetative cover.
- As short term, non-vegetative ground cover on steepened slopes to reduce rainfall impact, decrease the velocity of sheet flow, and settle out sediment.
- As ground cover around established plants, such as trees or shrubs, and on unprotected flat to minor slopes.
- Apply to planting areas where slopes are 2.5:1 (H:V) or less steep. Tacking agents or devices may be necessary for steeper slopes.
- Areas where climatic conditions require soil moisture retention aid to avoid cracking.

Approach

The term “mulch” is commonly used to describe a variety of materials, such as:

- Shredded tree bark and other woody materials, to protect trees and shrubs.
- Straw or hay, scattered across a slope or disturbed area.
- Peat mulch, used in planting trees and shrubs.

Table EPP-10-01 has a recommended application rate for various types of mulches.

Approach (cont'd)

Vegetative Fibers (Straw)

Loose hay or straw are the most common mulch materials used in conjunction with direct seeding of soil. Straw mulch is preferable over hay mulch, which may contain weeds and other objectionable material. Straw mulch is the short-term protection most commonly used with seeding. Wheat or oat straw is recommended from the current season's crop (less than 12 months old). Average fiber length should exceed 6 in.

Straw mulch is applied immediately after seeding, whether by machine or by hand distribution. Anchor the mulch in place using a tacking agent, plastic netting, or punching into the soil mechanically. Plastic netting requires wire staples, wooden stakes, or plastic stakes. If the slopes are too steep for netting, then tacking agents should be selected on the basis of longevity and the ability to hold the fibers in place.

<u>Anchoring</u>

- Crimping, tracking, disking, or punching into soil
  - Small areas - Hand punch mulch 2-3 inches into the loose soil.
  - Larger areas – Use mulching tool on tractor to punch and anchor mulch 2-8 inches into the soil.
  - Tracking – Cut straw into soil by using a bulldozer with cleated tracks, placed such that the cleat marks are perpendicular to the runoff.
  - Typically used on slopes 3:1 or flatter for safe operation of equipment.

- Covering with netting or mat
  - Nettings or biodegradable paper, plastic or cotton netting can be used to cover straw mulch. The safety of animals (small birds, snakes and other wildlife) should be considered when selecting materials for this measure.

- Spraying tackifiers (Polymer or Organic)
  - Polymer tackifiers are typically applied at a rate of 40-60 lbs/acre, or per manufacturer's recommendations.
  - Organic tackifiers are typically applied at a rate of 80-120 lbs/acre, or per manufacturer's recommendations.

- Cellulose fiber mulch
  - Can be tacked at a rate of 750 lbs/acre

Shredded Vegetation

"Green" mulch is produced by recycling of vegetation trimmings such as grass, shrubs, and trees. Methods of application are generally by hand, although pneumatic methods are currently being developed. It can be used as a temporary ground cover with or without seeding. The green mulch in place with a tacking agent on steep slopes and in areas where overland sheet flow is anticipated. The quality of green mulch may vary, and there is a strong potential for establishing unwanted weeds and plants.

Approach (cont'd)

Wood and Bark Chips

Wood and bark chips are suitable for landscaped areas that will not be closely mowed. Wood and bark chips may require nitrogen treatment to prevent nutrient deficiency. Bark chips do not require additional nitrogen fertilizer.

If there is a wood source near the project site, wood and bark chips can be very inexpensive. Caution must be used on steep slopes, since both wood and bark chips tend to wash down slopes exceeding 6 percent. Wood and bark chips are also used around trees and shrubs, or in ornamental or landscape gardens. A typical rate for placing wood and bark chip mulch is 6 tons per acre, at a depth of 2-3 inches.

Hydraulic Mulch

Hydraulic mulch can be made from virgin wood fibers or from recycled waste paper sources (newsprint, magazine). There are also mulches available which are a combination. In general, virgin wood fibers contain a longer fiber length than recycled paper mulch.

Hydraulic mulch is mixed in a hydraulic application machine (such as a hydroseeder or a mulch blower) and then applied as liquid slurry. The hydroseeder slurry contains recommended rates of seed and fertilizer for the site, usually specified with a tacking agent. Slurry must be constantly agitated to keep the proper application rate and achieve uniform effective coverage.

Table EPP-10-01
Recommended Rates for Mulching Materials

Mulch Product	Application Rate
Straw or Hay	1 ½ tons per acre
Wood Chips, Bark, Sawdust	5 - 8 tons per acre
Hydraulic mulches and soil binders	1 ½ - 2 tons per acre

Maintenance

- Must be inspected weekly and after rain for damage or deterioration.
- Inspect after episodes of high winds.
- Maintain an unbroken, temporary mulched ground cover throughout the period of construction that the soils are not being reworked. Inspect before expected rainstorms and repair any damaged ground cover and re-mulch exposed areas of bare soil.

Inspection Checklist

- ❑ All disturbed areas are properly covered per plans and specifications.
- ❑ Straw mulch has been properly crimped.
- ❑ Mulch has been replaced following intense wet weather events or episodes of high winds.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Erosion Prevention Practices (EPPs)

EPP-11

Activity: Nets and Mats (N and M)

N

M

PLANNING CONSIDERATIONS:

Design Life:
1 yr

Acreage Needed:
None

Estimated Unit Cost:
Low

Monthly Maintenance:
60% of Installation

Target Pollutants

Significant ♦ Partial ◊ Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

The security measures ensured by a protective blanket or soil stabilization mat to help prevent and reduce erosion on preceding shaped and seeded swales, channels and slopes while assisting in the establishment of temporary or permanent vegetation on steep slopes, channels, or stream banks. The implementation of this BMP will create a significant reduction in sediment.

Suitable Applications

- Preventing erosion of the soil surface.
- Promoting seed germination.
- Protecting young vegetation
- Preventing wind dispersal of seed or mulch
- Allowing for easy installation of seed and/or mulch.

Approach

Selection of an appropriate mat or blanket depends on the nature of the project. Manufacturers should be consulted in selecting the product for the intended purpose.

<u>Temporary Erosion Control Blankets</u>
Temporary erosion control blankets include the following options:

- plastic netting intertwined with a natural organic or manmade mulch
- jute mesh

- Typically used to stabilize concentrated flow areas where velocities meet or exceed 5 ft/sec and slopes 2.5:1 or steeper.
- Deteriorate in a short period of time
- Provide protection of the seed and soil from raindrop impact and subsequent soil displacement.
- Thermal consistency and moisture retention for seed.
- Accelerates germination of grasses and legumes more completely

Approach (cont'd)

Permanent Erosion Control Matting

Consist of permanent, non-degradable, three-dimensional plastic structures that are filled with soil prior to planting.

- Typically used to stabilize concentrated flow areas where velocities are between 5 and 10 ft/sec.
- Linings should be designed and selected by a professional experienced in the use of these materials
- Provides the same benefits as erosion control blankets.
- Protects channels from erosion within high capacity storm water conveyance channels.
- Filters fine sediment during lower flow stormwater events.

Installation Procedures

Always follow the manufacturer's recommendations for orientation, overlapping, entrenching, and securing blankets and mats.

Temporary Blankets

Some of the pertinent characteristics required in some machine produced temporary blankets are found in Table EPP-11-01

Table EPP-11-01
Temporary Blanket Characteristics

Blanket	Materials	Mesh	Minimum Thickness	Minimum Dry Weight
Straw	weed-free straw from agricultural crops	5/16" x 5/16"	3/8"	0.5 lbs/sy
Excelsior	curled wood excelsior (80% fibers are six inches or longer)	1 1/2" x 3"	1/4"	0.8 lbs/sy
Coconut Fiber	100% coconut fiber	5/8" x 5/8"	1/4"	0.5 lbs/sy
Wood Fiber	reprocessed wood fibers	5/8" x 3/4"	N/A	0.35 lbs/sy
Jute Mesh	woven root fiber or yarn	N/A	N/A	1 lbs/sy

All blankets should have a minimum width of 48 inches.

- Blankets are typically installed vertically from top to bottom of slopes.
- Trim blankets as needed to optimize coverage.
- In areas of concentrated flows, such as the bottom of a ditch, orient blanket in the same direction of the flow.
- Entrench blanket at the top and bottom of the slope.
- Overlap vertical joints at least 3 inches.
- Staples should be used to anchor blankets. Do not use stakes.

Installation Procedures (cont'd)

Permanent Matting

- Consists of webs, nettings, monofilaments or fibers that are entangled to form a strong and dimensionally stable matrix.
- Maintain shape before, during and after installation.
- Resistant to ultraviolet degradation
- Inert to chemicals in a natural soil environment.
- Begin installing permanent matting in storm conveyances at the bottom of the slopes and progress upstream.
- Staples or stakes can be used to anchor mats.

Maintenance

- Inspect erosion control matting before (if anticipated) and within 24 hours following rainfall events to check for movement of topsoil, mulch or erosion. Continue checking until vegetation is firmly established.
- Inspect blankets or mats at least every 14 days.
- Repair or replace netting that has been washed out, broken, eroded, and/or needing surface repair, re-seeding, re-sodding, re-mulching or topsoil replacement.

Inspection Checklist

- [ ] Channel grades are adequately managing runoff velocity.
- [ ] Staples are appropriately spaced to avoid loss of seed, topsoil and mulch to stormwater runoff and winds.
- [ ] Nets are adequately covered or anchored to prevent erosion, washout, and poor plant establishment.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Erosion Prevention Practices (EPPs)

EPP-12

Activity: Geotextiles (G)

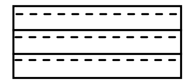
PLANNING CONSIDERATIONS:

Design Life:
N/A

Acreage Needed:
None

Estimated Unit Cost:
Low

Monthly Maintenance:
N/A



G

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

Geotextiles are woven or non-woven fabrics, applied between surfaces or materials, to reduce flow velocities, release runoff as sheet flow, remove some sediment from runoff and are likely to create a significant reduction in sediment. Runoff and pollution caused by construction activities can be prevented or reduced with this BMP.

Suitable Applications

- Construction sites desiring stability for disturbed soils.
- Sloppy area where anchoring must take place.
- Slopes steeper than 3:1 (H:V) and/or where erosion hazard is high.
- Slow growing vegetated areas.
- Critical slopes adjacent to sensitive areas (streams, wetlands, etc.).

Approach

Geotextiles provide stabilization, filtration, and separation properties. This BMP may be used when there is a need for separation between two materials or mediums that are likely to otherwise interfere with one another.

- Separating subsoil from aggregate within a subsurface drain.
- Separating subsoil from aggregate placed at the soil surface.
- Stabilization of soil surface during temporary stream diversion.
- Prevent buildup of hydrostatic pressure behind gabions, decorative, or retaining walls.

This BMP does not require design or selection by a professional experienced in geotextile applications. However, if hydrostatic pressure becomes a concern for stability of a retaining wall, then a professional should be consulted.

Geotextiles should be selected based on the standard specifications detailed in AASHTO M288.

Activity: Geotextiles	EPP-12

Installation Procedures	Geotextiles should be non-toxic to vegetation, and inert to soil chemicals. The materials selected should meet or exceed requirements of strength, resistance to distortion, permittivity, and resistance to ultraviolet degradation. Geotextiles should be installed according to the specifications of the manufacturer. ➢ Site preparation should include removal of rocks, clods, debris greater than 1" and any voids. ➢ The material should be loosely placed with no wrinkles, folds or distortions. ➢ The fabric should be in direct contact with the soil. ➢ Overlap sheets by placing the next consecutive sheet upstream on top of the downstream sheet. ➢ Fabric my require field joining with stakes or staples. ➢ Do not dump aggregate onto fabric from height greater than five feet. Aggregate should be placed to prevent damage. ➢ Damaged section may be repaired by placing a piece that overlaps the damaged area by at least 1 foot.
Maintenance	➢ Inspection to occur periodically, if any portion of the material is damaged, immediate correction is required. ➢ Inspections may occur prior to any anticipated wet weather events. ➢ Inspection to occur after significant rain storms to check for erosion and undermining. ➢ Repairs to the slope and re-installation should occur as a result of wash-out or breakage. ➢ Perform maintenance as required by the manufacturer.
Inspection Checklist	❑ Site is adequately prepared (grading or shaping, rocks, vegetation and debris removal, etc.). ❑ Seeding meets geotextile requirements. ❑ Anchoring is established at an acceptable depth. ❑ Anchoring trenches are used at the top and bottom of slopes. ❑ Trenches start, join and terminate geotextiles placed in channels. ❑ Soil filling is even and flat.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Erosion Prevention Practices (EPPs)

EPP-13

Activity: Terracing (T)

PLANNING CONSIDERATIONS:

Design Life:
Permanent

Acreage Needed:
As Required

Estimated Unit Cost:
Medium

Monthly Maintenance:
N/A

T

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

This BMP is likely to reduce sediment by creating small areas to establish vegetation to reduce runoff velocity, increase infiltration and trap sediment. This reduces the amount of sediment leaving a site.

Suitable Applications

- Cleared areas prior to temporary or permanent seeding and planting or erodible slopes steeper than 3:1 (H:V) and higher than 5 feet.
- Graded areas with smooth, hard surfaces.
- Areas where slopes need to be shortened. Adequate drainage and stabilized outlets must be a part of the design and should follow the guidelines of a licensed professional civil engineer based on site conditions.

Approach

Slope roughening/terracing is performed in several ways:

- Stair-step grading
- EPP-08
- Rough grading
- No grading

On slope 3:1 (H:V) the following practices found in EPP-08 can be considered:

- Grooving
- Furrowing
- Tracking

Installation Procedures

Graded areas with smooth, hard surfaces give a false impression of "finished grading" and a job "well done". It is difficult to establish vegetation on such surfaces due to reduced water infiltration and the potential for erosion. Rough slope surfaces with uneven soil and rocks left in place may appear unattractive or unfinished at first, but they encourage water infiltration, speed the establishment of vegetation, and decrease runoff velocity. Rough, loose soil surfaces give lime, fertilizer, and seed some natural coverage. Niches in the surface provide microclimates which generally provide a more favorable moisture level that aids seed germination.

There are different methods for achieving a roughened soil surface on a slope, and the selection of an appropriate method depends upon the type of slope. Roughening methods include stair-step grading, grooving, and tracking. Factors to be considered in choosing a method are slope steepness, mowing requirements, and whether the slope is formed by cutting or filling.

1. Disturbed areas which will not require mowing may be stair-step graded, grooved, or left rough after filling.
2. Graded areas steeper than 3:1 (H:V) should be stair-stepped with benches. The stair-stepping will help vegetation become attached and also trap soil eroded from the slopes above. Stair-step grading is particularly appropriate in soils containing large amounts of soft rock. Each "step" catches material which sloughs from above, and provides a level site where vegetation can become established. Stairs should be wide enough to work with standard earth moving equipment.
3. Make the vertical cut distance less than the horizontal distance, and slightly slope the horizontal position of the step in towards the slope.
4. Do not make individual vertical cuts more than 24 in. (600 mm) high in soft materials or more than 3 ft. (1 m) high in rocky materials.
5. Groove the slope using machinery to create a series of ridges and depressions that run across the slope and on the contour.

Fill Slope Roughening

- Place fill slopes with a gradient steeper than 3:1 (H:V) in lifts not to exceed 8 in. (200 mm), and make sure each lift is properly compacted.
- Ensure that the face of the slope consists of loose, uncompacted fill 4 in. (100 mm) to 6 in. (150 mm). This is not to be confused with proper compaction necessary for slope stabilization.
- Use grooving or tracking to roughen the face of the slopes, if necessary.
- Apply seed, fertilizer, and mulch and then track or crimp in the mulch. See EPP-05, EPP-06: Temporary Seeding and Temporary Mulching, respectively.
- Do not blade or scrape the final slope face.

Cuts, Fills, and Graded Areas

- Slopes that will be maintained by mowing should be no steeper than 3:1 (H:V).
- To roughen these areas, create shallow grooves by normal tilling, disking, harrowing, or use a mechanical seeder. Make the final pass of any such tillage on the contour.
- Make grooves formed by such implements close together, less than 10 in. (250 mm), and not less than 1 in. (25 mm) deep.
- Excessive roughness is undesirable where mowing is planned.

Maintenance	➢	Periodically check the seeded or planted slopes for rills and washes, particularly after significant storm events greater than 0.5 in. (12 mm). Fill these areas slightly above the original grade, then re-seed and mulch as soon as possible.
	➢	Inspect roughened slopes weekly and after rainfall for excessive erosion.
Inspection Checklist	❑	Furrows at least 6 in. deep.
	❑	Furrows are spaced no more than 50 ft. apart.
	❑	Horizontal distance is greater than vertical distance on stepped slopes.
	❑	Stepped slopes or terraced slopes cut so that they drain in on themselves.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Sediment Management Practices (SMPs)

SMP-01

Activity: Check Dams (CD)

CD

PLANNING CONSIDERATIONS:

Design Life:
6 – 12 months

Acreage Needed:
Minimal

Estimated Unit Cost:
Low

Monthly Maintenance:
30-40% of Installation

Target Pollutants

Significant ♦	Partial ◊	Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

Check dam are use to reduce the velocity of concentrated stormwater flows, small temporary constructions are built across swale or drainage ditch. Check dams reduce erosion and promotes sedimentation within the ditch line.

Suitable Applications

- Check dams are <u>not</u> to be used in streams and rivers. However, should be used in swales or ditch lines.
- Check dams are a temporary or permanent means of protection against erosion during the establishment of vegetative lining.
- Installation of erosion-resistant lining is not practical to use for short length of service for temporary ditches or channels.

Approach

- Stone Check Dams (CD-S)

A stone check dam is intended to be used on a small drainage areas (up to one (1) acre or less). These dams are constructed with large aggregate (#1 or #2 stone with a minimum size of 1.5").

- Rock Check Dam (CD-R)

Rock check dams are intended for larger drainage areas than the stone check dams (areas up to 5 Acres or less). Rock check dams utilize small rip-rap such as KTC Channel Lining Class III. Smaller rock should be used on the upstream side to reduce the velocity of flow through the device. Attention should be given to placement of rock as to minimize large void areas

- Sandbag Check Dams (CD-SB)

Sandbags with sand or aggregate fill may be used to perform the function of a check dam. The placement of bags should be staggered as to provide stability.

Design Criteria

The following design criteria should be used:

- Drainage Areas: Stone check dam (1 acre or less), Rock check dam (5 acres or less)
- Spacing: Two or more check dams should be used for areas greater than one acre. The maximum spacing should be determined by keeping the toe of the upstream dam equal to the spill over elevation of the downstream dam (See Table SMP-01-01 or attached nomograph).
- Dimensions: All check dams should be 24" or less in height. The overflow point should be at least 6" lower than the outer edges. Front and back slopes shall be 2:1. The designer should take into consideration potential impacts due to impounded water (see Detail SMP-01).
- Key-in: Rock check dams should utilized a 6" key-in techniques to aid in stabilization during peak flows.

Table SMP-01-01
Spacing for Silt Check Dams

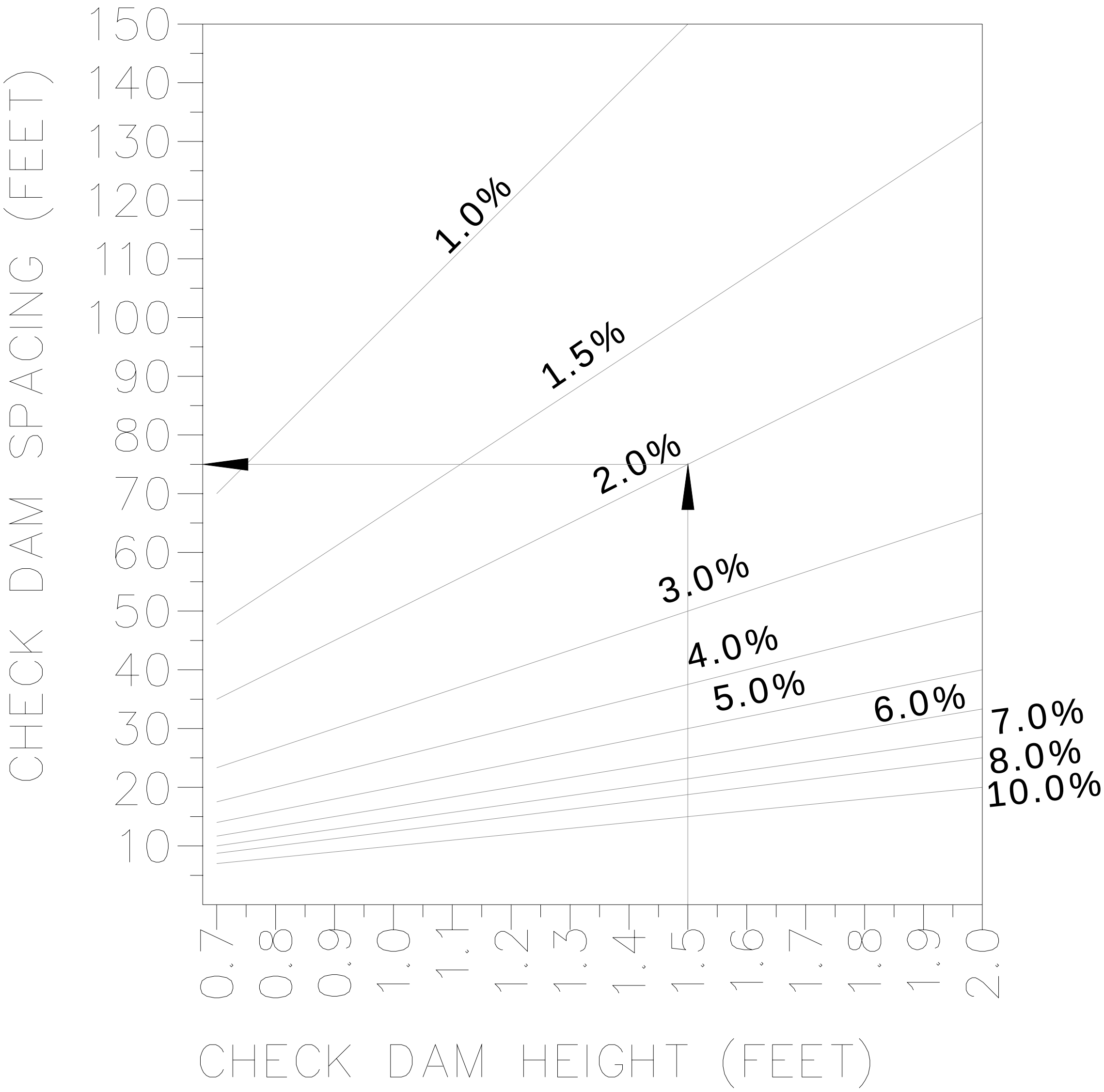
Ditch slope	Silt check dam spacing	Additional information
30%	10 ft.	Calculated for 3' high silt check dams. Center of dam should be 6" lower than sides Use 5" – 10" rock, stone bags, or commercial products.
20%	15 ft.	
15%	20 ft.	
10%	35 ft.	
5%	55 ft.	
3%	100 ft.	
2%	150 ft.	
1%	300 ft.	
0.5%	600 ft.	

Table SMP-01-02
Rock Sizing for Ditch Liners

Flow Velocity	Average Rock Diameter
6 ft. per second	5 inches
8 ft. per second	10 inches
10 ft. per second	14 inches
12 ft. per second	20 inches

Activity: Check Dams	SMP-01

Installation Procedures	Installation procedure is as follows: ➢ Excavate key-way (if required). ➢ Place geotextile (if required). ➢ Place check dam material to specified dimensions/elevations. ➢ A sump may be provided immediately upstream of the check dam to capture sediment. ➢ If grass is planted to stabilize the ditch or swale, the check dam should be removed when vegetation is stabilized.
Maintenance	➢ Sediment shall be removed before it reached one-half of the devices original height. ➢ Any lose or displaced stone should be repaired to the original specifications.
Inspection Checklist	❑ Stone meets specified sizes. ❑ Check dam spans the entire width of the channel. ❑ Dimensions/elevations are as specified. ❑ Filter fabric on upstream face is keyed into the bed (if applicable). ❑ Check dams are to be removed when vegetation is stabilized. ❑ Sediment is maintained less than one-half of the original height. ❑ Sites with rain accumulation of 0.5” should be checked within 24 hours.



NOMOGRAPH PROCEDURE

1. DRAW LINE VERTICALLY FROM HEIGHT VALUE ON "X" AXIS UPWARD UNTIL IT INTERSECTS DIAGONAL DITCH GRADE LINE AT THE APPROPRIATE GRADE VALUE.
2. FROM THE POINT OF INTERSECTION WITH GRADE LINE, DRAW LINE HORIZONTALLY UNTIL THE LINE INTERSECTS WITH "Y" AXIS (SPACING).
3. DETERMINE SPACING VALUE.

EXAMPLE

GIVEN: CHECK DAM HEIGHT = 18" (1.5')
DITCH GRADE = 2%

SOLUTION: CHECK DAM SPACING = 75 FEET

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Sediment Management Practices (SMPs)

SMP-02

Activity: Silt Fence (SF)

SF

PLANNING CONSIDERATIONS:

Design Life:
6 months

Acreage Needed:
Minimal

Estimated Unit Cost:
Low

Monthly Maintenance:
100% of Installation

Target Pollutants

Significant ♦	Partial ◊	Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

To detain sediment-laden water, silt fences are used to promote silt deposition behind the fence. These fences are made of filter fabric that has been entrenched, attached to support poles and occasionally supported by a wire fence. Silt fence is intended as a temporary sediment barrier and requires routine maintenance

Suitable Applications

- Silt fence should be used in area accepting sheet flow conditions.
- Silt fence should not be used in ditch lines, streams, or other areas of concentrated flows.
- Silt fencing can be used along the downstream perimeter, below the toe of a cleared slope, upstream of sediment traps or basins, along streams and channels and around temporary spoil areas.

Approach

- Light Duty Silt Fence (SF-LD)
  Type A silt fence is 36" in height. This type silt fence can be used on project lasting 6 months or greater.

- Heavy Duty Silt Fence (SF-HD)
  Type C silt fence is 36" in height and has wire reinforcement. This type silt fence should be used when high velocities are encountered. Table SPD-02-01 on pg. SMP-02-02.

Design Criteria

The design criteria for silt fence is as follows:

- Silt fencing should be installed along the contour. It should not be installed up and down slopes unless accompanied by measures such as "J" Hooks or other methods.
- The length of silt fence is determined by the amount of run-off area. The minimum area should not exceed 0.25 acre per 100 linear feet of silt fence.
- Spacing of silt fence is variable depending on the slope of land draining to the fence. See Table SMP-02-01 for spacing requirements.

Table SMP-02-01
Silt Fence Spacing on Sloping Sites

	Soil Type		
Slope Angle	Silty	Clays	Sandy
Very Steep (1:1)	50 ft.	75 ft.	100 ft.
Steep (2:1)	75 ft.	100 ft.	125 ft.
Moderate (4:1)	100 ft.	125 ft.	150 ft.
Slight (10:1)	125 ft.	150 ft.	200 ft.

Installation Procedures

Silt fence installation procedure is as follows:

- Secure suitable fence materials meeting requirement set herein.
- Stake or mark silt fence location.
- Trench (6" by 6") along proposed location.
- Place fence in the trench (most fence products have a colored line indicating the depth of burial). Drive post with spacing as specified by silt fence type. Attach fence material to post as specified.
- Backfill and compact trench anchoring fence material.
- When required fence splicing should be conducted as be the method contained herein.
- Silt fence should turn up hill six feet at ends (at least 1 foot raise in elevation).

Maintenance

- Inspect after every rainfall.
- Repair/replace fence when damaged or deteriorated.
- Sediment height not to exceed one-half the height of the fence.
- Perform required maintenance before a storm event.
- Remove fence when vegetation is established.

Inspection Checklist

- ❑ Silt fence has proper placement.
- ❑ The last 6 feet of the silt fence is turned uphill and secured to the post.
- ❑ Color band of the anchor trench is not visible.
- ❑ Accumulated sediment does not exceed one half the height of the fence.
- ❑ If washaround or underwash occurs then fence should be reset.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Sediment Management Practices (SMPs)

Activity: Brush or Rock Filters (F-B or F-R)

SMP-03

PLANNING CONSIDERATIONS:

Design Life:
Permanent

Acreage Needed:
Minimal

Estimated Unit Cost:
Medium

Monthly Maintenance:
Low

CB

CB

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

Filters, brush and berms are used to dissipate sediment in construction runoff by anchoring rock deposits, roles of fabric and/or brush barriers. These barriers are constructed of rocks ¾ to 5 inches in diameter that make up a berm to be placed along a contour. Brush wrapped in filter cloth and anchored to the toe of the slope creates a brush barrier, which acts as another trapping method. Additionally, a continuous role of fabric that captures sand, rock or native soil is an example of one more method to capture sediment.
This BMP is used for sediment trapping and velocity reduction that will aid in significantly reducing sediment.

Suitable Applications

- Rock filters should be applied near the toe of the slope, along the site perimeter, stream channels, spoil areas, small cleared areas, sediment traps
- Rock filters may also be used as check dams and with temporary roads

Approach

A filter berm can often be constructed from natural materials, such as brush or rocks. This is generally an efficient operation for the site contractor if these materials are already present on the project site, both timewise and in terms of installation cost. Brush and rock filter berms can also be installed with a geotextile fabric to increase sediment removal filtration and the overall stability of the berm. Wire netting (such as poultry fencing) can also be used to increase the stability for brush or rock berms. Gabions and other wire mattresses can also be used as a rock filter for erosion control.

Activity: Brush or Rock Filters and Continuous Berms	SMP-03

Approach (Continued)

Both types of filter berms are placed along a level contour. Common applications are along the edge of a gravel roadway or 5 to 7 feet beyond the toe of a slope, where overland sheet flow can be detained and ponded. Brush or rock filter berms slow the velocity of overland runoff, allowing sediment to settle out or become trapped in the filter. In this manner, the brush and rock filter berms are very similar in function to SMP-01, Check Dams, except that filter berms handle overland sheet flow and check dams handle stormwater runoff channels.

Brush and rock filter berms both contain materials (dirt, leaves, dust, silt) which could potentially cause more pollution than they might remove. These measures should be constructed and managed carefully in order to become effective BMPs. A silt fence or straw bale barrier may be needed as a secondary measure to control dirt and leaves.

➢ Brush Filter (F-B)

A brush filter berm is composed of brush, small tree limbs, rootmat, grass and leaves, or other material which is commonly generated as waste during the clearing and grubbing stage. The brush filter berm is constructed by piling these materials into a continuous and compacted mound along a level contour which is downhill from a disturbed area. Large logs or tree stumps should generally be avoided as part of the brush filter berm; they cause large voids or gaps in the berm and so defeat the purpose of detaining stormwater. However, large logs by themselves can be used to slow stormwater runoff in wooded areas, along paths and trails, or at the bottom of slopes.

A brush filter berm height of approximately 3 feet is recommended to slow or detain stormwater. The minimum height of 2 feet may be used for short slopes less than 100 feet long. A corresponding width is generally 5 to 10 feet, with a shape that can either be triangular or somewhat rounded. Standard dozers or other grading equipment are used to compact and shape the brush filter berm to be more dense. Use rope or sturdy string to shape the brush filter berm and to hold it together.

A geotextile fabric can be used to increase the sediment retention or to provide a more stable brush filter berm. Install the filter fabric into a trench 6 inches deep immediately uphill from the formed berm. Then lay the filter fabric over the front face of the brush filter berm. Secure the filter fabric using staples, stakes, ropes or wires so that the fabric will not be uplifted by winds or storms. Overlap edges of filter fabric by 6 inches.

Brush filter berms are generally not used in developed areas or wherever aesthetics will be of concern. Brush filter berms may also be unpredictable in terms of performance. Since they are composed of natural materials, they may or may not need to be removed after the uphill sites are stabilized. Brush filter berms may provide a habitat for various types of desirable wildlife, or they could harbor pests and rodents in areas where these problems are known to exist.

➢ Rock Filter (F-R)

A rock filter berm can be created from natural gravel or rock at the project site, or from imported gravel and rock. It is placed and compacted along a level contour, where sheet flow may be detained and ponded to promote sedimentation. Some type of geotextile fabric or wire screen is recommended to keep the berm shape intact. A gabion or wire mattress may be used to construct a rock filter berm, provided that the gabion wire spacing is compatible with size of aggregate or rock.

Activity: Brush or Rock Filters and Continuous Berms	SMP-03

Approach (Continued)

Rock filter berms can be used along the downslope edge of roadways or 5 to 7 feet beyond the toe of a slope. Rock filter berms can also be incorporated as part of a gravel road and other type of unpaved traffic area, in order to prevent stormwater from flowing into paved roads.

Construct a rock filter berm by first placing larger rocks as a base. If available, smaller rocks or gravel are placed on the uphill side of the larger rocks to form a natural filter. Geotextile filter fabric can be underneath the rock filter berm itself, which would adequately anchor the fabric. For areas where concentrated flows may occur, use larger rock without any dust or fine material, placed in a gabion or other type of staked woven-wire mattress.

Installation Procedures

- Prepare location for placement of berm according to plan.
- Place berm material as specified.
- Reinforce as necessary based on material.

Maintenance

- Daily Inspection is required when installing in stream beds
- After each heavy rainfall inspect berms
- Maintain berms to guarantee proper utilization
- Inspect for sediment accumulation removing when depth reaches ¼ of berm height or 12 inches
- Remove berms upon completion of the project

Inspection Checklist

- ❑ Sufficient space for ponded water.
- ❑ Brush filters are performing.
- ❑ Drainage to structure does not exceed 5 acres.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Sediment Management Practices (SMPs)

SMP-04

Activity: Sediment Traps (ST)

ST

PLANNING CONSIDERATIONS:

Design Life:
1-1 ½ years

Acreage Needed:
Minimal

Estimated Unit Cost:
Low

Monthly Maintenance:
30% of Installation

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ♦ Construction Waste ◊

Description

The sediment trap is a control measure that detains sediment-laden runoff from small disturbed areas in an earthen embankment that will allow ponding long enough to allow the sediment to settle within the depression.

Suitable Applications

- Install detention areas below disturbed vicinities of less than 10 acres.
- Along the perimeter of the site at locations where sediment-laden runoff is discharged off-site or areas where runoff can enter stabilized areas or waterways.
- Temporary sediment traps shall **not** be used in live or continuously-flowing streams. Sediment traps may kill nearby vegetation by excessive sediment or by long periods of submergence.
- Temporary sediment traps only remove coarse particles which settle quickly. Sediment traps are not effective for fine-grained soils such as silt or clay. Additional upstream erosion control measures are necessary.

Approach

- Prepare sediment traps prior to beginning of construction.
- Traps are to be located in areas by hollowing out areas across swales or low embankments, places where damages are excluded and areas needing maintenance to reduce sediment accumulation.
- Create larger traps to include a greater amount of sediment buildup.
- After stabilization of the construction area, the sediment trap may be removed and stabilize area as needed with vegetation or other cover.

Activity: Sediment Traps

SMP-04

Design Criteria

- Volume

Minimum volume of a sediment trap shall be 67 cubic yards per acre for the total drainage area. The volume shall be measured at an elevation equivalent to the spillway invert.

Optimal design volume of sediment trap depends on type of soil, size and slope of drainage area, amount of land disturbance, desired sediment removal efficiency, and desired cleanout frequency. A recommended volume for temporary sediment trap in heavily disturbed areas is 134 cubic yards per acre, which equates to 1 inch of stormwater runoff. Optimal design of this type of sediment trap includes an upper zone of at least 67 cubic yards per acre (to be dewatered using one of the outlet design alternatives) and a lower wet zone for sediment storage and settling.

- Shape

The designer should attempt to plan a basin that has a minimum 3:1 length to width ratio.

- Slopes

Basin side slopes should be restricted to 4:1 or flatter. However, the permeable, filter, portion should have a maximum cross section of 2:1.

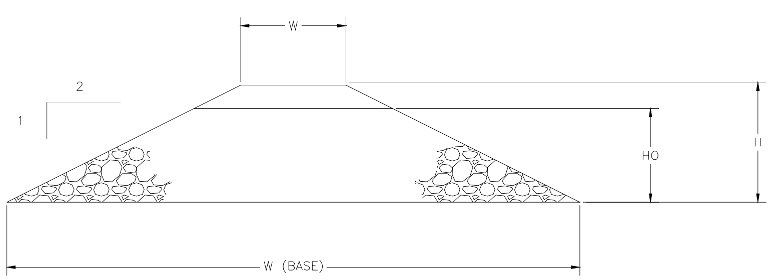
- Emergency Spillway

The emergency overflow outlet of the temporary sediment trap must be stabilized with rock, riprap, geotextile, vegetation or another suitable material which is resistant to erosion. A stable emergency spillway must be installed to safely convey stormwater runoff for the 10-year storm event.

An emergency overflow weir should be provided at an elevation of at least 1.5 feet below the top of embankment, with a minimum freeboard of 1 foot. The minimum bottom width of a trapezoidal section for an emergency overflow weir should be:

4 feet	-	1 acre (total drainage area)
6 feet	-	2 acres (total drainage area)
8 feet	-	3 acres (total drainage area)
10 feet	-	4 acres (total drainage area)
12 feet	-	5 acres (total drainage area)

*Drainage areas over 5 acres as designed



Sediment Trap Dimensions

H	*HO*	*W*	*W (BASE)*
2.0	1.0	5.0	9.0
2.5	1.0	5.5	10.5
3.0	1.5	6.0	12.0
3.5	2.0	6.5	13.5
4.0	2.5	7.0	15.0
4.5	3.0	7.5	16.5
5.0	3.5	8.0	18.0

Units: Feet

Installation Procedures

Contractors should construct temporary sediment traps near the beginning of a construction project, after establishing the perimeter erosion control measures and before any clearing or grading operations. This practice will be useful in the early stages of the construction process as it will negate the detrimental characteristics of grading, earthwork, trenching and other land-disturbing activities.

- Use perimeter erosion control measures in the vicinity adjacent to the sediment trap location. Areas under embankments should be cleared and grubbed. Grade and/or excavate to construct the required volume and to provide fill material for any embankments.

- Use clay for fill materials that is free of roots, large rocks, and organic material. Place fill and compact with a sheeps foot roller or other vibratory equipment in 6 inches layers.

- Install outlet structures such as rock outlet berm, or an emergency overflow weir. Prevent outlet failure by installing geotextile fabric and wire fencing. Baffles should be used to maximize storm water residence time within the sediment trap.

- Stabilize slopes using temporary vegetation, erosion control matting, mulch or other measures. Inspect final work for safety and function. Warning signs, barricades, perimeter fence or other measures necessary should be installed to protect construction workers and equipment.

Activity: Sediment Traps	SMP-04

Maintenance

- ➢ Inspect traps weekly and before and after heavy rainfall.
- ➢ Maintain traps to guarantee correct utilization.
- ➢ Remove sediment after it reaches $^1/_3$ the height of the trap.

Inspection Checklist

- ❑ Constructed traps serve 10 acres or less.
- ❑ Type of outlet structure used matches EPSC plan.
- ❑ Structure is stabilized to prevent erosion.
- ❑ Gage is visible and correctly indicates the depth of the trap.
- ❑ Sediment accumulation does not exceed $^1/_3$ the height of trap.
- ❑ Trap is constructed in such a way that no damage occurs to life or property.
- ❑ Trap is maintained

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Sediment Management Practices (SMPs)

SMP-05

Activity: Temporary Sediment/Detention Basin (DB)

PLANNING CONSIDERATIONS:

Design Life:
12-18 months

Acreage Needed:
Minimal

Estimated Unit Cost:
Medium

Monthly Maintenance:
30% of Installation

DB

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

Typically temporary sediment/detention basins require the construction of an embankment across the drainage path in order to create a pond to trap sediment and inhibit the potential of downstream flooding. Sediment basins are usually designed by a professionally licensed engineer.

Suitable Applications

- For disturbed areas between 5 to 10 acres. Areas greater than 10 acres will require a design by a licensed professional engineer.
- Collect and store sediment from areas that have been cleared in preparation for construction.
- Used in areas where sediment-laden runoff may enter waterways.
- Suitable for almost all construction projects.

Approach

- The sediment control basin should be designed by using SEDCAD, or another suitable computer program.
- The intent of this BMP is to trap sediment before it leaves the construction area.
- Provide a detention time of 24-48 hours for a 10-year 24-hour wet weather event.
- Provide a minimum storage capacity of 3600 cf per acre of bare soil.
- The ratio of basin flow length to flow width is 2:1.
- There are three components to the successful design of a sediment basin:
    - Embankment
    - Principal Spillway
    - Emergency Spillway

Approach (cont'd)

Embankment Recommendations

- Slopes of the embankments for a Class 1 basin shall not be steeper than 2:1 on the upstream side, and not steeper than 5:1 on the downstream side of the basin, in order to allow the area to be safely mowed and maintained. (See SMP-05-01).
- Slopes on either side of the embankment of Class 2 or 3 basins shall not be steeper than 2.5:1 for, in order to allow the area to be safely mowed and maintained. (See SMP-05-01).
- Provide for a minimum of 1-foot of freeboard for a 100-year 6-hour wet weather event.
- The minimum width at the top of the embankment is 12-inches.
- Stabilize the slope with vegetation or rip rap.

Principal Spillway Requirements

- Provide a subsurface drain or solid riser pipe with dewatering holes to allow sufficient detention time.
- The outlet pipe diameter shall be a minimum of 8-inches.
- The post construction peak flow shall exceed the pre-developed levels of the 2-year and 10-year 24-hour wet weather events.
- Install a trash rack and anti-vortex device on the riser pipe.
- Prepare a stabilized apron for the outlet pipe.

Emergency Spillway Requirements

- Emergency spillway shall be designed to pass a 100-year 6-hour wet weather event, to the top of the embankment.
- Provide a minimum of one foot of freeboard between the top of the riser pipe and the crest of the spillway.

Installation Procedures

- Construct this BMP prior to any clearing and grading on the construction site.
- Fill material for the embankment shall be free of roots, woody vegetation, oversized stones, rocks and other deleterious materials.
- Place fill material in 6 inch lifts with continuous layers extending the entire length fill, and compacted to 95 percent of maximum density and +/- 2 percent of optimum moisture content.
- Construction the embankment to a height 10% higher than the required crest elevation to allow for settlement if construction traffic (hauling in/out) is used to compact the soil. If compaction equipment is used, reduce the height to 5%.
- Weld the principal spillway pipe to the discharge pipe with a watertight connection.
- The principal spillway and discharge pipes shall be placed on a firm, smooth soil foundation. Pervious materials such as sand, gravel or crushed stone shall not be used as backfill around the pipes.

Activity: Temporary Sediment/Detention Basin	SMP-05

Installation Procedures (cont'd)

- Do not construct the emergency spillway in fill.
- Securely anchor and install anti-seep collar on the outlet pipe/riser for events larger than 2-year storm events.
- Stabilize the embankment with vegetation immediately following construction.
- Check with local ordinances and state requirements to ensure proper fencing and signage are placed, warning the public of potential sediment and flooding hazards.
- The basin's volume should capture at least a 2 year 24 hour storm.

Special Note

Any sediment basin may be required to meet the dam safety requirements and approval of the Kentucky Division of Water. The definition of a dam is any impounding structure that is 25-feet in height from downstream toe to crest, or has the capacity to impound up to 50 acre feet of water. Structures that do not meet these requirements but may have the same detrimental impact downstream are subject to similar criteria as the dams.

Maintenance

- Inspect weekly as well as before and after wet weather events.
- Repair all damages to and within the basin due to construction by the end of the work day.
- Maintain all aspects of the basin (outlet area, outlet structures, etc.).
- Remove sediment when storage is $^1/_2$ full.
- Ensure that all sediment removed from the basin will not erode from the site.
- Basin failure should not affect loss in life, property, roads, or utilities.

Inspection Checklist

- [ ] Structure has appropriate outlet design.
- [ ] Stabilized outlet prevents erosion.
- [ ] Sediment accumulation does not exceed $^1/_2$ depth of basin.
- [ ] Outlet is free of trash and deleterious materials that will clog the pipe and restrict flow.
- [ ] Trash rack and anti-vortex device on riser is free of debris and other deleterious materials that will clog and restrict flow.

Activity: Bank Stabilization (BS)

BS

PLANNING CONSIDERATIONS:

Design Life: Permanent

Acreage Needed: Minimal

Estimated Unit Cost: Medium

Monthly Maintenance: 50-70% of Installation

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◈ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

Bank stabilization is used to reduce erosion from stream banks by providing protective cover through the use of vegetation and other methods.

Suitable Applications

- Bank stabilization practices are used for stream banks susceptible to erosion, locations with high flow rate that are subject to produce erosion, and/or actively eroding stream banks.
- Due to the nature of these practices additional permitting through the state of other agencies may be required.
- Bank stabilization practices should be designed by a Professional Engineer licensed in the Commonwealth of Kentucky.

Approach

- Structural measures such as retaining walls, gabions, rip-rap or interlocking blocks.

Structural practices are used for projects in which a quick stabilization of stream banks is required. Generally speaking, these practices are more costly than bioengineer solutions. However, they usually require less maintenance than bioengineering measures.

- Bioengineering methods

Bioengineering methods are commonly used for this purpose,. These methods generally take longer to establish stabilization. However, they can be quite effective and economical to implement. As with any vegetative practice, careful selection of materials, installation, and maintenance is necessary to be effective.

Approach (Continued)

Several methods of Bioengineering solution are listed as follows:

- Live Stake

Live stakes are the insertion of live, rootable vegetative cuttings into the ground. Live stakes are an appropriate technique for repair of small earth slumps that are frequently wet. Or they can be used to supplement other types of bank stabilization plantings. Live stakes can also be installed through existing riprap or other aggregate materials, allowing a stabilized riprap location to eventually have natural vegetation.

Live stakes are usually 0.5 to 1.5 inches in diameter and approximately 2 to 3 feet in length. Typical spacing is 2 to 3 feet apart. The basal end (or root) is cut to an angled point for easy insertion. The top should be cut square. Willow branches have historically been specified for use as live stakes and are well-suited to the purpose. Other types of tree branches may be selected, depending on soil type and available moisture conditions, such as ash, alder, elm or dogwood.

Gently tamp the live stake into the ground at right angles to the slope. Approximately 80 percent of the live stake length should be installed into the ground. Pack soil firmly around live stake after installation. Do not split the stakes during installation; stakes that split should be removed and replaced. An iron bar can be helpful in establishing a pilot hole for the live stake.

- Live Fascine

A fascine is defined as a bundle of sticks or branches, tied together and used for a definite purpose such as preparing a primitive house, fort, or other structure. A live fascine is defined as a bundle containing live branch cuttings bound together into sausage-like structures, and then placed to provide slope stability or prevent erosion.

Live branch cuttings should be from species that easily root and have long, straight branches. Cuttings are tied together to form live fascine bundles that vary in length from 5 to 30 feet, depending on site conditions and limitations in handling. The completed bundles should be 6 to 8 inches in diameter, with all of the growing tips oriented in the same direction. Stagger the cuttings in the bundles so that tops are evenly distributed throughout the length of the uniformly sized live fascine.

Both live stakes and dead stakes are used to install fascine bundles. Stakes should be at least 2.5 feet long on cut slopes and at least 3 feet long on fill slopes. Dead stakes can be constructed from untreated 2x4 lumber with a minimum length of 2.5 feet. A diagonal cut across the 2x4 lumber will assist in creating stakes quickly.

Prepare the live fascine bundles and live stakes immediately before installation.
Begin at the base of the slope and work upwards. Dig a trench along a level contour just deep enough to contain the live fascine bundle. A typical trench size is 12 to 18 inches across and also 6 to 8 inches deep. Place the live fascine bundle into the trench.

Drive dead stakes directly through the bundle every 2 to 3 feet to securely fasten it. Extra stakes should be used at connections and overlaps. Leave the top of stakes flush with the installed bundle. Live stakes are generally installed on the downslope side of the bundle. Drive the live stakes below and against the bundle between the previously installed dead stout stakes. The live stakes should protrude 2 to 3 inches above the top of the live fascine. Place moist soil along the sides of the live fascine. The top of the fascine should be slightly visible when the installation is completed as shown in Figure SMP-06-01.

Approach (Continued)

Place straw or similar mulching material between rows. Slopes steeper than 3:1 may need erosion control matting or some type of mesh to prevent erosion. Recommended maximum slope lengths for live fascine bundles are:

Slope (H:V)	Maximum slope length
1 : 1 to 1.5 : 1	15 feet
1.5 : 1 to 2 : 1	20 feet
2 : 1 to 2.5 : 1	30 feet
2.5 : 1 to 3 : 1	40 feet
3 : 1 and flatter	50 feet

A willow mattress (also called a brush mattress) is similar to a fascine roll. Willow branches and cuttings are formed into a layered arrangement approximately 4 to 6 inches thick and then tied with twine or string. Excavate an anchor trench along the bottom of the willow mattress to a depth of 3 inches, to prevent downhill sliding. Loosen the subgrade soil throughout the mattress installation location; add lime and slow-release fertilizer as needed. A willow mattress is anchored onto a slope by using dead stout stakes and twine. Place 4 to 6 inches of fertile soil upon the willow mattress and tamp firmly.

- Branchpacking

Branchpacking consists of alternating layers of live branch cuttings and compacted backfill to create bank stabilization vegetation. It is often used to repair small localized slumps, gully washouts, or other small areas where the slope needs to be stabilized. Branchpacking can also be adapted as a method for planting an entire slope (see description below for brushlayering).

Live branch cuttings may range from 1/2 inch to 2 inches in diameter. Cuttings should be long enough to touch the undisturbed soil at the back of the trench. Wooden stakes (typically made from 2x4 lumber, untreated) are 5 feet or longer, depending on the depth of the hole and field conditions. Starting at the lowest point, drive the wooden stakes vertically 3 to 4 feet into the ground, at a typical spacing of 1 to 2 feet apart.

Place a 6-inch layer of live branch cuttings in the bottom of the hole or trench, between the vertical stakes and perpendicular to the slope face (as shown in Figure SMP-06-02). Cuttings should be placed in a crisscross configuration with the growing tips generally oriented toward the slope face. Most branch basal ends should touch the back of the hole or slope. Each layer of branches is followed by a layer of compacted soil, typically 6 to 8 inches thick, to ensure soil contact with the branch cuttings. Final grade should match the existing slope, and branches should protrude slightly from the filled face. The soil should be moist so that the live branch cuttings do not dry out.

Branchpacking may not be effective in slumped areas or gullies which are greater than 5 feet wide. Examine the slope closely to determine the cause of slumped areas and gullies. Wet soils, inadequate drainage, excessive stormwater runoff or other site conditions may require additional solutions.

Approach (Continued)

Brushlayering is a variation of branchpacking suitable for gentle slopes with only a moderate potential for erosion. The live branch cuttings are oriented perpendicular (up and down) to the slope level contours, installed in a trench or cut slope, and then covered with soil as before. The difference is that the soil for each downhill trench comes from the next excavated trench immediately uphill. The presence of branch cuttings in the soil will limit the amount of compaction that can be obtained on a slope, so that additional erosion control measures may be necessary. Straw mulch, temporary seeding, jute mesh and erosion control mats may be necessary, particularly for slopes steeper than 3:1. Avoid slopes steeper than 2:1 and generally limit slope lengths to 20 feet or less.

- Vegetative Crib Walls

A crib wall is a hollow, box-like, interlocking arrangement of structural members to create a retaining wall. A retaining wall is an engineered structure, with calculated loads and stresses used for the material selection and design. Crib walls made from prefabricated metal or reinforced concrete beams can be designed as very tall retaining walls that can handle large surcharge loads and traffic impacts; these types of crib walls must be designed by a professional engineer. Crib walls are filled with compacted soil or gravel, with provisions for subsurface drainage.

Adding vegetation may or may not affect structural stability of a retaining wall in the future. It would certainly affect large structural crib walls, but should not impact small crib walls such as the type shown in Figure SMP-06-03 for a relatively short height using untreated logs or timber. The structure is filled with suitable backfill material and layers of live branch cuttings which will root inside the crib structure and extend upward into the slope or outward into the wall face. This technique is appropriate at the base of a slope where a low wall may be required to stabilize the toe.

Live branch cuttings should be long enough to reach the back of the wooden crib structure. Logs or timbers are usually 6 inches in diameter or thickness. Large nails or rebar are required to secure the logs or timbers together. Place foundation of wall 2 to 3 feet below grade, as shown on Figure SMP-06-03.

Place the first course of logs or timbers at the front and back of the excavated foundation, approximately 4 to 5 feet apart. Place the second course of logs or timbers at right angles (perpendicular to the slope) on top of the previous course to overhang the front and back of the previous course by 3 to 6 inches. Repeat course in same manner and nail to the preceding course with nails or reinforcement bars. When the crib wall structure reaches the existing ground elevation, place live branch cuttings on the backfill perpendicular to the slope. Then cover the branch cuttings using fertile soil as backfill and compact firmly.

Installation Procedures

- Groove or stair step cut grading is recommended for slopes steeper than 3:1 (H:V)
- To control erosion vegetation and simple retaining structures should be considered
- Retaining structure must meet two minimums: pressure beneath the base must not exceed the allowable soil pressure; structure should possess adequate strength under loaded conditions.
- Cribwall structures consisting of vegetative matters are called “live” cribwall.
- Cribwall structures should start 2-3 feet below ground elevation at the lowest point of the slope to stabilize the structure.
- The first course of reinforcement should start 4-5 feet apart and parallel to the slope

Installation Procedures (cont'd)

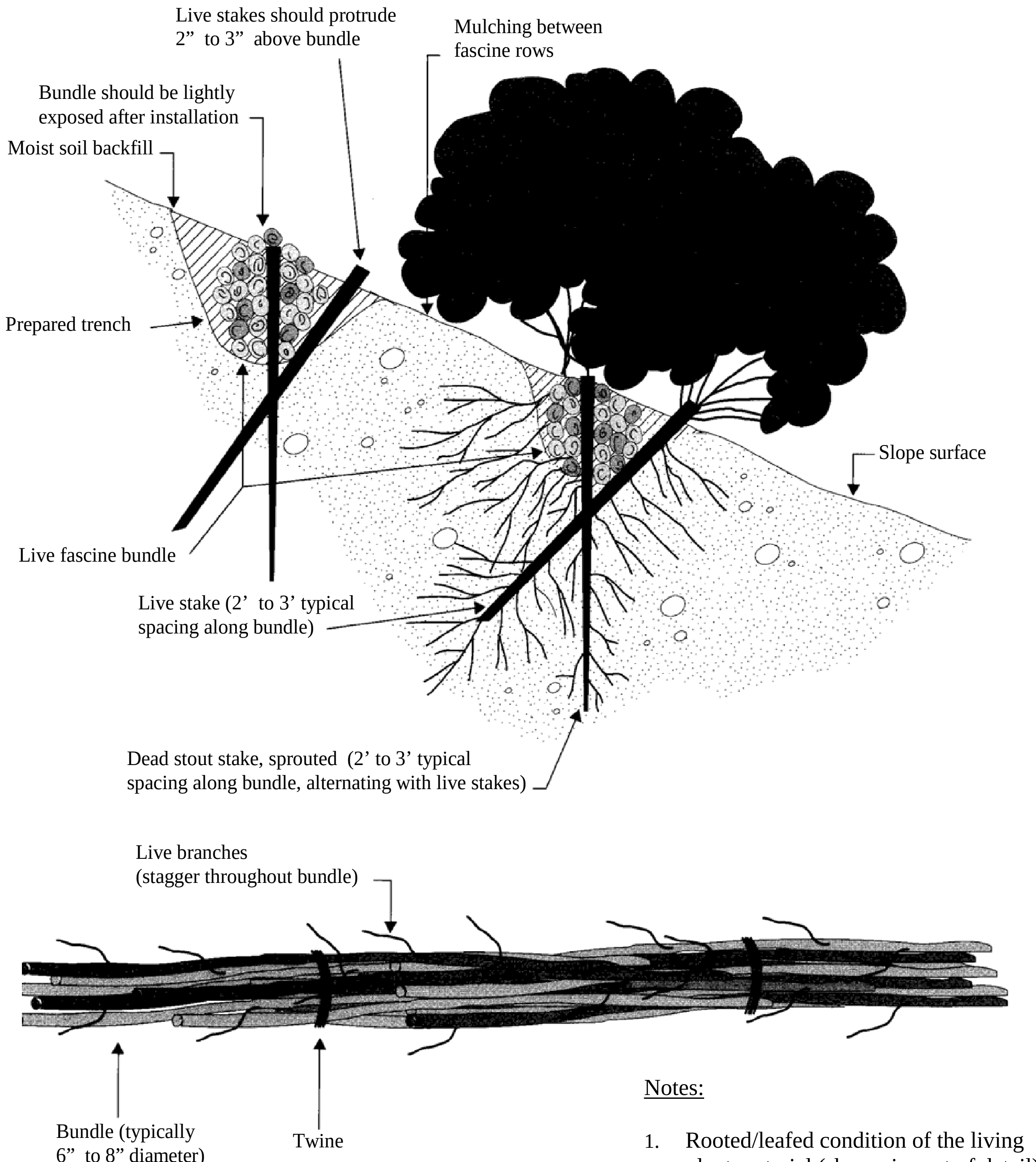
- Other courses of reinforcement will follow the same pattern as the first and second course while being fastened with nails, bars, or bands to the previous course.
- Rock Gabions follows the same procedures for foundation stabilization as Cribwall.
- The back of the foundation should be exhumed slightly deeper than the front to add stability.
- Fabricated wire baskets should be placed at the bottom of the exhumed site prior to rock filling. Rock filling should be between and behind the basket wire.
- Continue filling area with wire baskets and rock fill until desired height is reached.
- ALL structure construction must be performed by a Licensed Professional Engineer.

Maintenance

- Inspect structure before and after rainfalls.
- Make repairs when necessary.

Inspection Checklist

- ❑ Licensed Professional Engineer's stamp is clearly placed on plans in order to construct the appropriate retention structure.
- ❑ Changes to site conditions have been transmitted for review by the Project Engineer.



NOT TO SCALE

Notes:

1. Rooted/leafed condition of the living plant material (shown in part of detail) is not representative of the time of installation.
2. Use a combination of live stakes and dead stakes to anchor fascine bundles.

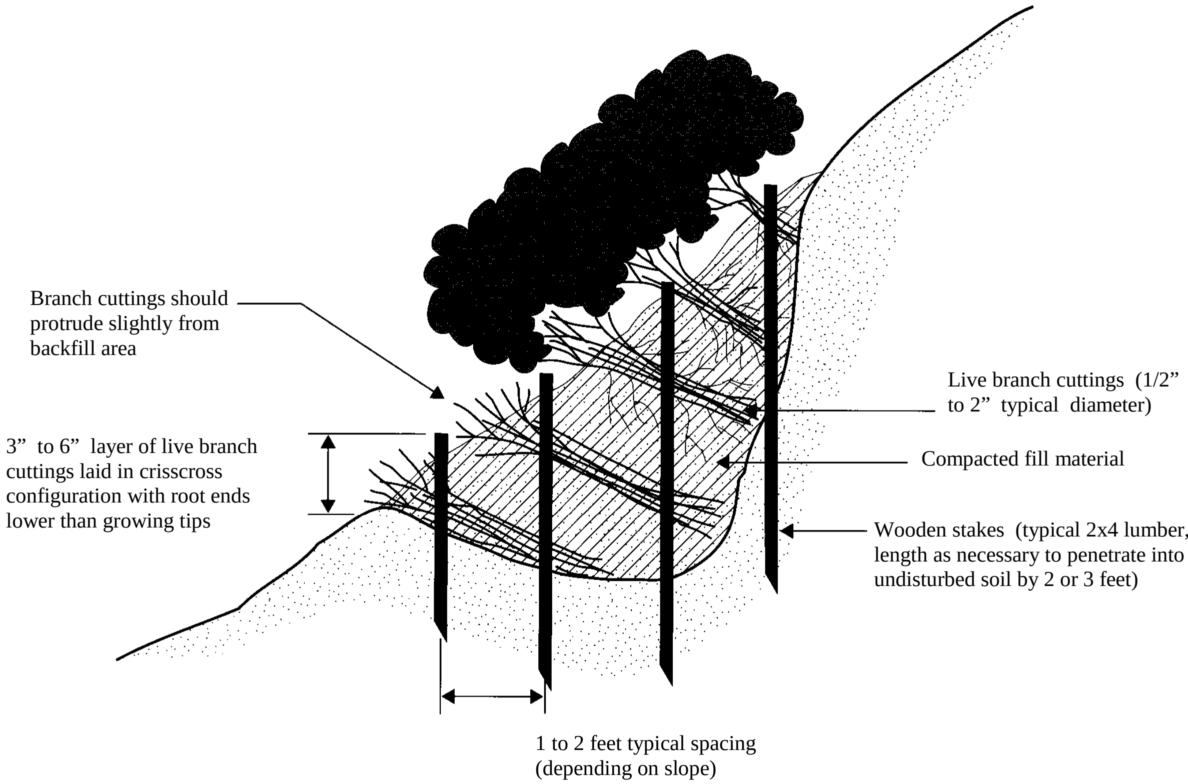
Figure SMP-06-01
Live Fascine Details

Source: Knoxville BMP Manual

Notes:

1. Rooted/leafed condition of the living plant material (shown in part of detail) is not representative of the time of installation.

2. Branchpacking locations are typically for small repairs of a slope or gully. Carefully examine site conditions to

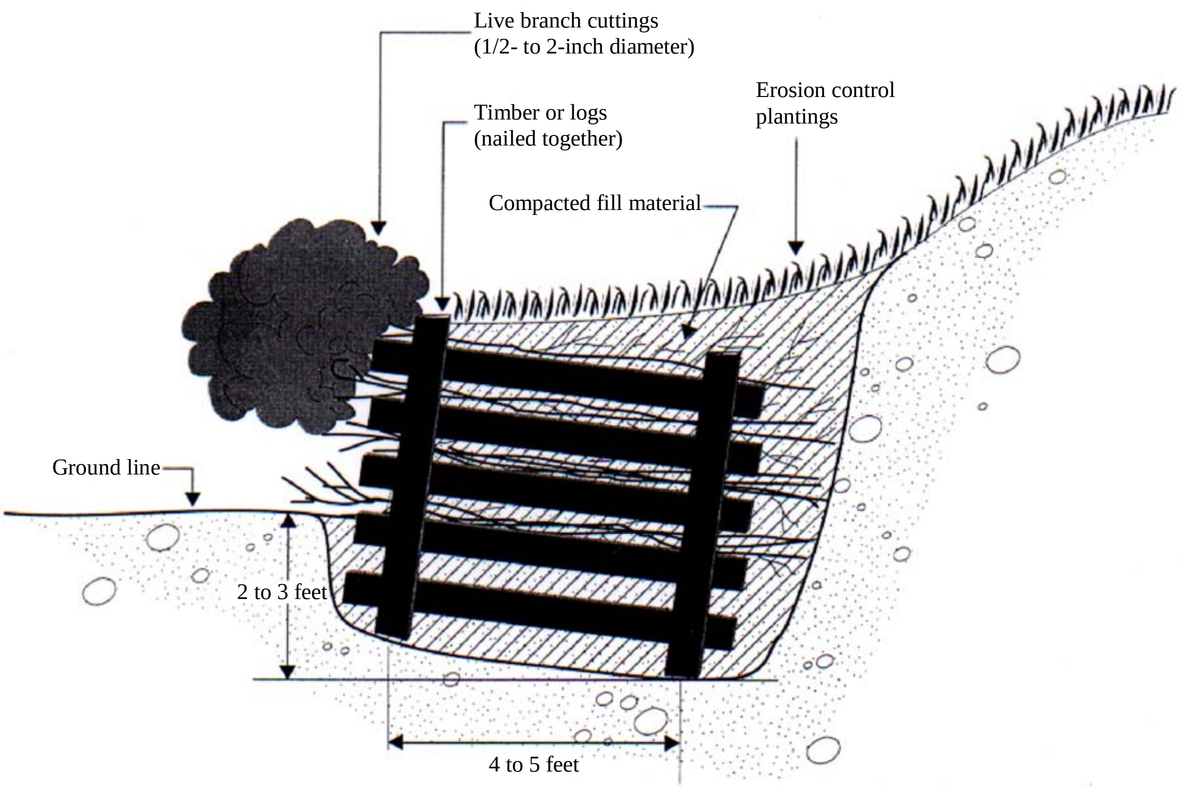


NOT TO SCALE

Figure SMP-06-02
Branchpacking Details

Source: Knoxville BMP Manual

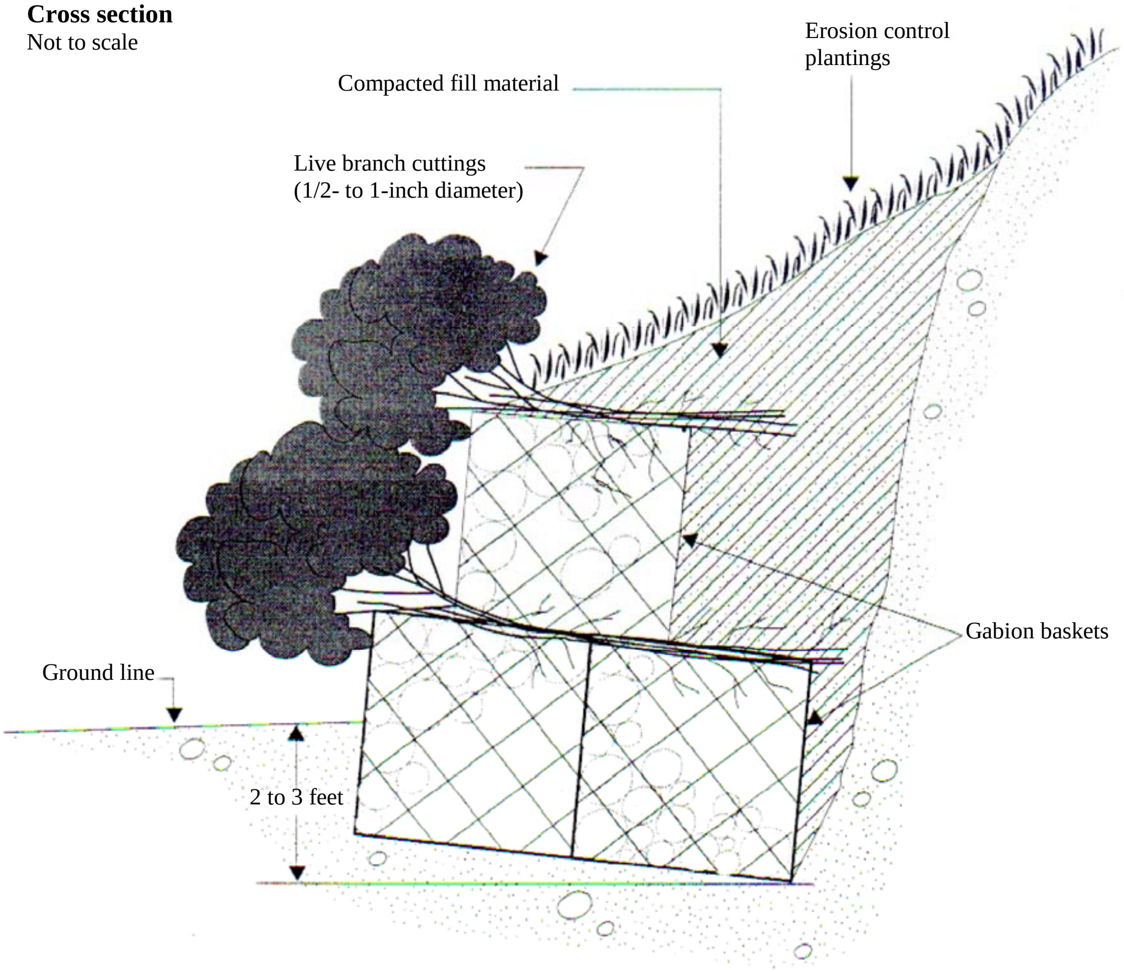
Cross section
Not to scale



Note:
Rooted/leafed condition of the living plant material is not representative of the time of installation.

Figure SMP-06-03
Vegetated Crib Wall

Source: Knoxville BMP Manual



Note:
Rooted/leafed condition of the living plant material is not representative of the time of installation.

Figure SMP-06-04
Vegetated Rock Gabions

Source: Knoxville BMP Manual

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Sediment Management Practices (SMPs)

SMP-07

Activity: Riprap (RR)

PLANNING CONSIDERATIONS:

Design Life:
Permanent

Acreage Needed:
Minimal

Estimated Unit Cost:
Medium

Monthly Maintenance:
20-40% of Installation

— RR —

RR

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

Riprap is a permanent erosion prohibiting ground cover that requires the placement of large, loose, angular stone with a geotextile or granular underlining. This BMP significantly reduces erosion and sediment movement.

Suitable Applications

- Along a stream or within a ditch to provide an erosion resistant lining.
- On lakefronts and riverfronts, or any other areas subject to wave harmonics.
- Surrounding culvert inlets and outlets to protect against scouring and undercutting
- In channels to reduce velocities, dissipate hydraulic energies and promote infiltration.
- On slopes that are not conducive to the establishment of ground cover.

Installation Procedures

- Riprap application and implementation for channel or slope stabilization should be designed by a professional familiar with drainage and stormwater conveyance measures.
- Riprap placement should be completed within a short time period (less than a week) to minimize potential damage resulting from stormwater runoff.
- The area should be cleared of trees and shrubs in order to provide sufficient access to the site for the construction equipment.
- When used as slope protection, riprap should be keyed into the slope toe by at least the greater of 6 inches or one half the designed riprap diameter.
- Riprap should not be placed until final subgrade elevation has been verified by the licensed engineer overseeing design and/or construction.

Installation Procedures (cont'd)

- Geotextile should be installed to maintain separation o frock material from the underlying soil. Geotextile should not be stretched or otherwise compromised. Secure fabric with anchor trenches, stakes, staples or any other method recommended by the manufacturer.
- When subgrade filters are required, place a layer of aggregate or sand so that the layer is smoothly graded and well compacted.
- When subgrade filters are not required, the subgrade should be compacted as to prevent undercutting or slumping from occurring.

Rubble-Stone Riprap (Plain)

- Rubble-stone riprap should consist of at least 90% of the stone not less than 8 inches wide by 12 inches long by 12 inches deep and should be approximately rectangular in shape. Rubble-stone should be hand placed so that the stones are close together, are staggered at all joints as far as possible, and are placed so as to reduce the voids to a minimum. The main stone should be thoroughly "chinked" or anchored in place with 1-in. to 3-in. stones by throwing them over the surface in any manner that is practical for the smaller stones to fill the voids.
- The standard depth should be 24 inches. The average depth should not be less than the required depth and is determined from evaluation of a 25 square foot surface area.
- When rubble-stone rip-rap is constructed in layers, the layers should be thoroughly tied together with large stones protruding from one layer into the other.

Rubble-Stone Riprap (Grouted)

- Stone placement for rubble-stone riprap (grouted) is the same as for rubble-stone rip-rap (plain). The grouting procedure is as follows:
- When grouting is used, care should be taken to prevent earth or sand from filling the spaces between the stones before the grout is poured. Grout should be composed of one part Portland cement and four parts of sand, measured by volume, and mixed thoroughly with sufficient water to a consistency that it will flow into and completely fill the voids.
- Immediately before pouring the grout, the stones should be wetted by sprinkling. Beginning at the lower portion of the riprap, the grout should be carefully poured into the voids between the stone and at a rate slow enough to prevent oozing to the surface. The pouring of the grout should be accomplished by the use of vessels, chutes, tubes, or hoses of adequate size and shape. Broadcasting, slopping, or spilling of grout from the vessels on the surface of the rip-rap is not allowed.
- As soon as any section of the grouted riprap has hardened sufficiently, it should be kept moist with water that is free from salt or alkali for a period of not less than 72 hours.

Installation Procedures (cont'd)

Sacked Sand-Cement Riprap

- Sand for sacked sand-cement riprap may be manufactured or natural but should conform to state regulations. The same is true for Hydraulic cement. The sand and cement should be mixed dry, with a mechanical mixer, in the proportion of one bag (94 pounds) of cement to 5 cubic feet of dry sand, until the mixture is uniform in color. The sand-cement mix should be poured into sacks of approximately 1 cubic foot capacity until they are approximately ¾ full. Sacks should be of either cotton or jute standard grade of cloth which will hold the sand-cement mixture without leakage during handling and tamping. The sacks should then be securely fastened with hog rings, by sewing, or by other suitable methods that prohibit leakage of the mixture from the bags.
- The sacks of sand-cement should be bedded by hand on the prepared grade with all the fastened ends on the grade and with the joints broken. The completed riprap should have a minimum thickness of 10 inches with a tolerance of 3 inches.
- The sacks should be rammed and packed against each other in such a manner as to form close contact and secure a uniform surface. Immediately after tight placement, the sacks of sand-cement should be thoroughly soaked by sprinkling with water. Water should not be applied under high pressure. Sacks that are ripped or broken in placement should be removed and replaced before being soaked with water.

Machined Riprap

- Machined riprap should be clean shot rock containing no sand, dust, or organic materials and should be the size designated for the class specified. The stone should be uniformly distributed throughout the size range.

Maintenance

- Riprap requires minimum maintenance
- Check after storm events for maintenance purposes, replace any portion of the riprap that needs attention
- Check for brush growth, remove the evidence which appears

Inspection Checklist

- ❑ Verify that displacement does not occur due to steep slopes or small riprap.
- ❑ Proper filter cloth is used.
- ❑ Riprap graded properly according to contract documents.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Sediment Management Practices (SMPs)

SMP-08

Activity: Channel Linings (CL)

CL

CL

PLANNING CONSIDERATIONS:

Design Life:
Permanent

Acreage Needed:
Minimal

Estimated Unit Cost:
Medium

Monthly Maintenance:
Negligible

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ♦ Nutrients ♦ Oxygen Demanding Substances ♦ Toxic Materials ◊
Oil& Grease ♦ Bacteria & Viruses ◊ Floatable Materials ◈ Construction Waste ◊

Description

Constructed or natural waterways will occasionally require vegetation or rock lining to protect it from erosion.

Suitable Applications

Rock Lined Channels

- Channels with runoff velocities exceeding 2 ft/sec.
- Channels or ditches with grades greater than 2 percent.
- Channels or ditches with highly erodible soils.
- Channels where the design velocity exceeds that allowable for grass lined channels.

Grass Lined Channels

- Slopes that do not exceed a 5% grade.
- Sites where vegetation is required.

Approach

There are two types of channel lining:

- Rock lined channels
  - Channel is required to carry the 10-year 24-hour peak flow where:
    - Q = V*A, where
      Q = Flow
      V = Velocity
      A = Flow Area
  - The Manning Equation shall be used to determine the velocity
    - $V = \frac{1.486}{n} * R^{2/3} * S^{1/2}$, where
      V = Velocity
      R = flow area/wetted perimeter
      S = Slope in ft/ft
      $n = 0.0395\ (D50)^{1/6}$

Approach (cont'd)

- Rock lined channels (cont'd)
  - The maximum depth of channel shall be calculated with the following equation
    - $D_{max} = \tau / (62.4 * S)$, where
      D_{max} = maximum depth of flow
      S = Slope in ft/ft
      τ = maximum tractive force of the liner in lbs/ft^2
      (see Table SMP-08-01 for shear stress quantities)
  - Side slopes shall be 2:1 or flatter
  - Riprap thickness: The thickness shall be 1.5 times thicker than the stone diameter, unless shown otherwise in the plans. Minimum of 6 inches.
  - Foundation: Extra-strength filter fabric or aggregate filter layered, as required.
  - Channel outlet must be stable.

- Vegetative channels
  - Grass channels are generally constructed with sides at a 3:1 slope to aid in establishment and safety in maintenance.
  - Channel is required to carry the 10-year 24-hour peak flow where:
    - Q = V*A, where
      Q = Flow
      V = Velocity
      A = Flow Area
  - The Manning Equation shall be used to determine the velocity
    - $V = \frac{1.486}{n} * R^{2/3} * S^{1/2}$, where
      V = Velocity
      R = flow area/wetted perimeter
      S = Slope in ft/ft
      n = 0.045 for grass
  - The maximum depth of channel shall be calculated with the following equation
    - $D_{max} = \tau / (62.4 * S)$, where
      D_{max} = maximum depth of flow
      S = Slope in ft/ft
      τ = maximum tractive force of the liner in lbs/ft^2
      (see Table SMP-08-02 for shear stress quantities)
  - *V-shaped Channels*
    - Typically used for smaller, roadside channels.
    - Use a grass or sod lining where velocities are low
  - *Parabolic Channels*
    - Used for larger flows if space allows.
    - Riprap should be used wherever velocities are highest
    - Areas of continuous flows use grass channels with centered reinforcement mats.
  - *Trapezoidal Channels*
    - For channels with large volume and flatter slopes.
    - In some cases concrete or riprapped channels may be required.

Approach (cont'd)

Table SMP-08-01

KYTC Channel Lining Values

KYTC Channel Lining	D50	Manning's n	Shear (lb/ft^2)
Class I	0.2	0.0302	1.00
Class II	0.5	0.0352	2.50
Class III	1.0	0.0395	5.00

Table SMP-08-01

Maximum Shear Stress of Liners

Material	Shear (lb/ft^2)
Dense sod, fair condition (Class D/E), moderately cohesive soil	0.35
Bermuda grass, fair stand < 5" tall, dormant	0.90
Bermuda grass, good stand < 5" tall, dormant	1.10
Bermuda grass, excellent stand 20" tall, dormant	2.70
Bermuda grass, excellent stand 20" tall, green	2.80
Bermuda grass, excellent stand >20" tall, green	3.20
Turf (immediately after construction)	0.20
Turf (after 3-4 season)	2.04
Turf reinforcement mat, permanent	8.00
Straw reinforcement mat, temporary	0.45
Jute mat	0.45
Straw with net	1.45
Curled wood net	1.55
Synthetic mat	2.00

Source: Salix Applied Earthcare – Erosion Draw 5.0

Installation (cont'd)

Rock Lined Channels

- Cross sections shall be excavated according to the grade shown on plans
- Overcut for thickness of rock and filter
- As soon is foundation is prepared, place filter and/or fabric filter immediately.
- Rock should be placed such that it forms a dense, uniform, well graded mass with few voids. Hand placement may be required in places that machinery can not reach.
- Channel outlet shall be stabilized.

Grass Lined Channels

- *See the specifications for seeding and erosion control blankets.*

Activity: Channel Linings	SMP-08

Maintenance

- Inspect after every storm event greater than 0.5 inches, if not every week.
- Check rip-rap BMP for appropriate installation and maintenance processes.
- Remove any deleterious debris.
- Repair eroded or damaged material immediately.
- Check grass lined channels for establishment.
- For grass lined channels, check to see if established cover is withstanding high velocity flows.

Inspection Checklist

- [ ] Adequate coverage is provided to prevent washout.
- [ ] Repair torn netting or mats.
- [ ] Slope of channel is consistent with contract documents.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Sediment Management Practices (SMPs)

SMP-09

Activity: Temporary Diversions, Drains and Swales (TD)

PLANNING CONSIDERATIONS:

Design Life:
Permanent

Acreage Needed:
Minimal

Estimated Unit Cost:
Medium

Monthly Maintenance:
N/A

→ TD → TD

TD

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ♦ Nutrients ♦ Oxygen Demanding Substances ♦ Toxic Materials ◊
Oil& Grease ♦ Bacteria & Viruses ◊ Floatable Materials ◈ Construction Waste ◊

Description

These temporary drains offer features such as conveyance for runoff down cut or fill slopes, subsurface drains that drain off excessive soil saturation, minimization of sheet flow over slope surfaces and reduced sedimentation. Once stabilized, diversions require relatively little maintenance.

Suitable Applications

- Provide drains to prevent slope failures, damage to adjacent property, erosion and sediment control and removes excess water from soil.
- Diversions to catch runoff at the end of an undisturbed slope before entering a bared area, direct runoff, preserve stable conveyance and to prevent overflow.

Installation Procedures

A diversion prevents erosion by directing runoff to an erosion control device such as a sediment trap or directing runoff away from an erodible area. Temporary diversions should not adversely impact adjacent properties and must conform to local floodplain management regulations. This practice should not be used in areas with slopes steeper than 10%. The advantages of the temporary earth dike include the ability to handle flows from large tributary areas. Additionally, they are relatively inexpensive to install since the soil material required for construction may be available on-site, and can be constructed as part of the initial grading operations, while the equipment is on-site.

Temporary swales will effectively convey runoff and avoid erosion if constructed and maintained properly:

- Size temporary swales in the same manner as a permanent channel.
- A permanent channel must be designed by a licensed professional civil engineer.
- At a minimum, the swale should conform to predevelopment flow patterns and capacities.
- Construct the swale with an uninterrupted, positive grade to a stabilized outlet.

Installation Procedures (cont'd)

Drains

Diversion drains are only effective if they are properly installed. Swales are more effective than dikes because they tend to be more stable. The combination of a swale with a dike on the downhill side is the most cost-effective diversion.

- Can be placed on or buried underneath the slope surface.
- Should be anchored at regular intervals of 50 to 100 ft.
- If a slope drain conveys sediment-laden water, direct flows to a sediment trap or basin.
- When using slope drains, limit tributary area to 2 acres per pipe. For larger areas, use a rock-lined channel or a series of pipes.
- Maximum slope generally limited to 2:1 (H: V), as energy dissipation below steeper slopes is difficult.
- Drain or swale should be laid at a minimum grade of 1%, but not more than 15%.
- The swale must not be overtopped by the 10-year, 24-hour storm, meeting or exceeding the design criteria stated above.
- Remove all trees, stumps, obstructions, and other objectionable material from the swale when it is built.
- Compact any fill material along the path of the swale.
- Stabilize all swales immediately. Seed and mulch swales at a slope of less than 5 percent, and use rip-rap or sod for swales with a slope between 5 and 15 percent.
- Do not operate construction vehicles across a swale unless a stabilized crossing is provided.
- Direct surface runoff to slope drains with diversion swales, dikes and berms.
- When installing slope drains:
  - Install slope drains perpendicular to slope contours.
  - Compact soil around and under entrance, outlet, and length of pipe.
  - Securely anchor and stabilize pipe and appurtenances into soil.
  - Check to ensure that pipe connections are watertight.
  - Protect inlet and outlet of slope drains: use standard flared end section at entrance for pipe slope drains 12 in. and larger.
  - Protect area around inlet with filter cloth.
  - Protect outlet with geosynthetics and rip-rap or other energy dissipation device. For high-energy discharges, reinforce rip-rap with concrete or use reinforced concrete devices.
- When installing subsurface drains:
  - Slightly slope subsurface drain towards outlet.
  - Check to ensure that pipe connections are watertight.
  - Review relative size of soil and slot/perforation size in the pipe to prevent sediment from entering pipe.
  - Relief drains lower groundwater table. Install parallel to slope and drain to side of slope. Use gridiron, herringbone or random pattern.
  - Interceptor drains prevent excessive soil saturation on sensitive slopes. Install perpendicular to slope and divert discharge to the side of the slope.

Activity: Temporary Diversions, Drains and Swales	SMP-09

Installation Procedures (cont'd)

Diversions

- Select design flows and safety factor based on careful evaluation of risks due to erosion of the measure, over topping, flow backups, or washout.
- High flow velocities may require the use of a lined ditch, or other methods of stabilization.
- When installing diversion ditches and berms:
  - Protect outlets from erosion.
  - Utilize planned permanent ditches/berms early in construction phase when practicable.
- All dikes and berms should be compacted by earth-moving equipment.
- All dikes should have positive flow to a stabilized outlet.
- Top width may be wider and side slopes may be flatter at crossings for construction traffic.
- Dikes should direct sediment-laden runoff into a sediment trapping device.
- Dikes should be stabilized with vegetation, chemicals, or physical devices.
- Compact any fills to prevent unequal settlement.
- Dikes should remain in place until disturbed areas are permanently stabilized.
- Examine the site for run-on from off-site sources (control off-site flows through or around site).
- Select flow velocity limit based on soil types and drainage flow patterns for each project site
- Establish a maximum flow velocity, shear stress or 3-5 ft/s, for using earth dikes and swales, above which a lined ditch must be used.
- Design an emergency overflow section or bypass area for larger storms that exceed the 10-year design storm.
- Conveyances must be lined or reinforced when velocities exceed allowable limits for soil. Consider use of geotextiles, engineering fabric, vegetation, rip-rap or concrete.

Maintenance

- Inspect drains before and after each storm event
- Inspect weekly until drainage area is stabilized
- Maintain drains and swales to eliminate erosion, accumulation of debris and sediment
- Check status of water ponding activities. Remove water if such activities occur
- Temporary conveyances should be removed when surroundings become stable or when the construction is complete

Inspection Checklist

- [ ] Routine visit after every heavy rain water event.
- [ ] No evidence of washout, accumulated debris and build up in ditches or berms.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Sediment Management Practices (SMPs)

SMP-10

Activity: Filter Strips (FS)

FS

FS

PLANNING CONSIDERATIONS:

Design Life:
1 year

Acreage Needed:
Minimal

Estimated Unit Cost:
Low

Monthly Maintenance:
N/A

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ◈ Nutrients ◈ Oxygen Demanding Substances ◈ Toxic Materials ◈
Oil& Grease ◈ Bacteria & Viruses ◊ Floatable Materials ◈ Construction Waste ◊

Description

Utilizing vegetation allows soil to be protected from erosion and velocity flow while reducing or preventing discharge of pollutants to the storm system or waterways. This method uses filter strips to accomplish the goal of filtering sediment needing to be settled out of runoff.

Suitable Applications

- Areas that need immediate cover (such as sodding and plugging) due to having turf prior to construction, areas subject to erosion (graded or cleared areas), and permanent vegetative areas
- Wetlands and/or sensitive water bodies
- Steep and unstable slopes
- Temporary or permanent buffer areas that include the floodway and 50 feet perpendicular to the floodway. If a floodway has not been determined then the buffer must be 25 feet perpendicular from each side of the stream bank, creek, or unnamed waterway under “bank-full conditions” (See EPP-04 Buffer Zones.)
- Area within the buffer must not be cleared. It should be surveyed, flagged and delineated by a colored temporary fence and these instructions explained to each employee on the site

Activity: Filter Strips	SMP-10

Installation Procedures

- Cultivate the area then install the irrigation system
- Areas should be excavated and backfilled (plant holes)
- Areas are to be fine graded and rolled prior to sodding
- Sodded areas are to be uniform and smooth (prior to sodding) and distributed with top soil were needed (to even out the area)
- Sod end of adjacent strips should stagger by half the width or length
- Areas adjacent to sidewalks, concrete headers, header boards and other paved borders shall be 1.5 in-0.25 in below the top grade of the facilities
- Seed beds should be added to fertilizers and added to the correct site condition to slow the velocity of runoff and allow sedimentation to take place
- Roll sod to eliminate air pockets and allow a closer contact with the soil.
- Water sod so that the soil at a minimum depth of 4 feet is moistened
- Do not allow sod to dry out
- Sod should not be planted on slopes that are greater than 3:1 (H:V) if no mowing is to occur
- Vegetate sodded areas
- Do not use buffer strip for vehicular traffic
- All fertilization efforts should follow the outline of the state, county, and/or local government

Maintenance

- Inspect weekly after rainfall events until turf is established
- Mowing shall consist of “tall” mowing, weeding and the irrigation system is growing and operating properly
- Fertilize as needed and as indicated by soil testing
- Overseed, repair bare spots, or apply additional mulch as necessary

Inspection Checklist

- [ ] Practice has been properly mowed and maintained.
- [ ] Construction vehicles have been kept off BMP.
- [ ] Dead areas have been re-seeded, plugged or re-sodding
- [ ] Underwash turf has been maintained and compacted.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Sediment Management Practices (SMPs)

Activity: Temporary Inlet Protection (TIP)

SMP-11

TIP

PLANNING CONSIDERATIONS:

Design Life:
1 yr

Acreage Needed:
Minimal

Estimated Unit Cost:
Low

Monthly Maintenance:
60% of installation

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◈ Construction Waste ◊

Description

This practice allows sediment to settle prior to entering into a stormwater catch basin or inlet. The detainment of sediment-laden runoff through filtering devices allows a cleaner runoff to be discharged into the environment.

Suitable Applications

- Protection of storm drain inlets or catch basins from sedimentation upstream of the inlet.
- Areas where ponds are not encroached into access road or highway traffic.
- Disturbed tributary areas have not yet been permanently stabilized.
- Areas where drainage is 1 acre or less.
- Areas with drainage more than 1 acre must be accompanied by a downstream sediment trap or basin.

Approach

Sediment control can be maintained using one of the following practices:

- Filter Fabric Fences
- Block and Gravel Filter
- Gravel and Wire Mesh Filter
- Excavated Inlet Sediment Traps

Installation Procedures

Sediment filters are used as storm inlet protectors.

- Filter Fabric Fences are desired for basins less than one acre with less than a 5% slope. Place 2 in. by 2 in. wooden stakes around the perimeter of the inlet a max. of 3 feet apart with an ending depth of at least 8 in. into the ground. Stakes should be 3 feet long. Excavate trench 8 inches wide and 12 inches deep around the outside perimeter of the stakes. Staple fabric to the stakes so that 32 in of the fabric extend out and can be formed into the trench (use heavy-duty wire staples at least 1 in. in length). Backfill trench with a ¾ in or less washed gravel all the way around.

Installation Procedures (cont'd)

- Block and Gravel Filter is desired for flows greater than 0.5 cfs. Hardware cloth should be dropped ½ in over drop inlet so that wire extends a minimum of 1 ft on each side. Concrete blocks should be placed lengthwise on their sides in a single row around the perimeter of the inlet with ends abut adjacently. Height can be 4, 8 or 12 in. wide by stacking combinations of concrete. Rows should be no greater than 24 inches high. Wire mesh should be over the outside vertical face of the concrete blocks to prevent stone from washing through blocks. Pile wash stone against the wire mesh to the top of the blocks. Use ¾ to 3 in. gravel.
- Gravel and Wire Mesh Filter is used on curb or drop inlets where construction equipment may drive over the inlet. Place over drop inlet so that wire extends on both sides at a minimum of 1 ft. Use hardware cloth or wire mesh with ½ in. opening. Place ¾ to 3 in. gravel over the filter fabric/wire mesh. Depth should be 12 inches over the entire inlet opening. Excavate drop inlet sediment trap, minimum storage capacity calculated at the rate of 67 cubic yards per acre (yd^3/ac) of tributary area should be sized.
- Sand Bag Barriers are used to create a small sediment trap upstream of inlets on sloped, paved streets. Bags should be made of geotextile material and filled with ¾ in. rock or ¼ in. pea gravel. Leave room upstream for settlement and ponding. Place several layers of bags and pack them tightly together leaving a gap of one bag on the top row to serve as a spillway.
- Excavated Drop Inlet Sediment Traps are excavated areas around inlets to trap sediment.
- Gates and inlets should be a sealed to prevent seepage of sediment-laden water.
- Excavate sediment sumps 1 to 2 feet with 2:1 (H:V) side slopes around the inlet.
- Provide areas around the inlet for water to pond without flooding structures and property.

Maintenance

- Replace clogged fabric immediately.
- Remove sediment when depth exceeds half the height of the filter or half the depth of the sediment trap.
- Inspect all inlets and catch basins weekly before and after each rain event.
- Inspect once every 24 hours during heavy rainfall events.
- After site is stabilized remove all inlet devices within 30 days.
- Bring disturbed area to final grade and smooth and compact it.
- Clean around and inside the storm drain inlet.

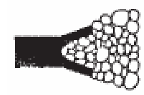
Inspection Checklist

- [ ] Filter fabric stakes are secure.
- [ ] Filter fabric is cleaned or replaced to prevent clogging.
- [ ] Sediment from behind the fabric less than ½ the height of the silt fence.
- [ ] Gravel filter is in working order. No evidence of gravel washing through.
- [ ] Do not clean any gravel adjacent to any inlet or waterway.
- [ ] Bags are properly maintained.
- [ ] No evidence of displacement of the practice.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Sediment Management Practices (SMPs)

SMP-12

Activity: Temporary Outlet Protection (TOP)



TOP

PLANNING CONSIDERATIONS:

Design Life:
1 yr

Acreage Needed:
Minimal

Estimated Unit Cost:
Low

Monthly Maintenance:
N/A

Target Pollutants		
Significant ♦	Partial ◈	Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

This protection outlet is constructed of rock, grouted rip-rap or concrete rubble. This practice prevents scour of the soil due to high pipe flow velocities. The dissipation of flow energy to produce non-erosive velocities is also a function of this BMP.

Suitable Applications

- Areas where culverts, conduits or channels are sufficient to erode the immediate downstream reach.
- Outlets of pipes, drains, culverts, conduits, channels, locations at the bottom of mild to steep slopes, outlets of which carry continuous flows of water, short intense flows of water, lined conveyances discharge to unlined conveyance
- A sediment trap is recommended if runoff is sediment laden
- Do not use grouted rip-rap during freezing, which will cause grout to break

Installation Procedures

- Should be designed and sized by a licensed professional as a part of the culvert, conduit or channel design.
- Apply a rip-rap apron for temporary use during construction.
- Apron should consist of a zero grade, alignment with receiving stream. Avoid damaging the underlain filter fabric. Keep apron straight throughout the length of the stream, curving in the upper section of the harpoon if curve is needed. Bank reinforcement should be downstream to account for the curved apron.
- Sizing for average rock diameter and apron dimensions are found in Table SMP-12-01.

Table SMP-12-01
Sizing for Flow Dissipaters at Culvert Outlet

Culvert Size	Avg. Rock Diameter	Apron Width*	Apron Length**	Apron Length***
8”	3”	2-3 ft.	3-5 ft.	5-7 ft.
12”	5”	3-4 ft.	4-6 ft.	8-12 ft.
18”	8”	4-6 ft.	6-8 ft.	12-18 ft.
24”	10”	6-8 ft.	8-12 ft.	18-22 ft.
30”	12”	8-10 ft.	12-14 ft.	22-28 ft.
36”	14”	10-12 ft.	14-16 ft.	28-32 ft.
42”	16”	12-14 ft.	16-18 ft.	32-38 ft.
48”	20”	14-16 ft.	18-25 ft.	38-44 ft.

Maintenance

- Grouted or wire-tied rock rip-rap minimizes maintenance requirements.
- Inspect weekly and before and after rainfall events.
- Inspect apron for displacement and/or damage to the underlying fabric, scour beneath the rip-rap and around outlet.
- Remove devices as soon as work is completed to the construction site.
- Grouted rip-rap may break up in areas of freeze and thaw.
- Grouted rip-rap may break up from hydrostatic pressure without adequate drainage.

Inspection Checklist

- ☐ Stones that have been displaced by wet weather events have been re-set and/or replaced.
- ☐ Apron has been cleaned and properly maintained.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Sediment Management Practices (SMP)

SMP - 13

Activity: Slope Drains (SD)

PLANNING CONSIDERATIONS:

Design Life:
3 years

Acreage Needed:
None

Estimated Unit Cost:
Low

Monthly Maintenance:
Low

SD

SD

Target Pollutants

Significant ♦ Partial ◊ Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

The slope drain is constructed of pipe or lined (rock or concrete) channel that extends from the top of a cut or fill slope to the bottom. This practice is used to direct and intercept storm water runoff to a controlled path to minimize slope erosion.

Suitable Applications

Storm drains may be used on land development sites where slopes are steep or susceptible to erosion.

Approach

- Pipe capacity should be designed using the 10-year 24-hour storm or size chart listed below.

Drainage Area (acres)	Pipe Diameter (in.)
0.5	12
1.5	18
2.5	21
3.5	24
5.0	30

- Use heavy-duty materials such as corrugated plastic pipe or corrugated metal pipe.
- Conduit should be staked down at intervals equal to or less than 10 feet.
- Extend conduit beyond the toe of the slope.
- A standard flared-inlet pipe should be used at the entrance.
- Fittings should be water tight.

Activity: Slope Drains	SMP-13

Installation Procedures

- Slope drains should be installed on well-compacted fill or undisturbed soil.
- Slope the lower section of pipe towards its outlet.
- Compact soil under and around the entrance section in lifts less than or equal to 6 inches.
- Ensure watertight connections.
- Compact all fill material.
- Secure the drain with stakes or grommets less than 10 feet apart.
- Protect the outlet from erosion using rip-rap or similar material.
- Extend conduit beyond the toe of the slope.
- Compact dike ridge no less than 1 foot above the top of the inlet pipe.
- Immediately stabilize all disturbed areas following construction.

Maintenance

- After stabilization remove temporary measures.
- Re-set or replace displaced stones after wet weather events.
- Remove sediment accumulation from slope drain inlet, channel, and outlet.

Inspection Checklist

- [ ] Stones that have been displaced by wet weather events have been re-set and/or replaced.
- [ ] Pipe connections are water tight.
- [ ] Inlet/outlet has been cleaned and properly maintained.
- [ ] Remove sediment accumulation from channel.
- [ ] Construction traffic removed from slope drain.

	Somerset, Kentucky **Stormwater Best Management Practices (BMPs)** **Good Housekeeping Practices (GHPs)**	GHP-01
	Activity: Dewatering Operations (DW)	

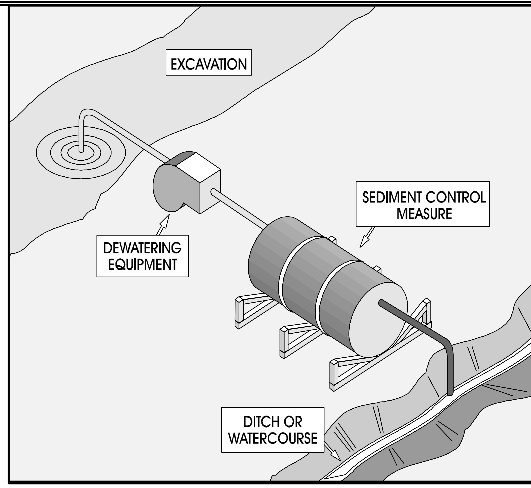
PLANNING CONSIDERATIONS:

Design Life:
1-2 years

Acreage Needed:
Minimal

Estimated Unit Cost:
Medium

Monthly Maintenance:
Moderate



Target Pollutants

Significant ♦ | Partial ◊ | Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

Testing of groundwater for pollution accumulation by using sediment controls is the basis of this BMP. This dewatering operation will reduce or prevent discharge of pollutants and aid in a partial reduction in toxic materials.

Approach

Sediment and toxic and petroleum products are two general classes of pollutants that may result from dewatering operations. Toxics and petroleum are rarely found in dewatering discharges unless the site or the surrounding vicinity has been used for light or heavy industrial activities. Sediment, on the other hand, usually has a high content in dewatering discharges due to the commonality of the operation. This BMP only addresses capture of sediment. If it is determined that dewatering will result in transfer or accumulation of toxics or petroleum products then the Kentucky Division of Water (KDOW) should be consulted before any dewater activities are performed.

Methods for Mitigating sediment discharge

- Use of sock filters or sediment filter bags on discharge pipes.
- Discharge muddy water into silt fence enclosures installed in vegetated areas away from water ways.
- Discharge muddy water to a de-silting basin.

Afterwards sediment can be removed once water has dispersed and stabilized. Seeding the area is also suggested.

Maintenance and Inspection Checklist

- ❑ Inspect filtering device frequently and repair or replace once the sediment build-up prevents the structure from functioning as designed.
- ❑ Sediment removal must be disposed of at a disposal site or spread and stabilized onsite.
- ❑ Inspect excavated areas daily for signs of contaminated water (signs such as discolored water, oily sheen or odor).

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Good Housekeeping Practices (GHPs)

GHP-02

Activity: Paving Operations (PO)

PLANNING CONSIDERATIONS:

Training:
None

Inspection Frequency:
Daily

Implementation Cost:
Low

Monthly Maintenance:
Low

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ◈ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◈
Oil& Grease ◈ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

Paving operations have the potential to introduce a large amount of pollutants to into the environment. This BMP will reduce or prevent the discharge of pollutants by using measures to prevent run-on and runoff pollution along with proper disposal of waste, and proper training of employees and subcontractors.

Approach

- Do not pave during wet weather.
- Store paving materials away from water courses to prevent stormwater run-off.
- Protect water courses, particularly in areas with a grade, by implementing BMPs to divert runoff or trap/filter sediment (see SMP-05, -06, -10, -12).
- Leaks and spills can contain toxic levels of heavy metals and oil and grease generated from paving equipment. To alleviate these pollutants into the area, place drip pans or absorbent materials under paving equipment when they are not being used. When spills do occur, clean up spills with absorbent materials (see GHP-05).
- Cover catch basins and manholes when applying seat coat, tack coat, slurry seal or fog seal.
- Most commercial covers will magnetically seal flat catch basins and inlets.
- If paving involves Portland cement concrete, see GHP-09, Concrete Waste Management
- If paving involves asphalt concrete do the following:
  1. Keep sand or gravel placed over new asphalt from being washed into storm drains, streets or creeks by sweeping. Refer to GHP-06, Solid Waste management for proper disposal.
  2. Old asphalt must be disposed of properly. Collect and remove all broken asphalt from the site and recycle.
  3. If paving involves on-site mixing plant, follow the stormwater permitting requirements for Industrial activities.

Activity: Paving Operations	GHP-02

Maintenance	➢ Maintain inlet protection so that water is not allowed to back up onto areas subject to traffic. Alternative measures should be employed if back up occurs. ➢ When sediment reaches storage capacity inlets need to be cleaned and repair as needed. ➢ Keep ample supplies of drip pans or absorbent materials on-site.
Inspection Checklist	❑ Machinery is not leaking and properly maintained. ❑ Inspect employees and subcontractors to ensure that measures are being followed.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Good Housekeeping Practices (GHPs)

Activity: Structure Construction and Painting (SCP)

GHP-03

PLANNING CONSIDERATIONS:

Training:
None

Inspection Frequency:
Daily

Implementation Cost:
Low

Monthly Maintenance:
Low

Target Pollutants

Significant ♦ | Partial ◈ | Low or Unknown ◇

Sediment ♦ Heavy Metals ◇ Nutrients ◇ Oxygen Demanding Substances ◇ Toxic Materials ◈
Oil& Grease ◇ Bacteria & Viruses ◇ Floatable Materials ◈ Construction Waste ◈

Description

A number of preventive measures around the construction site greatly decrease the amount of pollution entering the environment. Enclosing, covering or berming building material storage areas, using good housekeeping practices, utilizing safer products and training employees and subcontractors will make a significant difference in the amount of pollutants entering stormwater runoff. This will cause a significant reduction in floatable materials, other construction waste and a partial reduction of toxic materials.

Approach

- Keep the work site clean and orderly. Remove debris in a timely fashion. Sweep the area regularly.
- Use soil erosion control techniques if bare ground is exposed. See Erosion Prevention Practices (EPP).
- Buy recycled or less hazardous products to the maximum extent practicable.
- Conduct painting operations consistent with local air quality and Occupational Safety and Health Administration (OSHA) regulations.
- Properly store paints and solvents. See GHP-04: Material Delivery, Storage and Use in this section.
- Properly store and dispose waste materials generated from the activity. See the waste management BMPs GHP-06,-07, -08,-09 and -10 in this section.
- Recycle residual paints, solvents, lumber, and other materials to the maximum extent practicable.
- Make sure that nearby storm drains are well marked to minimize the chance of inadvertent disposal of residual paints and other liquids.

Approach (cont'd)

- Clean the storm drain system in the immediate construction area after construction is completed.
- Educate and remind employees who are doing the work of the importance of keeping pollutants out of the stormwater system.
- Inform subcontractors of company policy on these matters and include appropriate provisions in their contract to make certain proper housekeeping and disposal practices are implemented.
- For a quick reference on disposal alternatives for specific wastes, see the table presented in the GHP 14-1, Employee/Subcontractor Training BMP fact sheet.
- For oil-based paints, paint out brushes to the extent practical, and filter and reuse thinners and solvents.
- Never clean paintbrushes or rinse paint containers into a street, gutter, storm drain or watercourse.
- Dispose of any paint, thinners, residue, and sludges that cannot be recycled as hazardous waste. For a quick reference on disposal alternatives for paint, thinners, residue and sludges see the table presented in the Employee/Subcontractor Training BMP fact sheet, Table GHP-14-1.
- Latex paint and paint cans, used brushes, rags, absorbent materials, and drop cloths, when thoroughly dry and are no longer hazardous, may be disposed of with other construction debris.
- Use recycled and less hazardous products when practical.
- Recycle residual paints, solvents, lumber, and other materials.

Maintenance

- Minimum maintenance required.
- Spot check employees and subcontractors monthly to assure appropriate practices are being employed.

Inspection

- ❑ Unused materials are properly contained, sealed and stored.
- ❑ Containment measures are being used to keep materials from entering watercourses.
- ❑ Used or discarded materials are properly disposed.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Good Housekeeping Practices (GHPs)

Activity: Material Delivery, Storage and Use (MS)

GHP-04

PLANNING CONSIDERATIONS:

Training:
None

Inspection Frequency:
Weekly

Implementation Cost:
Low

Monthly Maintenance:
Low

Target Pollutants		
Significant ♦	Partial ◈	Low or Unknown ◇

Sediment ◈ Heavy Metals ◇ Nutrients ◈ Oxygen Demanding Substances ◇ Toxic Materials ◈
Oil& Grease ◈ Bacteria & Viruses ◇ Floatable Materials ◈ Construction Waste ◇

Description

A properly maintained and organized construction site can partially reduce the amount of contaminated sediment, nutrients, toxic materials, oil and grease and floatables from leaving the vicinity. By limiting the amount of onsite hazardous materials, storing materials in designated areas, installing secondary containment, conducting regular inspections and training employees and subcontractors, pollution can be prevented or reduced.

Approach

The following materials are commonly stored on construction sites:

- Soil
- Concrete compounds
- Pesticides and herbicides
- Fertilizers
- Detergents
- Plaster or other products
- Petroleum products such as fuel, oil, and grease
- Other hazardous chemicals such as acids, lime, glues, paints, solvents, and curing compounds.

Activity: Material Delivery, Storage and Use	GHP-04

Approach (cont'd)

Storage of these materials on-site can pose various degrees of the following risks:

- Stormwater pollution,
- Injury to workers or visitors,
- Groundwater pollution, and
- Soil contamination.

Therefore, the following steps should be taken to minimize your risk:

1. Designate areas of the construction site for material delivery and storage.
2. Place near the construction entrances and away from waterways.
3. Avoid transport near drainage paths or waterways.
4. Surround with earth berms, dikes, swales or other containment practices.
5. Place in an area which will be paved.
6. Storage of reactive, ignitable, or flammable liquids must comply with the fire codes of your area. Contact the local Fire Marshal to review site materials, quantities, and proposed storage area to determine specific requirements. See the Flammable and Combustible Liquid Code, NFPA30.
7. Follow manufacturer's instructions regarding uses, protective equipment, ventilation, flammability, and mixing of chemicals.
8. For a quick reference on disposal alternatives for specific wastes, see the table presented in the Employee/Subcontractor Training BMP fact sheet, Table GHP-14-1.
9. Keep an accurate, up-to-date inventory of materials delivered and stored on-site.
10. Keep your inventory as close to "when you need it" levels as possible.
11. Minimize hazardous materials stored on-site and handle hazardous materials as infrequently as possible.
12. Consider storing materials in a covered area. Store materials in secondary containment's such as an earthen dike, horse trough, or even a children's wading pool for non-reactive materials such as detergents, oil, grease, and paints. Small amounts of material may be secondarily contained in 'bus boy' trays or concrete mixing trays.
13. Do not store chemicals, drums, or bagged materials directly on the ground unless otherwise contained. Place these items on a pallet and, when possible, in secondary containment.
14. Try to keep chemicals in their original containers, and keep them well labeled. If other containers are used then be sure they are well marked and can be adequately sealed and stored in an appropriate place.
15. Train employees and subcontractors.

Maintenance

- Keep designated storage areas clean and organized.
- Conduct routine weekly inspections and check for external corrosion of material containers.
- Keep an ample supply of clean up material on hand.
- Inspect storage areas before and after rainfall events.
- Repair or replace perimeter controls, containment structures and covers needed for functionality.

Inspection Checklist

- ☐ Inspect storage area frequently for cleanliness and spills and leaks.
- ☐ Functions are appropriately utilized and ensured to allow proper procedures for delivery, storage and use.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Good Housekeeping Practices (GHPs)

GHP-05

Activity: Spill Prevention and Control (SPC)

PLANNING CONSIDERATIONS:

Training:
Yes

Inspection Frequency:
Weekly

Implementation Cost:
Low

Monthly Maintenance:
Low

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◇

Sediment ◇ Heavy Metals ◇ Nutrients ◇ Oxygen Demanding Substances ◇ Toxic Materials ◈
Oil& Grease ◈ Bacteria & Viruses ◇ Floatable Materials ◇ Construction Waste ◇

Description

Leaks and spills increase the amount of pollution entering stormwater runoff. The reduction of chances of spills, stopping the source of spills, containing and cleaning up spills, properly disposing of spill material, and training employees all lead to a cleaner environment. The incorporation of this BMP and GHP-04 (Material, Delivery, Storage, and Use) has information that will lead to a reduction toxic materials and oil and grease.

A number of familiar hazardous substances that affect construction sites are: soil stabilizers, palliatives, herbicides, growth inhibitors, fertilizers, deicing/anti-icing chemicals, fuels, lubricants, and other petroleum distillates.

Approach

Determine the criteria for defining significant and insignificant spills and which materials should be used in response for each incident. Review of the Materials Safety Data Sheet (MSDS) or other documentation will clarify what is and is not a significant spill. A few measures to follow concerning spill prevention and control:

General Measures

- Store hazardous materials and wastes in covered containers to protect against vandalism.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Educate employees and subcontractors on potential dangers to humans and the environment that result from spills and leaks.
- Train employees in spill prevention and cleanup procedures for the site.

Approach (cont'd)

- Hold regular meetings to discuss and reinforce appropriate disposal procedures (incorporate into regular safety meetings).
- Establish a continuing education program to indoctrinate new employees.
- Designate a foreman or supervisor to oversee and enforce proper spill prevention and control measures.

NOTE: The first step for any spill cleanup, whether minor or significant, is for the employee to identify the spilled material or to find a co-worker that can do so. Once identified it may be necessary for personnel to use Personal Protective Equipment (PPE) prior to continuing with the cleanup. If the spill is significant or hazardous, then it will likely require help from a local emergency response team with more experience.

Cleanup

- Clean up leaks and spills immediately.
- Use as little water as possible when cleaning spills. Use a rag for small spills, a damp mop for general cleanup, and absorbent material for larger spills. If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to either a certified laundry (rags) or disposed of as hazardous waste.
- Never hose down or bury dry material spills. Clean up as much of the material as possible and dispose of properly. See the waste management BMPs in this section for specific information.

Minor Spills

- Minor spills typically involve small quantities of oil, gasoline, paint, etc. which can be controlled by the first responder at the discovery of the spill.
- Use absorbent materials on small spills rather than hosing down or burying the spill.
- Remove the absorbent materials promptly and dispose of properly.
- The practice commonly followed for a minor spill is:
    1. Contain the spread of the spill.
    2. Recover spilled materials.
    3. Clean the contaminated area and/or properly dispose of contaminated materials.

Semi-Significant Spills

- Remove the absorbent materials promptly and dispose of properly.
- Semi-significant spills still can be controlled by the first responder along with the aid of other personnel such as laborers and the foreman, etc. This response may require the cessation of all other activities and the use of PPEs.
- Clean up spills immediately:
    1. Notify the project foreman immediately. The foreman shall notify the Engineer or Safety Manager.
    2. Determine if spill response construction personnel are qualified to perform the cleanup in a safe manner. Alert additional trained personnel if necessary including a Haz-Mat team or dial 911 for local authorities.
    3. Contain spread of the spill.

Approach (cont'd)

4. If the spill occurs on paved or impermeable surfaces, clean up using "dry" methods (absorbent materials, cat litter and/or rags). Contain the spill by encircling with absorbent materials and do not let the spill spread widely.
5. If the spill occurs during rain, cover spill with tarps or other material to prevent contaminating runoff.

Significant/Hazardous Spills

For significant or hazardous spills that cannot be controlled by personnel in the immediate vicinity, the following steps shall be taken:

1. Notify the Engineer immediately and follow up with a written report.
2. Notify the local emergency response by dialing 911. In addition to 911, the contractor will notify the proper county officials. It is the contractor's responsibility to have all emergency phone numbers at the construction site.
3. For spills of state reportable quantities or into a waterbody or adjoining shoreline, the contractor shall notify the Kentucky Division of Water (KDOW) general hotline – environmental assistance at 1-800-928-2380.
4. For spills of federal reportable quantities or into a waterbody or adjoining shoreline, the contractor shall notify the National Response Center at (800) 424-8802.
5. Notification should first be made by telephone and followed up with a written report.
6. The services of a spill contractor or a Haz-Mat team shall be obtained immediately. Construction personnel should not attempt to clean up until the appropriate and qualified staff has arrived at the job site.
7. Other agencies which may need to be consulted include, but are not limited to, the Fire Department, the City Engineer, the City/County Police Department, Occupational Safety and Health Administration (OSHA), etc.

See GHP-12 and -13 for details about spill prevention and control while maintaining or fueling vehicles and equipment.

Maintenance

- Keep an ample supply of spill control and cleanup material on-site, near storage, unloading and maintenance areas.
- Employee Training

Inspection Checklist

- [ ] Required amount of clean up material available at the site.
- [ ] Employees clearly understand their duties when a spill occurs.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Good Housekeeping Practices (GHPs)

GHP-06

Activity: Solid Waste Management (SWM)

PLANNING CONSIDERATIONS:

Training:
No

Inspection Frequency:
Weekly

Implementation Cost:
Low

Monthly Maintenance:
Low

Target Pollutants

Significant ♦ Partial ⟐ Low or Unknown ◊

Sediment ⟐ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ⟐
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ♦ Construction Waste ♦

Description

The management of waste in and out of a construction site reduces and in some cases prevents the discharge of pollutants to stormwater. This waste may be solid or construction waste, and can be disposed of at designated waste collection areas and in containers. This management practice will significantly reduce the quantity of floatable materials and other construction waste materials from escaping the construction site.

Approach

Solid waste is one of the major pollutants resulting from construction. Construction debris includes:

- Solid waste generated from trees and shrubs removed during land clearing, demolition of existing structures (rubble), and building construction;
- Packaging materials including wood, paper and plastic;
- Scrap or surplus building materials including scrap metals, rubber, plastic, glass pieces, and masonry products;
- Concrete, brick, and mortar;
- Pipe and electrical cuttings;
- Pavement planning or grinding and removal;
- Wood framing or false work; and
- Domestic wastes including food containers such as beverage cans, coffee cups, paper bags, and plastic wrappers, and cigarettes.

Approach (cont'd)

The following steps will help keep a clean site and reduce stormwater pollution:

- Designate waste storage areas that are away from storm drain inlets, stormwater facilities, or watercourses.
- Provide containers in areas where employees congregate for breaks and lunch.
- Inform trash-hauling contractors that you will accept only watertight dumpsters for on-site use. Inspect dumpsters for leaks or open drain valves and repair any dumpster that is not watertight and tightly close the drain valve.
- Do not hose out dumpsters on the construction site. Leave dumpster cleaning to trash hauling contractor.
- Arrange for regular waste collection before containers overflow.
- If a container does spill, clean up immediately.
- Locate storage containers in a covered area and/or in secondary containment.
- Segregate potentially hazardous waste from non-hazardous construction site waste.
- Provide an adequate number of containers with lids or covers that can be placed over the container to keep rain out or to prevent loss of wastes when it is windy.
- Plan for additional containers and more frequent pickup during the demolition phase of construction.
- Collect site trash daily, especially during rainy and windy conditions.
- Erosion and sediment control devices tend to collect litter. Remove this solid waste promptly.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- Salvage or recycle any useful material. For example, trees and shrubs from land clearing can be used as a brush barrier or converted into wood chips, then used as mulch on graded areas.
- Make sure that construction waste is collected, removed, and disposed of only at authorized disposal areas.
- Train employees and subcontractors in proper solid waste management.
- Require that employees and subcontractors follow solid waste handling and storage procedures.
- For a quick reference on disposal alternatives for specific wastes, see the table presented in the Employee/Subcontractor Training BMP fact sheet, Table GHP-14-1.

Maintenance

- Collect site trash daily.
- Inspect construction waste area regularly.
- Arrange for regular waste collection.

Inspection Checklist

- ☐ There are no major limitations to this best management practice.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Good Housekeeping Practices (GHPs)

GHP-07

Activity: Hazardous Waste Management (HWM)

PLANNING CONSIDERATIONS:

Training:
Yes

Inspection Frequency:
Weekly

Implementation Cost:
Low

Monthly Maintenance:
Low

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◇

Sediment ◇ Heavy Metals ◇ Nutrients ◇ Oxygen Demanding Substances ◇ Toxic Materials ◈
Oil& Grease ◇ Bacteria & Viruses ◇ Floatable Materials ◇ Construction Waste ◇

Description

Educating employees and subcontractors on methods for properly managing, storing, and disposing hazardous waste will aid in reducing pollution leaving the construction site, thus resulting in a partial reduction of toxic materials entering stormwater conveyance systems.

Approach

Most chemicals used on-site can be hazardous materials which become hazardous waste upon disposal. These wastes may include:

- Paints and solvents
- Petroleum products such as oils, fuels, and grease
- Herbicides and pesticides
- Acids for cleaning masonry
- Concrete curing compounds

In addition, sites with existing structures may contain wastes which must be disposed of in accordance with Federal, State, and local regulations. These wastes include:

- Sandblasting grit mixed with lead-, cadmium-, or chromium-based paints;
- Asbestos; and
- PCBs (particularly in older transformers).

Activity: Hazardous Waste Management	GHP-07

Approach (cont'd)

The following steps will help reduce stormwater pollution from hazardous wastes:

Material Use

- Use the entire product before disposing of the container.
- Do not remove the original product label, it contains important safety and disposal information.
- Material Safety Data Sheets should be provided for each product being handled. All persons using or handling the product should be made aware of the safety information and the location of the readily available Material Safety Data Sheets.
- Do not over-apply herbicides and pesticides. Prepare only the amount needed. Follow the recommended usage instructions. Over-application is expensive, environmentally harmful and generally doesn't provide the intended additional benefit. Apply surface dressings in several smaller applications, as opposed to one large application, to allow time for infiltration and to avoid excess material being carried off-site by runoff. Do not apply these chemicals just before it rains. People applying pesticides must be trained and certified in accordance with Federal and State regulations.
- Do not clean out brushes or rinse paint containers into the dirt, street, gutter, storm drain, or stream. "Paint out" brushes as much as possible. Rinse water-based paints to the sanitary sewer. Filter and re-use thinners and solvents. Dispose of excess oil-based paints and sludge as hazardous waste.

Waste Recycling/Disposal

- Select designated hazardous waste collection areas on-site.
- Regularly schedule hazardous waste removal to minimize on-site storage.
- Hazardous materials and wastes should be stored in covered containers and protected from vandalism. They should be stored in the original containers or in other well marked containers.
- Place hazardous waste containers in secondary containment.

Storage Procedures

- Ensure that adequate hazardous waste storage volume is available.
- Ensure that hazardous waste collection containers are conveniently located.
- Designate hazardous waste storage areas on site, away from storm drains or watercourses.
- Minimize production or generation of hazardous materials and hazardous waste on the jobsite.
- Use containment berms in fueling and maintenance areas and where the potential for spills is high.
- Segregate potentially hazardous waste from non-hazardous construction site debris.
- Store hazardous materials and wastes in covered containers and protected from vandalism.
- Keep liquid or semi-liquid hazardous waste in appropriate containers (closed drums or similar) and under cover.

Approach (cont'd)

- Clearly mark on all hazardous waste containers which materials are acceptable for the container.
- Place hazardous waste containers in secondary containment.
- Do not allow potentially hazardous waste materials to accumulate on the ground.
- Do not mix wastes as this can cause unforeseen chemical reactions, make recycling impossible and complicate disposal.
- Recycle any useful material such as used oil or water-based paint.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for non-hazardous construction debris.
- Arrange for regular waste collection before containers overflow.
- Make sure that hazardous waste (e.g. excess oil-based paint and sludges) is collected, removed, and disposed of only at authorized disposal areas.
- For a quick reference on disposal alternatives for specific wastes, see the table presented in the Employee/Subcontractor Training BMP fact sheet, Table GHP-14-1.

Training

- Educate employees and subcontractors on hazardous waste storage and disposal procedures.
- Educate employees and subcontractors of potential dangers to humans and the environment from hazardous wastes.
- Instruct employees and subcontractors on safety procedures for common construction site hazardous wastes.
- Instruct employees and subcontractors in identification of hazardous and solid waste.
- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).
- Designate a foreman or supervisor to oversee and enforce proper solid waste management procedures and practices.
- Make sure that hazardous waste is collected, removed, and disposed of only at authorized disposal areas.
- Train employees and subcontractors in proper hazardous waste management including review of material safety data sheets.
- Warning signs should be placed in areas recently treated with chemicals.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- If a container does spill, clean up immediately.

Activity: Hazardous Waste Management	GHP-07

Maintenance

- ➢ Inspect hazardous waste receptacles and area regularly.
- ➢ Arrange for regular hazardous waste collection.

Inspection

- ❑ Hazardous waste receptacles are properly maintained.
- ❑ Hazardous waste material is properly and routinely removed from the site by a licensed hazardous waste hauler.

	Somerset, Kentucky **Stormwater Best Management Practices (BMPs)** **Good Housekeeping Practices (GHPs)**	GHP-08
	Activity: Contaminated Soil Management (SM)	

PLANNING CONSIDERATIONS:

Training:
Yes

Inspection Frequency:
Weekly

Implementation Cost:
Low

Monthly Maintenance:
Low

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◇

Sediment ◈ Heavy Metals ◇ Nutrients ◇ Oxygen Demanding Substances ◇ Toxic Materials ♦
Oil& Grease ◈ Bacteria & Viruses ◇ Floatable Materials ◇ Construction Waste ◇

Description

Contaminated soil and highly acidic or alkaline soils produce pollutants in stormwater. Contaminated Soil Management allows preventive measures such as pre-construction surveying, inspecting excavations regularly, and remediating contaminated soil promptly all reduce or prevent the discharge of pollutants to stormwater.

Suitable Applications

- Applicable to many construction projects, especially those in highly urbanized or industrial areas, where soil contamination may have occurred due to spills, illicit discharges, and underground storage tanks.
- Applicable to highway widening projects in older areas where median and shoulder soils may have been contaminated by aerially deposited lead.

Approach

Contaminated soils are often identified in the project material report with known locations identified in the plans and specifications. The contractor shall review applicable reports and investigate appropriate callouts in the plans and specifications.

Contaminated soils may occur on your site for several reasons including:

- Past site uses and activities;
- Detected or undetected spills and leaks; and
- Acid or alkaline solutions from exposed soil or rock formations high in acid or alkaline-forming elements.

Approach (cont'd)

Most developers conduct pre-construction environmental assessments as a matter of routine. Recent court rulings holding contractors liable for cleanup costs when they unknowingly move contaminated soil, highlight the need for contractors to confirm that a site assessment is completed before earth moving begins.

The following steps will help reduce stormwater pollution from contaminated soil:

- Conduct thorough site planning including pre-construction geologic surveys.
- Look for contaminated soil as evidenced by discoloration, odors, differences in soil properties, abandoned underground tanks or pipes, or buried debris.
- Prevent leaks and spills to the maximum extent practicable. Contaminated soil can be expensive to treat and/or dispose of properly. However, addressing the problem before construction is much less expensive than after the structures are in place.
- For a quick reference on disposal alternatives for specific wastes, see the table presented in the Employee/Subcontractor Training BMP fact sheet, Table GHP-14-1.

Application of this BMP Fact Sheet

Excavation, transport, and disposal of contaminated material and hazardous material shall be in accordance with the rules and regulations of the following agencies (the specifications of these agencies shall supersede the procedures outlined in this BMP):

- United States Environmental Protection Agency (USEPA)
- Kentucky Division of Water (KDOW)
- UST Branch, Kentucky Division of Waste Management (KDWM)
- Kentucky Division of Occupation Safety and Health Administration (OSHA)

Education

- Prior to performing any excavation work at the locations containing material classified as hazardous, employees and subcontractors shall complete a safety-training program.
- Educate employees and subcontractors on contaminated soil handling and disposal procedures.
- Instruct employees and subcontractors in identification of contaminated soil.
- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).
- Provide additional training for field supervisors and inspectors, including hazardous material safety training.

Handling Procedures for Material with Aerially Deposited Lead

- Materials from areas designated as containing aerially deposited lead may, if allowed by the contract special provisions, be excavated, transported, and used in the construction of embankments and/or backfill.
- Excavation, transportation, and placement operations shall result in no visible dust.
- Use caution to prevent spillage of lead containing material during transport.
- Monitor the air quality during excavation of soils contaminated with lead.

Approach (cont'd)

Handling Procedures for Contaminated Soils or Hazardous Materials

- Test suspected soils at a certified laboratory.
- If the soil is contaminated, work with KDOW or environmental contractor to develop options for treatment and/or disposal.
- Avoid temporary stockpiling of contaminated soils or hazardous material.
- If temporary stockpiling is necessary:
  1. Cover the stockpile with plastic sheeting or tarps.
  2. Install a berm around the stockpile to prevent runoff from leaving the area.
  3. Do not stockpile in or near storm drains or watercourses.
  4. Implement stockpile controls as presented in GHP-04: Material Delivery, Storage, and Use.
- Contaminated material and hazardous material on exteriors of transport vehicles shall be removed and placed either into the current transport vehicle or the excavation prior to the vehicle leaving the exclusion zone.
- Monitor the air quality continuously during excavation operations at all locations containing hazardous material.
- Procure all permits and licenses, pay all charges and fees, and give all notices necessary and incident to the due and lawful prosecution of the work, including registration for transporting vehicles carrying the contaminated material and the hazardous material.
- Collect water from decontamination procedures and dispose of at an appropriate disposal site.
- Collect non-reusable personal protective equipment (PPE), once used by any personnel, and dispose of at an appropriate disposal site.
- Install temporary security fence to surround and secure the exclusion zone. Remove fencing when no longer needed.

Procedures for Underground Storage Tank Removals

- Prior to commencing tank removal operations, obtain the required underground storage tank removal permits and approval from UST Branch, Kentucky Division of Waste Management, which has jurisdiction over such work.
- Arrange to have tested, as directed by the design professional, any liquid or sludge found in the underground tank prior to its removal to determine if it contains hazardous material.
- Following the tank removal, take soil samples beneath the excavated tank and perform analysis as required by UST Branch, Kentucky Division of Waste Management and the local agency representative(s).
- The underground storage tank, any liquid and/or sludge found within the tank, and all contaminated material and hazardous material removed during the tank removal shall be transported to disposal facilities permitted to accept such material by a licensed hazardous waste hauler.

Activity: Contaminated Soil Management	GHP-08

Approach (cont'd)

Water Control

- Take all necessary precautions and preventive measures to prevent the flow of water, including ground water, from entering hazardous material or underground storage tank excavations. Such preventative measures may consist of, but are not limited to berms, cofferdams, grout curtains, freeze walls, and seal course concrete or any combination thereof.
- If water does enter an excavation and becomes contaminated, such water, when necessary to proceed with the work, shall be discharged to clean, closed top, watertight, transportable holding tanks, and disposed of in accordance with federal, state, and local laws.

Maintenance

- Inspect excavated areas daily for indications of contaminated soil.
- Implement GHP-05: Spill Prevention and Control, to prevent leaks and spills as much as possible.
- Monitor air quality continuously during excavation operations at all locations containing hazardous material.
- Coordinate contaminated soils and hazardous material management with the appropriate federal, state, and local agencies.
- Inspect hazardous waste receptacles and areas regularly.

Inspection Checklist

- ❑ The procedures and practices presented in this BMP are general. The contractor shall identify appropriate practices and procedures for the specific contaminants known to exist or discovered on site.
- ❑ Contaminated soils that cannot be treated on-site must be disposed of off-site by a licensed hazardous waste hauler.
- ❑ The presence of contaminated soil may indicate contaminated water as well. See GHP-01: Dewatering Operations for more information.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Good Housekeeping Practices (GHPs)

GHP-09

Activity: Concrete Waste Management

PLANNING CONSIDERATIONS:

Training:
No

Inspection Frequency:
Weekly to Monthly

Implementation Cost:
Low

Monthly Maintenance:
Low

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◇

Sediment ◇ Heavy Metals ◇ Nutrients ◇ Oxygen Demanding Substances ◇ Toxic Materials ◇
Oil& Grease ◇ Bacteria & Viruses ◇ Floatable Materials ◇ Construction Waste ◈

Description

Concrete waste management requires simple measures including off-site washouts, performing on-site washout in a designated area, and training employees and subcontractors. These procedures will help reduce concrete pollutant discharge to stormwater

Approach

The following steps will help reduce stormwater pollution from concrete wastes:

- Store dry and wet materials under cover, away from drainage areas.
- Avoid mixing excess amounts of fresh concrete or cement on-site.
- Perform washout of concrete trucks off site or in designated areas only – such as a specially designed soil mixing sump protected by a sediment trap.
- Do not wash out concrete trucks into storm drains, open ditches, streets, or streams.
- Do not allow excess concrete to be dumped on-site, except in designated areas. For on-site washout:
- Locate washout area at least 50 feet from storm drains, open ditches, or water bodies. Do not allow runoff from this area by constructing a temporary pit or bermed area large enough for liquid and solid waste;
- Wash out wastes into the temporary pit where the concrete can set, be broken up, and then disposed of properly.
- Be sure the stormwater collection system is protected by means of a sediment trap or similar practice.

Approach (cont'd)

- When washing concrete to remove fine particles and expose the aggregate, avoid creating runoff by draining the water to a bermed or level area.
- Do not wash sweepings from exposed aggregate concrete into the street or storm drain. Collect and return sweepings to aggregate base stockpile, or dispose in the trash.
- Train employees and subcontractors in proper concrete waste management.
- For a quick reference on disposal alternatives for specific wastes, see the table presented in the Employee/Subcontractor Training BMP fact sheet, Table GHP-14-1.
- Illicit dumping on-site or off-site without property owner's knowledge and consent is unacceptable.
- Washout locations may be flagged with lath and surveyors tape or designated as necessary to insure that truck drivers utilize proper areas.

Education

- Instruct drivers and equipment operators on proper disposal and equipment washout practices.
- Educate employees, subcontractors, and suppliers on concrete waste storage and disposal procedures.
- Designate a foreman or supervisor to oversee and enforce concrete waste management procedures. Make supervisors aware of the potential environmental consequences of improperly handled concrete wastes.

Demolition Practices

- Monitor weather and wind direction to ensure concrete dust is not entering storm drains, watercourses, or surface waters.
- Where appropriate, construct sediment traps or other types of sediment detention devices downstream of demolition activities.

Maintenance

- Inspect subcontractors to ensure that concrete wastes are being properly managed.
- If using a temporary pit, dispose hardened concrete on a regular basis that will prevent the pit from being more than half-full.
- Foreman and/or construction supervisor shall monitor on site concrete waste storage and disposal procedures at least weekly.

Inspection

- ☐ Concrete waste receptacles are maintained and emptied routinely.
- ☐ On-site wash out area is located at least 50 ft. from storm drains, open ditches, or other water bodies
- ☐ On-site wash out area is properly maintained and cleaned.

	Somerset, Kentucky **Stormwater Best Management Practices (BMPs)** **Good Housekeeping Practices (GHPs)**	GHP-10
	Activity: Sanitary/Septic Waste Management (S&SWM)	

PLANNING CONSIDERATIONS:

Training:
Yes

Inspection Frequency:
Weekly

Implementation Cost:
Medium

Monthly Maintenance:
Medium

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ◊ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ♦ Floatable Materials ◊ Construction Waste ◈

Description

Providing convenient well-maintained sanitary and septic waste facilities with regular service and disposal reduces or prevents discharge of pollutants to stormwater from sanitary/septic waste.

Approach

- Sanitary or septic wastes should be treated or disposed of in accordance with Kentucky Division of Water (KDOW) and local health department requirements.
- Locate sanitary facilities in a convenient location.
- Never discharge untreated or raw wastewater to a ditch, creek or other waterway, or bury on site.
- Temporary septic systems should treat wastes to appropriate levels prior to discharging. KDOW should be consulted to determine appropriate levels.
- If using an on-site disposal system (OSDS), such as a septic system, comply with local health agency requirements.
- Temporary sanitary facilities that discharge to the sanitary sewer system should be properly connected and inspected by the local sewer authority to avoid illicit discharges to the storm sewer system and other pertinent requirements.
- Privately held sanitary/septic facilities should be maintained in good working order by a licensed service.
- Arrange for regular waste collection by a licensed hauler before facilities overflow.
- For a quick reference on disposal alternatives for specific wastes, see the table presented in the Employee/Subcontractor Training BMP fact sheet, Table GHP-14-1.
- Anchor portable sanitary facilities, when needed, to prevent them from tipping by vandals.

Activity: Sanitary/Septic Waste Management	GHP-10

Maintenance

- ➢ Inspect facilities regularly.
- ➢ Arrange for regular waste collection.

Inspection Checklist

- ❑ There are no major limitations to this best management practice other than those that may be imposed by the local sewer authority.

	Somerset, Kentucky **Stormwater Best Management Practices (BMPs)** **Good Housekeeping Practices (GHPs)**	GHP-11
	Activity: Vehicle and Equipment Cleaning (VEC)	

PLANNING CONSIDERATIONS:

Training:
No

Inspection Frequency:
Monthly

Implementation Cost:
Low

Monthly Maintenance:
Low

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ♢

Sediment ◈ Heavy Metals ◈ Nutrients ♢ Oxygen Demanding Substances ♢ Toxic Materials ◈
Oil& Grease ◈ Bacteria & Viruses ♢ Floatable Materials ♢ Construction Waste ♢

Description

Proper vehicle and equipment cleaning can prohibit pollutants from entering stream and ditches by cleaning equipment using an off-site facility, washing in designated contained areas only, infiltrating or recycling the wash water and by training employees and subcontractors.

Approach

- Use off-site commercial washing businesses as much as possible except for removing mud and dirt off equipment while on site. Washing vehicles and equipment outdoors or in areas where wash water flows onto paved surfaces or into drainage pathways can pollute stormwater. If you wash a large number of vehicles or pieces of equipment, consider conducting this work at an off-site commercial business.
- Off-site commercial businesses are better equipped to handle and dispose of the wash waters properly. Performing this work off-site can also be economical by eliminating the need for a separate washing operation at your site.
- If washing must occur on-site, use designated, bermed wash areas to prevent wash water entering stormwater infrastructure, creeks, rivers, and other water bodies. The wash area can be sloped for wash water collection and subsequent infiltration into the ground.
- Use phosphate-free, biodegradable soaps.
- Educate employees and subcontractors on pollution prevention measures about the importance of this practice.
- Do not permit steam cleaning on-site. Steam cleaning can generate significant pollutant concentrations.
- Clean all vehicles/equipment off-site that regularly enter and leave the construction site.

Activity: Vehicle and Equipment Cleaning | GHP-11

Approach (cont'd)

- When vehicle/equipment washing/cleaning must occur on-site, and the operation cannot be located within a structure or building equipped with sanitary sewer facilities, the outside cleaning area shall have the following characteristics:
  1. Located away from storm drain inlets, drainage facilities, or watercourses;
  2. Paved with concrete or asphalt, or stabilized with an aggregate base;
  3. Configured wash area with a sump to allow collection and disposal of wash water;
  4. Discharge wash water to a sanitary or process waste sewer (where permitted), or to a dead end sump. Wash waters shall not be discharged to storm drains or watercourses.
- When cleaning vehicles/equipment with water:
  1. Use as little water as possible to avoid having to install erosion and sediment controls for the wash area. High-pressure sprayers may use less water than a hose, and should be considered.
  2. Use positive shutoff valve to minimize water usage.
- DO NOT use solvents to clean vehicles/equipment on site.

Maintenance

- Minimal, some berm repair may be necessary, inspect weekly.
- Service sump regularly.

Inspection Checklist

- [ ] No phosphate-free, biodegradable soaps are being used.
- [ ] Vehicles and equipment are sent off-site using the stabilized construction entrance and mud tracking removal.
- [ ] The local sewer authority has been contacted and is aware of all pretreatment and monitoring of wash water discharges to the sanitary sewer.

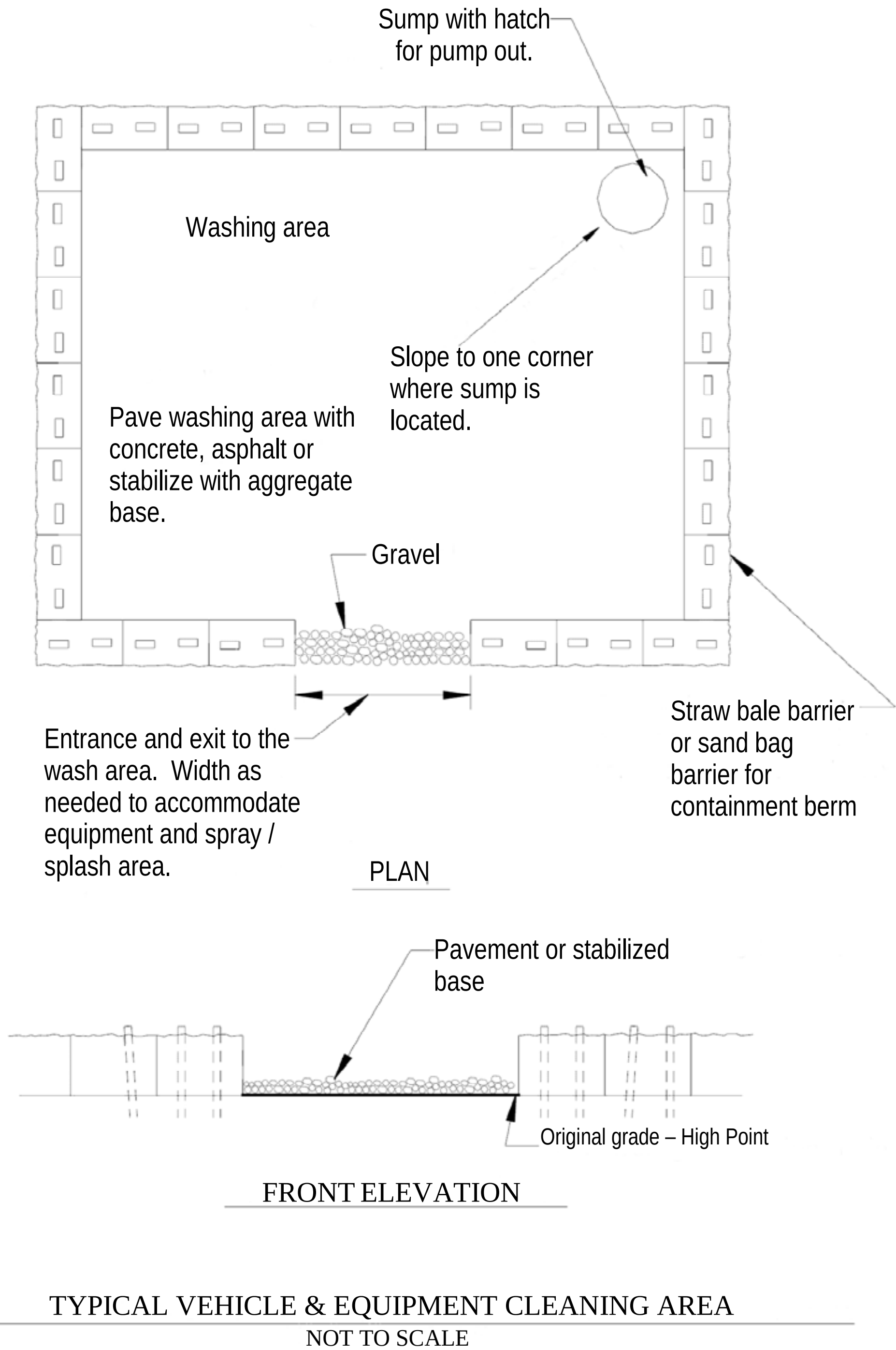


Figure GHP-11
Typical Vehicle and Equipment Cleaning Area

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Good Housekeeping Practices (GHPs)

GHP-12

Activity: Vehicle and Equipment Fueling (VEF)

PLANNING CONSIDERATIONS:

Training:
No

Inspection Frequency:
Monthly

Implementation Cost:
Low

Monthly Maintenance:
Low

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◇

Sediment ◇ Heavy Metals ◇ Nutrients ◇ Oxygen Demanding Substances ◇ Toxic Materials ◈
Oil& Grease ◈ Bacteria & Viruses ◇ Floatable Materials ◇ Construction Waste ◇

Description

This BMP prevents fuel spills and leaks and their impact to stormwater by using off-site facilities, fueling in designated areas only, enclosing or covering stored fuel, implementing spill controls, and training employees and subcontractors.

Approach

- Use off-site fueling stations as much as possible. Fueling vehicles and equipment outdoors or in areas where fuel may spill/leak onto paved surfaces or into drainage pathways can pollute stormwater. If you fuel a large number of vehicles or pieces of equipment, consider using an off-site fueling station. These businesses are better equipped to handle fuel and spills properly. Performing this work off-site can also be economical by eliminating the need for a separate fueling area at your site.
- If on-site fueling can not be avoided, designated areas, located away from drainage courses, can be used to prevent the run-on of stormwater and the runoff of spills.
- Educate employees and subcontractors not to “top-off” fuel tanks.
- When fueling, use secondary containment, such as a drain pan or drop cloth, to catch spills/leaks.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Use adsorbent materials on small spills rather than hosing down or burying the spill. Remove the adsorbent materials promptly and dispose of properly.

Activity: Vehicle and Equipment Fueling	GHP-12

Approach (cont'd)

- Observe Federal and State requirements regarding stationary above-ground storage tanks with special attention given to secondary containment.
- Avoid mobile fueling of mobile construction equipment around the site; rather, transport the equipment to designated fueling areas. With the exception of tracked equipment such as bulldozers and perhaps forklifts, most vehicles should be able to travel to a designated area with little lost time.
- For a quick reference on disposal alternatives for specific wastes, see the table presented in the Employee/Subcontractor Training BMP fact sheet, Table GHP-14-1.
- Locate fueling areas on a paved surface where practical.
- Protect fueling areas with berms and/or dikes to prevent run-on, runoff, and to contain spills.
- Use vapor recovery nozzles to help control drips as well as air pollution where required by Air Quality Management Districts.

Maintenance

- Keep ample supplies of spill cleanup materials on-site.
- Inspect fueling areas and storage tanks on a regular schedule.

Inspection Checklist

- ☐ Secondary containment area is properly maintained and preventing petroleum products from runoff to streams and ditches.
- ☐ Construction site has proper materials for cleaning spills.
- ☐ Fueling tanks are working properly.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Good Housekeeping Practices (GHPs)

GHP-13

Activity: Vehicle and Equipment Maintenance (VEM)

PLANNING CONSIDERATIONS:

Training:
No

Inspection Frequency:
Monthly

Implementation Cost:
Low

Monthly Maintenance:
Low

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ◊ Heavy Metals ◈ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◈
Oil& Grease ◈ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

Contractors occasionally require an on-site vehicle and equipment maintenance area to avoid work stoppage for extended periods due to inoperable equipment. Whenever possible, the contractor should operate a "dry site" to reduce or prevent discharge of pollutants to stormwater from vehicles and equipment maintenance. This involves using off-site facilities (whenever feasible), performing work in designated areas only, providing cover for materials stored outside, checking for leaks and spills, containing and cleaning up spills immediately and training employees and subcontractors.

Approach

- Keep vehicles and equipment clean; don't allow excessive build-up of oil and grease.
- Use off-site repair shops as much as possible. Maintaining vehicles and equipment outdoors or in areas where vehicle or equipment fluids may spill or leak onto the ground can pollute stormwater. If you maintain a large number of vehicles or pieces of equipment, consider using an off-site repair shop. These businesses are better equipped to handle vehicle fluids and spills properly. Performing this work off-site can also be economical by eliminating the need for a separate maintenance area.

Waste Reduction

- Reducing the number of solvents used for cleaning equipment makes recycling easier and reduces hazardous waste management costs.
    - Replace chlorinated organic solvents (1,1,1-trichloroethane, methylene chloride, etc.) with non-chlorinated solvents. Non-chlorinated solvents like kerosene or mineral spirits are less toxic and less expensive to dispose of properly.

Approach (cont'd)

- Check for inactive ingredients to see whether it contains chlorinated solvents. The "chlor" term indicates that the solvent is chlorinated.
- Substitute a wire brushes for solvents to clean parts.

➢ If maintenance must occur on-site, use designated areas, located away from watercourses, to prevent the run-on of stormwater and the runoff of spills.

➢ Use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.

➢ Place a stockpile of spill cleanup materials where it will be readily accessible.

➢ Place drip pans or absorbent materials under paving equipment when not in use.

➢ Use adsorbent materials on small spills rather than hosing down or burying the spill. Remove the adsorbent materials promptly and dispose of properly.

➢ Regularly inspect on-site vehicles and equipment for leaks, and repair immediately.

➢ Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around.

➢ Check incoming vehicles and equipment (including delivery trucks, and employee and subcontractor vehicles) for leaking oil and fluids. Do not allow leaking vehicles or equipment on-site.

➢ Oil filters disposed of in trashcans or dumpsters can leak oil and pollute stormwater. Place the oil filter in a funnel over a waste oil recycling drum to drain excess oil before disposal. Oil filters can also be recycled. Ask your oil supplier or recycler about recycling oil filters.

➢ Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

➢ Segregate and recycle wastes, such as greases, used oil or oil filters, antifreeze, cleaning solutions, automotive batteries, hydraulic, and transmission fluids.

➢ Train employees and subcontractors in proper maintenance and spill cleanup procedures.

➢ For a quick reference on disposal alternatives for specific wastes, see the table presented in the Employee/Subcontractor Training BMP fact sheet, Table GHP-14-1.

➢ Perform maintenance activities on paved surfaces where practical.

➢ Use diversion berms to protect maintenance areas from run-on.

➢ Provide spill containment dikes or secondary containment around stored oil and chemical drums.

➢ For long-term projects, consider using portable tents or covers over maintenance areas.

➢ Do not dump fuels and lubricants onto the ground.

➢ Do not place used oil in a dumpster or pour into a storm drain or watercourse.

➢ Do not bury used tires.

Approach (cont'd)

Recycling/Disposal

- Separating wastes allows for easier recycling and may reduce disposal costs. Keep hazardous and non-hazardous wastes separate, do not mix used oil and solvents, and keep chlorinated solvents (like 1,1,1-trichloroethane) separate from non-chlorinated solvents (like kerosene and mineral spirits).
- Do not dispose of extra paints and coatings by dumping liquid onto the ground or throwing it into dumpsters. Allow coatings to dry or harden before disposal into covered dumpsters.

Maintenance

- Keep ample supplies of spill cleanup materials on-site.
- Inspect maintenance areas on a regular schedule.
- Maintain waste fluid containers in leak proof condition.
- Vehicle and equipment maintenance areas shall be inspected regularly.
- Inspect equipment for damaged hoses and leaky gaskets routinely. Repair or replace as needed.

Inspection Checklist

- [ ] On-site maintenance area is cleaned and properly maintained.
- [ ] Construction site has proper materials for cleaning spills.
- [ ] Watercourses in the vicinity are protected from spills by a diversion berm.
- [ ] Sending vehicles/equipment off-site should be done in conjunction with a stabilized construction entrance.

	Somerset, KY **Stormwater Best Management Practices (BMPs)** **Good Housekeeping Practices (GHPs)** **Activity: Employee/Subcontractor Training (EST)**	GHP-14

PLANNING CONSIDERATIONS:

Training:
Yes

Inspection Frequency:
None

Implementation Cost:
Medium

Monthly Maintenance:
Low

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ◊ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

Employee or subcontractor training will determine the success of the stormwater pollution prevention program. This BMP will focus on approaches to assure that employees and subcontractors are familiar with Bowling Green's the Storm Water Pollution Prevention Plan (SWPPP) and will turn the attention from an individualized source control into a comprehensive training program.

Suitable Applications

Employee/subcontractor training should be based on four objectives:

1. Promote a clear identification and understanding of the problem, including activities with the potential to pollute stormwater;
2. Identify solutions (BMPs);
3. Promote employee/subcontractor ownership of the problems and the solutions; and
4. Integrate employee/subcontractor feedback into training and BMP implementation.

Approach

- Integrate training regarding stormwater quality management with existing training programs that may be required for your business by other regulations such as the 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) standard (29 CFR 1910.120); and the Spill Prevention Control and Countermeasure (SPCC) Plan (40 CFR 112).
- Supervisors and inspectors should receive additional annual 8-hour refresher courses.

Approach (cont'd)

- Businesses, particularly smaller ones that may not be regulated by Federal, State, or local regulations, may use the information in this BMP Manual to develop a training program to reduce their potential to pollute stormwater.
- Use the quick reference on disposal alternatives (Table GHP-14-1) to train employee/subcontractors in proper and consistent methods for disposal.
- Consider posting the quick reference table around the job site or in the on-site office trailer to reinforce training.
- Train employee/subcontractors in standard operating procedures and spill cleanup techniques described in the fact sheets. Employee/subcontractors trained in spill containment and cleanup should be present during the loading/unloading and handling of materials.
- Personnel who use pesticides should be trained in their use.
- Proper education of off-site contractors is often overlooked. The conscientious efforts of well trained employee/subcontractors can be lost by unknowing off-site contractors, so make sure they are well informed about what they are expected to do on-site.

TABLE GHP-14-1 QUICK REFERENCE – DISPOSAL ALTERNATIVES

All of the waste products on this chart are prohibited from discharge to the storm drain system. Use this matrix to decide which alternative disposal strategies to use. ALTERNATIVES ARE LISTED IN PRIORITY ORDER.

Key:

HHW	Household hazardous waste	MWS	Municipal Waste System
NPDES	National Pollutant Discharge Elimination System (NPDES) Office.	POTW	Publicly Owned Treatment Plant

"Dispose to sanitary sewer" means dispose into sink, toilet, or sanitary sewer clean-out connection.
"Dispose as trash" means dispose in dumpsters or trash containers for pickup and/or eventual disposal in landfill.
"Dispose as hazardous waste" for business/commercial means contract with a hazardous waste hauler to remove and dispose.

DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	BUSINESS/COMMERCIAL Approval	RESIDENTIAL Disposal Priorities
General Construction and Painting: Street and Utility Maintenance			
Excess paint (oil based)	1. Recycle/reuse. 2. Solidify and dispose as hazardous waste.		1. Recycle/reuse. 2. Take to HHW drop-off.
Excess paint (water based)	1. Recycle/reuse 2. Dry residue in cans, dispose as trash. 3. If volume is too much to dry, solidify and dispose as hazardous waste.		1. Recycle/reuse. 2. Dry residue in cans, dispose as trash. 3. If volume is too much to dry, take to HHW drop-off.
Paint cleanup (oil based)	Wipe paint out of brushes, then: 1. Filter & reuse thinners, solvents. 2. Solidify and dispose as hazardous waste.		Wipe paint out of brushes, then: 1. Filter & reuse thinners, solvents. 2. Take to HHW drop-off.
Paint cleanup (water-based)	Wipe paint out of brushes, then 1. Rinse to sanitary sewer.		Wipe paint out of brushes, then 1. Rinse to sanitary sewer.
Empty paint cans (dry)	1. Remove lids, dispose as trash.		1. Remove lids, dispose as trash.
Paint stripping (with solvent)	1. Dispose as hazardous waste.		1. Take to HHW drop-off.
Building exterior cleaning (high-pressure water)	1. Prevent entry into storm drain and remove offsite. 2. Wash onto dirt area, spade in. 3. Collect (e.g. mop up) and discharge to sanitary sewer.	POTW-MWS	
Cleaning of building exteriors which have HAZARDOUS MATERIALS (e.g. mercury, lead) in paints	1. Use dry cleaning methods. 2. Contain and dispose washwater as hazardous waste (Suggestion: dry material first to reduce volume).		

General Construction and Painting: Street and Utility Maintenance (cont'd.)			
Non-hazardous paint scraping/sand blasting	1. Dry sweep, dispose as trash.		1. Dry sweep, dispose as trash.
HAZARDOUS paint scraping/sand blasting (e.g. marine paints or paints containing lead or tributyl tin)	1. Dry sweep, dispose as hazardous waste.		1. Dry sweep, take to HHW drop-off.
Soil from excavations during periods when storms are forecast	1. Should not be placed in street or on paved areas. 2. Remove from site or backfill by end of day. 3. Cover with tarpaulin or surround with silt fences, or use other runoff controls. 4. Place filter mat over storm drain. Note: Thoroughly sweep following removal of dirt in all four alternatives.		
Soil from excavations placed on paved surfaces during periods when storms are not forecast	1. Keep material out of storm conveyance systems and thoroughly remove via sweeping following removal of dirt.		
Cleaning streets in construction areas	1. Dry sweep and minimize tracking of mud. 2. Use silt ponds and/or similar pollutant reduction techniques when flushing pavement.		
Soil erosion, sediments	1. Cover disturbed soils, use erosion controls, block entry to storm drain. 2. Seed or plant immediately.		
Fresh cement, grout, mortar	1. Use/reuse excess 2. Dispose to trash		1. Use/reuse excess 2. Dispose to trash
Washwater from concrete/mortar (etc.) cleanup	1. Wash onto dirt area, spade in. 2. Pump and remove to appropriate disposal facility. 3. Settle, pump water to sanitary sewer.	POTW-MWS	1. Wash onto dirt area, spade in. 2. Pump and remove to appropriate disposal facility. 3. Settle, pump water to sanitary sewer.
Aggregate wash from driveway/patio construction	1. Wash onto dirt area, spade in. 2. Pump and remove to appropriate disposal facility. 3. Settle, pump water to sanitary sewer.	POTW-MWS	1. Wash onto dirt area, spade in. 2. Pump and remove to appropriate disposal facility. 3. Settle, pump water to sanitary sewer.
Rinsewater from concrete mixing trucks	1. Return truck to yard for rinsing into pond or dirt area. 2. At construction site, wash into pond or dirt area.		

General Construction and Painting: Street and Utility Maintenance (cont'd.)			
Non-hazardous construction and demolition debris	1. Recycle/reuse (concrete, wood, etc.). 2. Dispose as trash.		1. Recycle/reuse (concrete, wood, etc.). 2. Dispose as trash.
Hazardous demolition and construction debris (e.g. asbestos)	1. Dispose as hazardous waste.		1. Do not attempt to remove yourself. Contact asbestos removal service for safe removal and disposal. 2. Very small amounts (less than 5 lbs.) may be double-wrapped in plastic and taken to HHW drop-off.
Saw-cut slurry	1. Use dry cutting technique and sweep up residue. 2. Vacuum slurry and dispose off-site. 3. Block storm drain or berm with low weir as necessary to allow most solids to settle. Shovel out gutters; dispose residue to dirt area, construction yard or landfill.		
Construction dewatering (Nonturbid, uncontaminated groundwater)	1. Recycle/reuse. 2. Discharge to storm drain.		
Construction dewatering (Other than nonturbid, uncontaminated groundwater)	1. Recycle/reuse. 2. Discharge to sanitary sewer. 3. As appropriate, treat prior to discharge to storm drain.	POTW-MWS MDPW-NPDES	
Portable toilet waste	1. Leasing company shall dispose to sanitary sewer at POTW.	POTW-MWS	
Leaks from garbage dumpsters	1. Collect, contain leaking material. Eliminate leak, keep covered, return to leasing company for immediate repair. 2. If dumpster is used for liquid waste, use plastic liner.		
Leaks from construction debris bins	1. Insure that bins are used for dry nonhazardous materials only (Suggestion: Fencing, covering help prevent misuse).		
Dumpster cleaning water	1. Clean at dumpster owner's facility and discharge waste through grease interceptor to sanitary sewer. 2. Clean on site and discharge through grease interceptor to sanitary sewer.	POTW-MWS POTW-MWS	

DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval	RESIDENTIAL Disposal Priorities
General Construction and Painting: Street and Utility Maintenance (cont'd.)			
Cleaning driveways, paved areas (Special Focus = Restaurant alleys, grocery dumpster areas)	1. Sweep and dispose as trash (Dry cleaning only). 2. For vehicle leaks, restaurant/grocery alleys, follow this 3-step process: a. Clean up leaks with rags or absorbents. b. Sweep, using granular absorbent material (cat litter). c. Mop and dispose of mopwater to sanitary sewer (or collect rinsewater and pump to the sanitary sewer). 3. Same as 2 above, but with rinsewater (2c)(no soap) discharged to storm drain.		1. Sweep and dispose as trash (Dry cleaning only). 2. For vehicle leaks follow this 3-step process: a. Clean up leaks with rags or absorbents; dispose as hazardous waste. b. Sweep, using granular absorbent material (cat litter). c. Mop and dispose of mopwater to sanitary sewer.
Steam cleaning of sidewalks, plazas	1. Collect all water and pump to sanitary sewer. 2. Follow this 3-step process: a. Clean oil leaks with rags or adsorbents. b. Sweep (Use dry absorbent as needed). c. Use no soap, discharge to storm drain.		
Potable water/line flushing Hydrant testing	1. Deactivate chlorine by maximizing time water will travel before reaching creeks.		
Super-chlorinated (above 1 ppm) water from line flushing	1. Discharge to sanitary sewer. 2. Complete dechlorination required before discharge to storm drain.		
Landscape/Garden Maintenance			
Pesticides	1. Use up. Rinse containers, use rinsewater as product. Dispose rinsed containers as trash. 2. Dispose unused pesticide as hazardous waste.		1. Use up. Rinse containers, use rinsewater as pesticide. Dispose rinsed container as trash. 2. Take unused pesticide to HHW drop-off.
Garden clippings	1. Compost. 2. Take to Landfill.		1. Compost. 2. Dispose as trash.
Tree trimming	1. Chip if necessary, before composting or recycling.		1. Chip if necessary, before composting or recycling.

DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval	RESIDENTIAL Disposal Priorities
Landscape/Garden Maintenance (cont'd.)			
Swimming pool, spa, fountain water (emptying)	1. Do not use metal-based algicides (i.e. Copper Sulfate). 2. Recycle/reuse (e.g. irrigation). 3. Determine chlorine residual = 0, wait 24 hours and then discharge to storm drain.	POTW-MWS	1. Do no use metal-based algicides (i.e. Copper Sulfate). 2. Recycle/reuse (e.g. irrigation). 3. Determine chlorine residual = 0, wait 24 hours and then discharge to storm drain.
Acid or other pool/spa/fountain cleaning	1. Neutralize and discharge to sanitary sewer.	POTW-MWS	
Swimming pool, spa filter backwash	1. Reuse for irrigation. 2. Dispose on dirt area. 3. Settle, dispose to sanitary sewer.		1. Use for landscape irrigation. 2. Dispose on dirt area. 3. Settle, dispose to sanitary sewer.
Vehicle Wastes			
Used motor oil	1. Use secondary containment while storing, send to recycler.		1. Put out for curbside recycling pickup where available. 2. Take to Recycling Facility or auto service facility with recycling program. 3. Take to HHW events accepting motor oil (i.e. car parts store).
Antifreeze	1. Use secondary containment while storing, send to recycler.		1. Take to Recycling Facility.
Other vehicle fluids and solvents	1. Dispose as hazardous waste.		1. Take to HHW event.
Automobile batteries	1. Send to auto battery recycler. 2. Take to Recycling Center.		1. Exchange at retail outlet. 2. Take to Recycling Facility or HHW event where batteries are accepted.
Motor home/construction trailer waste	1. Use holding tank. Dispose to sanitary sewer.		1. Use holding tank, dispose to sanitary sewer.
Vehicle washing	1. Recycle. 2. Discharge to sanitary sewer, never to storm drain.	POTW-MWS	1. Take to Commercial Car Wash. 2. Wash over lawn or dirt area. 3. If soap is used, use a bucket for soapy water and discharge remaining soapy water to sanitary sewer.
Mobile vehicle washing	1. Collect washwater & discharge to sanitary sewer.	POTW-MWS	
Rinsewater from dust removal at new car fleets	1. Discharge to sanitary sewer. 2. If rinsing dust from exterior surfaces for appearance purposes, use no soap (water only); discharge to storm drain.	POTW-MWS	

DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	 Approval	RESIDENTIAL Disposal Priorities
Vehicle Wastes (cont'd.)			
Vehicle leaks at Vehicle Repair Facilities	Follow this 3-step process: 1. Clean up leaks with rags or absorbents. 2. Sweep, using granular absorbent material (cat litter). 3. Mop and dispose of mopwater to sanitary sewer.		
Other Wastes			
Carpet cleaning solutions & other mobile washing services	1. Dispose to sanitary sewer.	POTW-MWS	1. Dispose to sanitary sewer.
Roof drains	1. If roof is contaminated with industrial waste products, discharge to sanitary sewer. 2. If no contamination is present, discharge to storm drain.		
Cooling water Air conditioning condensate	1. Recycle/reuse. 2. Discharge to sanitary sewer.	 POTW-MWS	
Pumped groundwater, infiltration/foundation drainage (contaminated)	1. Recycle/reuse (landscaping, etc.) 2. Treat if necessary; discharge to sanitary sewer. 3. Treat and discharge to storm drain.	MDPW-NPDES POTW-MWS MDPW-NPDES	
Fire fighting flows	If contamination is present, Fire Dept. will attempt to prevent flow to stream or storm drain.		
Kitchen Grease	1. Provide secondary containment, collect, send to recycler. 2. Provide secondary containment, collect, send to POTW via hauler.	POTW-MWS	1. Collect, solidify, dispose as trash.
Restaurant cleaning of floor mats, exhaust filters, etc.	1. Clean inside building with discharge through grease trap to sanitary sewer. 2. Clean outside in container or bermed area with discharge to sanitary sewer.		
Clean-up wastewater from sewer back-up	1. Follow this procedure: a. Block storm drain, contain, collect, and return spilled material to the sanitary sewer. b. Block storm drain, rinse remaining material to collection point and pump to sanitary sewer (no rinsewater may flow to storm drain).		

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Good Housekeeping Practices (GHPs)

GHP-15

Activity: Pesticides, Herbicides and Fertilizer Use (PHF)

PLANNING CONSIDERATIONS:

Training:
No

Inspection Frequency:
Monthly

Implementation Cost:
Low

Monthly Maintenance:
Low

Target Pollutants

Significant ♦ Partial ◊ Low or Unknown ◊

Sediment ◊ Heavy Metals ◊ Nutrients ♦ Oxygen Demanding Substances ♦ Toxic Materials ♦
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

Fertilizers, herbicides and pesticides are potentially harmful chemicals that require safe and organized practices to assure that pollution does not enter into stormwater.

Approach

- For a quick reference on disposal alternatives for specific wastes, see the table presented in the Employee/Subcontractor Training BMP fact sheet, Table GHP-14-1, and MSDS.
- Contractors/subcontractors should develop controls on the application of pesticides, on-site. Controls may include:
    - List of approved pesticides and selected uses
    - Product and application information for users
    - Equipment use and maintenance procedures
    - Record keeping and public notice procedures
    - MSDS

The following discussion provides some general information on good housekeeping:

- Always use caution when handling any pesticide or fertilizer product. Many products contain toxic chemicals that can cause severe injury or death.
- Store pesticide or fertilizer products securely and away from children, pets, and sources of heat, sparks, and flames.
- Avoid contact with eyes and skin. Wear gloves and eye protection when using or handling hazardous substances. Do not wear contact lenses, which can absorb hazardous vapors.

Activity: Pesticides, Herbicides, and Fertilizer Use	GHP-15

Approach (cont'd)

- Work in only well ventilated areas if handling these materials in doors.
- Use up the entire product before disposing the container.
- Do not dispose of pesticide or fertilizer wastes:
  1. in trash
  2. down storm drains or into creeks
  3. onto the ground
  4. by burning
- Do dispose of hazardous wastes at household hazardous waste collection events or facilities.

Maintenance

- Employee and subcontractor training,
- Contractor and subcontractor employees who handle potentially harmful materials should be trained in good housekeeping practices. Personnel who use pesticides must be trained in their use.
- The primary cost is for staff time as noted above.

Inspection Checklist

- ☐ Fertilizers, herbicides and pesticides are properly stored.
- ☐ Fertilizers, herbicides and pesticides are clearly marked for easy identification.
- ☐ Old or used fertilizers, herbicides and pesticides have been properly disposed.
- ☐ Storage unit is properly ventilated.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Good Housekeeping Practices (GHPs)

GHP-16

Activity: Dust Control and Tracking (DC)

PLANNING CONSIDERATIONS:

Training:
No

Inspection Frequency:
As needed

Implementation Cost:
Medium

Monthly Maintenance:
Low

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ◊ Toxic Materials ◈
Oil& Grease ◈ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

Dust control measures are used to stabilize soil from wind erosion and reduce dust generated by construction activities. This temporary measure-an intermediate treatment between disturbance in construction, paving, or vegetation, reduces the amount of eroded material exposed to stormwater runoff.

Approach

- Clearing and grading activities.
- Construction vehicle traffic on temporary or unpaved roads or construction site access paths.
- Drilling and blasting activities.
- Sediment tracking onto paved roads.
- Soil and debris storage piles.
- Batch drop from front end loaders.
- Areas with unstabilized soil.
- Final grading/site stabilization usually is sufficient to control post-construction dust sources.
- Dust control should be practiced at all construction sites by performing phased clearing and grading operations, using temporary stabilization methods, and/or placing undisturbed vegetative buffers of at least 50 ft. (15 m) length between areas being graded and those areas to remain undeveloped.
- Dust control is particularly important in windy or wind-prone areas.

Approach (cont'd)

- Schedule construction activities to minimize exposed area by clearing only areas where phased construction is to take place.
- Quickly stabilize exposed soils using vegetation, mulching, spray-on adhesives, calcium chloride, sprinkling, and stone/gravel layering.
- Identify and stabilize key access points prior to commencement of construction. See SMP-02 and -03.
- Minimizing the impact of dust by anticipating the direction of prevailing winds.
- Direct most construction traffic to stabilized roadways within the project site.
- Dust control BMP's generally stabilize exposed surfaces and minimize activities that suspend or track dust particles. Table GHP-16-1 shows which Dust Control BMPs apply to site conditions which cause dust. For heavily traveled and disturbed areas, wet suppression (watering), chemical dust suppression, gravel or asphalt surfacing, temporary gravel construction entrances, equipment wash-out areas, and haul truck covers can be employed as dust control applications. Permanent or temporary vegetation and mulching and sand fences can be employed for areas of occasional or no construction traffic.
- Preventive measures would include minimizing surface areas to be disturbed, limiting on-site vehicle traffic to 15 miles per hour, and controlling the number and activity of vehicles on a site at any given time.
- Pave, vegetate, or chemically stabilize access points where unpaved traffic surfaces adjoin paved roads.
- Provide covers for haul trucks transporting materials that contribute to dust.
- Provide for wet suppression or chemical stabilization of exposed soils.
- Provide for rapid clean-up of sediments deposited on paved roads. Furnish stabilized construction road entrances and vehicle wash down areas.
- Stabilize unpaved haul roads, parking and staging areas. Reduce speed and trips on unpaved roads.
- Implement dust control measures for material stockpiles.
- Prevent drainage of sediment-laden stormwater onto paved surfaces.
- Stabilize abandoned construction sites using vegetation or chemical stabilization methods.
- For the chemical stabilization, there are many products available for chemically stabilizing gravel roadways and stockpiles. The types of chemicals available and recommendations for their use are tabulated in Table GHP-16-2, Commonly Used Chemicals for Dust Control.

Selection of Methods

Selection of dust control agents should be based primarily on cost-effectiveness and environmental hazards.

Chemical methods are dust suppressant or binding agents that are used on the soil surface to bind finer particles together. Chemical dust control agents must be environmentally benign, easily applied, easily maintained, economical and not significantly detrimental to traffic ability.

Activity: Dust Control and Tracking	GHP-16

Approach (cont'd)

Approximately three-quarters of chemical dust control agents are inorganic compounds which are compatible with soil and biota. After application, the compounds dampen and penetrate into the soil; a hygroscopic reaction pulls moisture from the atmosphere into the surface and adheres fines to aggregate surface particles. The compounds may not penetrate soil surfaces made up primarily of silt and clay, so soil tests are required.

Key factors in determining the method include the following:

- Soil types and surface materials - both fines and moisture content are key properties of surface materials.
- Properties of the agents - the five most important properties are penetration, evaporation, resistance to leaching, abrasion, and aging.
- Traffic volumes – the effectiveness and life span of dust control agents decreases as traffic increases. For high traffic areas, agents need to have strong penetrating and stabilizing capabilities.
- Climate – some hygroscopic agents lose their moisture-absorbing abilities with lower relative humidity, and some may lose resilience. Under rainy conditions, some agents may become slippery or even leach out of the soil.
- Environmental requirements – the primary environmental concern is the presence and concentration of heavy metals in the agent that may leach into the immediate ecosystem, depending on the soil properties.
- Frequencies of application – rates and frequencies of application are based on the type of agent selected, the degree of dust control required, sub grade conditions, surface type, traffic volumes, types of vehicles and their speeds, climate, and maintenance schedule.

Application of Methods

For dust control agents, once all factors have been considered, the untreated soil surface must first contain sufficient moisture to assist the agent in achieving uniform distribution (except when using a highly resinous adhesive agent). The following steps should be followed in general:

- Ideally, application should begin in late spring, after seasonal rains - not during or just before heavy rainfall- so that sub grade and surface materials will not have dried.
- If the surface has minimal natural moisture, the area to be protected must be pre-wetted so that the chemicals can uniformly penetrate the surface.
- In general, cooler and/or more humid periods result in decreased evaporation, increased surface moisture, and thus significant increase in control efficiency. However, chemical and organic agents should not be applied under frozen conditions, rainy conditions, or when the temperature is below 40° F. Tar and bitumen agents should not be applied in fog or in rain or below 55°F.
- More than one treatment with salts or organic compounds per year is often necessary, although the second treatment should probably be significantly diluted.

Maintenance

- Most dust control measures require frequent, often daily, attention.
- The primary maintenance requirement is the reapplication of the selected dust control agent at intervals appropriate to the agent type. High traffic areas shall be inspected on a daily basis, and lower traffic areas shall be inspected on a weekly basis.

Activity: Dust Control and Tracking	GHP-16

Inspection Checklist

- ☐ Water is applied daily to reduce dust.
- ☐ Trucks hauling soil or rock have dust covers over materials.
- ☐ Material stockpiles have fabric, mulch or ground cover to provide sediment control.

TABLE GHP-16-1 DUST CONTROL BMPs FOR GIVEN SITE CONDITIONS

	DUST CONTROL BMPs								
SITE CONDITION	Permanent Vegetation	Mulching	Wet Suppression (Watering)	Chemical Dust Suppression	Gravel or Asphalt Surfacing	Silt or Sand Fences	Temporary Gravel Construction Entrances/ Equipment Wash Down	Haul Truck Covers	Minimize Extent of Area Disturbed
Disturbed Areas not Subject to Traffic	X	X	X	X	X				X
Disturbed Areas Subject to Traffic			X	X	X				X
Material Stock Pile Stabilization			X	X		X			X
Demolition			X				X	X	
Clearing/ Excavation			X	X					X
Truck Traffic on Unpaved Roads			X	X	X			X	
Mud/Dirt Carry-Out					X		X		

TABLE GHP-16-2 COMMONLY USED CHEMICALS FOR DUST CONTROL

	SALTS	ORGANIC, NON PETROLEUM-BASED	PETROLEUM BASED PRODUCTS [1]
CHEMICAL TYPES	. Magnesium Chloride . Natural Brines	. Calcium Lignosulfonate . Sodium Lignosulfonate . Ammonium Lignosulfonate	. Bunker Oil . Asphalt Primer . Emulsified Asphalt
LIMITATIONS	Can lose effectiveness in dry periods with low humidity. Leaches from road in heavy rain. Not recommended for gravel road surfaces with low fines. Recommended 10-20% fines.	Not affected by dry weather and low humidity. Leached from road in heavy rain if not sufficiently cured. Best performance on gravel roads with high surface fines (10-30%) and dense compact surface with loose gravel.	Generally effective regardless of climatic conditions may pothole in wet weather. Best performance on gravel roads with 5-10% fines.
COMMENTS	Calcium Chloride is popular. May become slippery when wet on gravel surfaces with high fines.	Ineffective on gravel surfaces low in fines. May become slippery when wet on gravel surfaces with high fines content.	Creates a hardened crust.

1 Motor oils and oil treatments are not recommended due to adverse effects on plant life and groundwater. They should only be applied in areas that will soon be paved.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Good Housekeeping Practices (GHPs)

GHP-17

Activity: Maintenance of Collection Facilities and Appurtenances (MCF)

PLANNING CONSIDERATIONS:

Training:
Minimal

Inspection Frequency:
Monthly

Implementation Cost:
High

Monthly Maintenance:
High

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ♦ Nutrients ◊ Oxygen Demanding Substances ♦ Toxic Materials ◊
Oil& Grease ♦ Bacteria & Viruses ♦ Floatable Materials ♦ Construction Waste ◊

Description

The sediment sump in catch basins are designed to trap sediments below the overflow point or basin outlet. As sediment fills the sump, runoff enters the basin and immediately discharges through the outlet without depositing any sediment in the sump. Proper use of this practice will reduce high pollutant concentration during first flush of storms, prevent clogging of the downstream conveyance system and restore the catch basins' sediment trapping capacity. Proper maintenance and siltation removal is required to have an effective storm water pollutant removal system for both wet and dry detention ponds and infiltration devices.

Approach

- The catch basins must be regularly maintained. Clogged catch basins are not only useless but may act as a source of sediments and pollutants.
- Proper maintenance of detention ponds and infiltration device systems is a source control procedure necessary to ensure effective stormwater pollutant removal efficiency. Proper maintenance of these structures requires periodic silt/sediment and trash removal, as well as timely vegetation control. They should be cleaned out when it is recognized that they have filled from $^{1}/_{5}$ to $^{1}/_{3}$ of their pollutant (sediment) storage capacity.
- More frequent sediment removal is recommended, especially in areas where roadway drainage provides a significant runoff component. High accumulation rates of heavy metal contaminants (lead, zinc, and copper) have been identified in these BMP structures adjacent to high traffic areas. In order to avoid situations of hazardous waste disposal, sediment dredging and excavation should be given frequent priority.

Approach (cont'd)

- Clean catch basins in high pollutant load areas just before the wet season to remove sediments and debris accumulated during the summer.
- Catch basins should be inspected weekly and cleaned if necessary to reduce the possibility of sediment and other pollutants from leaving the construction site. This should be checked after all areas have been stabilized and at the end of the project.
- To prevent sediment and pollutant build-up in on-site catch basins, be sure to follow the guidelines set out in Temporary Inlet Protection, SMP-11.
- Maintain a clean work site, free of litter that can build-up and clog catch basins and downstream conveyance systems.
- Discourage dumping into catch basins and stormwater inlets whenever possible.
- Removal of accumulated paper, trash, and debris should occur weekly or as needed to prevent clogging of control devices throughout the construction project.
- Vegetation growth in stormwater quality devices should not be allowed to exceed 24 inches in height.
- Mow the slopes periodically and check for clogging, erosion and tree growth on the embankment.
- Corrective maintenance may require more frequent attention (as required).
- Keep accurate maintenance logs to evaluate materials removed and improvements made.

Maintenance

- Maintenance crews may require access vehicles, dump trucks, bulldozers, and dredging/excavation equipment. Manual use equipment (such as rakes, shovels, sickles, and machetes) may suffice for maintenance of dry detention ponds and infiltration device systems. Staffing will require a minimum crew of two (2) properly trained person for health and safety reasons and effective structural BMP maintenance.
- Crews must be trained in proper maintenance, including record keeping and disposal.
- Appropriate excavation and maintenance procedures.
- Proper waste disposal procedures.
- Channel maintenance and use of heavy equipment.
- Identification and handling of hazardous materials/wastes.
- Application of this technique in "blue line" streams requires permits from the U.S. Army Corps of Engineers, and the Kentucky Division of Water
- Frequent sediment removal is labor and cost intensive.

Inspection Checklist

- [ ] Dredged sludge is dried prior to removal to waste management facility. (See GHP-01: Dewatering Operations.)
- [ ] All drainage activities are approved by Kentucky Division of Water (KDOW) and the local drainage authority.

	Somerset, Kentucky **Stormwater Best Management Practices (BMPs)** **Good Housekeeping Practices (GHPs)**	GHP-18
	Activity: Preservation and Maintenance of Existing Vegetation (PMV)	

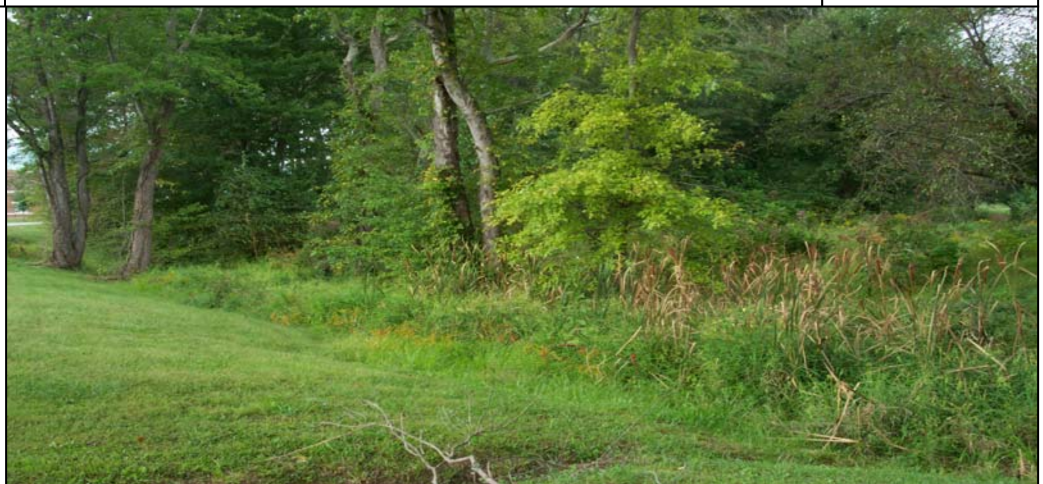
PLANNING CONSIDERATIONS:

Training:
No

Inspection Frequency:
Prior to construction

Implementation Cost:
Low

Monthly Maintenance:
Low



Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ◊ Nutrients ♦ Oxygen Demanding Substances ♦ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ♦ Construction Waste ◊

Description

The careful preservation of existing vegetation minimizes the potential of removing or injuring existing trees, vines, shrubs and/or grasses that serve as erosion controls or otherwise stabilize or slopes.

Suitable Applications

This technique is applicable to all types of construction sites. Areas where preserving vegetation can be particularly beneficial are floodplain, buffers, wetlands, streambanks, steep slopes, and other areas where erosion control would be difficult to establish, install, and maintain, or areas where there are critical resources downstream.

- Preservation of existing vegetation should be practiced in the following locations:
- Areas within site where construction activity is not permitted (such as buffers) or does not occur or occurs at a later date.
- Sensitive areas where natural vegetation exists and should be preserved, such as: steep slopes, watercourses, and building sites in wooded areas.
- Areas where local, state and federal government requires preservation, such as: vernal pools, wetlands, marshes, certain oak trees, etc.

Installation Procedures

- Preservation of vegetation on a site should be planned before any site disturbance begins. Preservation requires good site management to minimize the impact of construction activities on existing vegetation, which may adversely affect their respiration, food processing, and growth.
- During a pre-construction conference, vegetation preservation and protection measures for that project should be reviewed with the contractor and any subcontractors.

Activity: Preservation and Maintenance of Existing Vegetation	GHP-18

Installation Procedures (cont'd)

Planning

The following planning steps should be taken to preserve existing vegetation:

- A plan for vegetation preservation should be completed before clearing and construction begins.
- Critical areas, such as floodplains, buffers, steep slopes, and wetlands should be left in their natural condition unless disturbance is unavoidable and permitted by buffer and floodplain/floodway requirements.
- Decisions on which vegetation to save should be based on the following considerations:

  1. Life expectancy and present age
  2. Health and disease susceptibility
  3. Structure
  4. Cleanliness
  5. Aesthetic values
  6. Comfort relative to site temperature variations and wind
  7. Wildlife benefits
  8. Adaptability to the proposed project
  9. Survival needs of the vegetation
  10. Relationship to other vegetation

- Areas for buffers where construction is not permitted should be delineated in the field with flags or colored temporary construction fencing.
- All vegetation to be retained should be delineated and identified (species and size) on the site plan and identified in the field by an easily seen colored flag.
- Plans should include the maintenance of existing grade around vegetation to be preserved. Most vegetation damage due to construction activities is to the root zone, which can result in the vegetation dying within a few years. Raising the grade can suffocate roots, and lowering the grade may expose roots.
- Plans for tree preservation should: avoid compaction of the soil within the drip line of a tree which can block off air and water from the roots and avoid changes in soil chemistry that can result from refuse of chemicals deposited on the soil surface.
- Temporary roadways should be located to minimize damage to shrub and tree stands, following contours to reduce cutting and filling.
- Locate multiple utilities in the same trench to minimize trenching. Excavations should be outside the drip line of trees.
- Construction material storage and crew parking should be noted on the site plan and located where they will not cause root compaction. They can eventually kill a tree.
- For retention of existing trees in paved areas, at least 5 ft. of ungraded ground beyond the drip line should be left to help ensure tree survival.
- Soil stabilization measures should be located at the limits of clearing to prevent sediment deposition within the area where vegetation is being preserved.
- Wind damage can result from exposure of vegetation to increased wind velocities, therefore this must be considered when removing adjacent vegetation.
- Equipment must be kept away from trees to be preserved to avoid trunk damage caused by equipment nicking or scarring the trunk.

Installation Procedures (cont'd)

Timing

The following timing considerations should be taken to preserve existing vegetation.

- Preservation of existing vegetation should be planned before any site disturbance begins. Preservation of existing vegetation should be planned during the design stages by the design engineer and the contractor should meet onsite with the design engineer.
- No vegetation should be destroyed or altered until the design of roads, buildings, and utility systems is finalized.

Tree and Vegetation Marking and Protection

- Clearing limits should be outside of the drip line of any retained tree, and at a minimum of 5 ft. from the trunk regardless of the size of the tree. A protective device, such as a colored temporary construction fence, to guard against damage to roots, trunk, and tops of trees, should be placed at these limits.
- Individual trees, stands of trees, and areas of vegetation to be retained should be marked before construction at a height visible to equipment operators. Orange-colored plastic construction fencing or other suitable material should be used. Within 40 ft. of a proposed building or excavation, however, retained trees should be protected by fencing. The following are alternatives for tree and vegetation protection:
- Board fencing on 4-in. square posts set securely and 6 ft. apart, and protruding at least 4 ft. above the ground, placed at clearing limits.
- A cord fence with 2 rows of cord at least 3 in. in thickness running between posts. Each post should be at least 2 in. thick set securely and 6 ft. apart, protruding at least 4 ft. above the ground placed at clearing limits. Strips of colored surveyor's flagging should be tied securely to the cord at intervals of no more than 3 ft.
- Plastic fencing of 40 in. high orange polyethylene webbing, secured to metal "T" or "U" posts driven to a depth of at least 18 in., on 6 ft. minimum centers, placed at the clearing limits. The posts should be chemically inert to most chemicals and acids.
- An earth berm constructed according to specifications, but only if its presence does not conflict with drainage patterns. The base of the berm on the tree or vegetation side should be located at the clearing limits.
- Leaving a buffer zone of existing trees between the trunks of retained trees and the clearing limits. Trees in this buffer zone should be a maximum of 6 ft. apart so that equipment and material cannot pass. These trees should be re-examined before construction is completed to check for and ensure survival or be removed.
- As a last resort, a tree trunk may be armored with burlap wrapping and 2-in. studs wired vertically, no more than 2 in. apart encircling the trunk to a height of 5 ft. No nailing should ever be done to a retained tree. The root zone, however, will still require protection.

Installation Procedures (cont'd)

- Employees and subcontractors should be instructed to honor protective devices. No heavy equipment, vehicular traffic, or storage piles of any construction materials should be permitted within the drip line of any tree to be retained. Removed trees should not be felled, pushed, or pulled into any retained trees. Fires should not be permitted within 100 ft. of the drip line of any retained trees. Any fires should be of limited size, and should be kept under continual surveillance. No toxic or construction materials including paint, acid, nails, gypsum board, chemicals, fuels, and lubricants should be stored within 50 ft. of the drip line of any retained trees, nor disposed of in any way which would injure vegetation. This also precludes vehicle fueling or maintenance in these areas.

Grade Protection

- If the ground level must be raised around an existing tree or tree group, a tree well can be constructed. A professional arborist should be consulted if a tree well appears to be warranted or desired. A well may be created around the tree slightly beyond the drip line to retain the natural soil in the area of the feeder roots.
- If the grade is being lowered, trees can be protected by constructing a surrounding tree wall of large stones, brick, or block, filled with topsoil. Fertilizer and water should be applied thoroughly and drainage provided so that water does not accumulate.
- Remove vegetation and organic matter from beneath the retained tree(s) to at least 3 ft. beyond the drip line, loosening the soil to at least 3 in. in depth without damaging roots.
- Apply fertilizer to the loosened soil at rates not to exceed those recommended by the fertilizer manufacturer.
- Construct a dry well to allow for trunk growth. Provide 12 in. between the trunk and the wall for older, slow-growing trees, and at least 24 in. for younger trees.
- The well should be just above the level of the proposed fill, and the wall should taper away from the trunk by 1 in./ft. of wall height.
- The well wall should be constructed of large stone, brick, building tile, concrete blocks, or cinder blocks, with openings left in the wall for the flow of air and water. Mortar should be used only near the top of the well and above the porous fill.
- Drain lines beginning at the lowest point inside the well should be built extending outward from the trunk in a radial pattern with the trunk as the hub. They should be made of 4-in. drain tiles, sloping away from the well at a rate of 0.125 in./ft. A circumferential line of tiles should be located beneath the drip line; vertical tiles or pipes should be placed over the intersections of the two tile systems for fills greater than 24 in. in depth, held in place with stone fill. All tile joints should be tight. Drainage may be improved by extending a few radial tiles beyond each intersection and slope sharply downward. Coarse gravel may be substituted for tile in areas where water drainage is not a problem. Stones, crushed rock, and gravel may be added instead of vertical tiles or pipes, so the upper level of these porous materials slopes toward the surface near the drip line.
- Tar paper or an approved equivalent should be placed over the tile or pipe joint to prevent clogging, and a large stone placed around and over drain tiles or pipes for protection.

Installation Procedures (cont'd)

- Layer 2 in. to 6 in. of stone over the entire area under the tree from the well outward at least to the drip line. For fills up to 24 in. deep, a layer 8 in. to 12 in. should be adequate. Deeper fills require thicker layers of stone to be built to a maximum of 30 in.
- A layer of 0.75-in. to 1-in. stone covered by straw, fiberglass mat, or filter fabric should be used to prevent soil clogging between stones. Do not use cinders as fill material.
- Complete filling with porous soil (to sustain vegetation) until the desired grade is reached.
- Crushed stone should be placed inside the dry well over the openings of the radial tiles to prevent clogging of the drain lines. Vertical tiles should also be filled with crushed rock and covered with a screen.
- The area between the trunk and the well wall should be covered by an iron grate or filled with a 1:1 mixture of crushed charcoal and sand to prevent anyone from falling into the well or to prevent leaves, debris, rodents, or mosquitoes from accumulating.
- One-half of these systems may be constructed if the grade is being raised on only one side of the tree(s).

Trenching and Tunneling

- Trenching should be as far away from tree trunks as possible, usually outside of the tree crown. Curve trenches around trees to avoid large roots or root concentrations. If roots are encountered, consider tunneling under them. When trenching and/or tunneling proximate to trees to be retained, tunnels should be at least 18 in. below the ground surface, and not below the tree center to minimize impact on the roots.
- Tree roots should not be left exposed to air; they should be covered with soil as soon as possible, protected, and kept moistened with wet burlap or peat moss until the tunnel and/or trench can be completed.
- The ends of damaged or cut roots should be cut off smoothly and protected by painting them with a tree-wound dressing.
- Trenches and tunnels should be filled as soon as possible. Careful filling and tamping will eliminate air spaces in the soil, which can damage roots. Be careful not to over-compact as this can smother and kill the tree.
- To induce and develop root growth, peat moss should be added to the fill material.
- The tree should be mulched to conserve moisture and fertilized to stimulate new root growth.
- Remove any trees intended for preservation if those trees are damaged seriously enough to affect their survival. If replacement is desired or required, the new tree should be of similar species and of at least 2-in. caliper balled and burlapped nursery stock, unless otherwise required by the contract documents.
- Because protected trees may be destroyed by carelessness during the final cleanup and landscaping, fences and barriers should be removed last, after all other work is complete.

Installation Procedures (cont'd)

Vegetation Control

- Mechanical control of vegetation includes mowing, "bush-hogging", and hand cutting. Large scale mowing is typically done by tractor-type mowers similar to farm machinery. "Bush-hogging" usually refers to tractor mounted mowing equipment with hydraulically mounted cutting machinery. On smaller areas, lawn tractors or push mowers may be used. In areas that are inaccessible by machinery, such as steep grades and rocky terrain, hand cutting using gas powered weed trimmers and scythes may be used.
- Clippings and cuttings are the primary waste produced by mowing and trimming. Clippings and cuttings are almost exclusively leaf and woody materials. Minimize transportation of clippings and cuttings into the stormwater conveyance system. Compost piles are encouraged to create mulch and topsoil for landscaping.
- Clippings/cuttings carried into the stormwater system and receiving streams can degrade water quality in several ways. Suspended solids will increase causing turbidity problems. Since most of the constituents are organic, the biological oxygen demand will increase causing a lowering of the available oxygen to animal life. In areas where litter and other solid waste pollution exists, toxic materials may be released into receiving streams with a resulting degradation of water quality.
- Mowing should be performed at optimal times (e.g., when it is dry). Mowing should not be performed if significant rain events are predicted.
- Mulching mowers may be recommended for certain areas. Mulching mowers should be encouraged for homeowners in flat areas. Mulching mowers have the added benefit of reducing the fertilizer demand through reuse of organic material. Other techniques may be employed to minimize mowing such as selective vegetative planting using low maintenance grasses and shrubs. Alternatively, the grass clippings can be bagged and used in composting.

Maintenance

- During construction, the limits of disturbance should remain clearly marked at all times. Irrigation or maintenance of existing vegetation should conform to the requirements in the landscaping plan.
- If damage to protected trees still occurs, maintenance guidelines described below should be followed:
- Soil, which has been compacted over a tree's root zone, should be aerated by punching holes 12 in. deep with an iron bar, and moving the bar back and forth until the soil is loosened. Holes should be placed 18 in. apart throughout the area of compacted soil under the tree crown.

Any damage to the crown, trunk, or root system of a retained tree should be repaired immediately.

- Damaged roots should be immediately cut cleanly inside the exposed area and surfaces painted with approved tree paint, and moist soil or soil amendments should be spread over this area.
- If bark damage occurs, all loosened bark should be cut back into the undamaged area, with the cut tapered at the top and bottom, and drainage provided at the base of the wound. Cutting of the undamaged area should be as limited as is possible.
- Serious tree injuries should be attended to by an arborist, forester or tree specialist.
- Stressed or damaged broadleaf trees should be fertilized to aid recovery.

Activity: Preservation and Maintenance of Existing Vegetation	GHP-18

Maintenance (cont'd)

- Trees should be fertilized in the late fall or early spring.
- Fertilizer should be applied to the soil over the roots and in accordance with label instructions, but never closer than 3 ft. to the trunk. The fertilized area should be increased by one-fourth of the crown area for conifers that have extended root systems.

Inspection Checklist

- ❑ Protecting existing vegetation requires detailed planning, and may constrict the area available for construction activities.
- ❑ It is appropriate to evaluate the existing vegetation for species type for use in landscaping plans. Natural vegetation and invasive or "alien" species should be delineated. The use of natural vegetation is preferred.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Good Housekeeping Practices (GHPs)

GHP-19

Activity: System Flushing (SF)

PLANNING CONSIDERATIONS:

Training:
Minimal

Inspection Frequency:
Monthly

Implementation Cost:
Low

Monthly Maintenance:
Moderate

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◇

Sediment ♦ Heavy Metals ◈ Nutrients ◇ Oxygen Demanding Substances ◇ Toxic Materials ◈
Oil& Grease ◇ Bacteria & Viruses ◇ Floatable Materials ◈ Construction Waste ◇

Description

Storm drain pipes with grades to flat to be self cleansing require routine flushing. This helps to maintain flow as well as removes pollutants from the storm drain system. The suspension and removal of deposited materials are “flushed” out of storm drains.

Approach

- Locate reaches of storm drain with deposit problems and develop a flushing schedule that keeps the pipe clear of excessive buildup.
- Whenever possible, flushed effluent should be collected and pumped to a sediment trap, or basin, or a detention pond.
- Storm drain flushing usually takes place along segments of pipe with grades that are too flat to maintain adequate velocity to keep particles in suspension. An upstream manhole is selected to place an inflatable device that temporarily plugs the pipe. Further upstream, water is pumped into the line to create a flushing wave. When the upstream reach of pipe is sufficiently full to cause a flushing wave, the inflated device is rapidly deflated with the assistance of a vacuum pump, releasing the backed up water and resulting in the cleaning of the storm drain segment.
- If the flushed water does not drain to a stormwater treatment device (e.g., detention pond or swale), then a second inflatable device, placed well downstream, may be used to re-collect the water after the force of the flushing wave has dissipated. A pump may then be used to transfer the water and accumulated material to a stormwater treatment practice. In some cases, an interceptor structure may be more practical or required to re-collect the flushed waters.

Approach (cont'd)

Regulations

- Kentucky Division of Waste Management (KDWM) regulations prohibit the discharge of soil, debris, refuse, hazardous waste, and other pollutants that may hinder the designed conveyance capacity or damage stormwater quality or habitat in the storm drain system. This includes flushing a system to "Waters of the State". Do not execute this practice until the KDWM has been consulted.

Equipment

- Water source (water tank truck, fire hydrant).
- Sediment collector (educator/vacuum truck, dredge).
- Inflatable devices to block flow.
- Sediment/turbidity containment/treatment equipment required if flushing to an open channel.

Inspection Checklist

- ❑ BMP is properly applied to an appurtenance 36" in diameter or smaller.
- ❑ Contractor is using the nearest available water source.
- ❑ Flushed effluent is captured and treated downstream prior to being released into a waterway.
- ❑ Requires liquid/sediment disposal.

	Somerset, Kentucky **Stormwater Best Management Practices (BMPs)** **Residential and Homeowners (RHPs)**	RHP-01
	Activity: Non-Stormwater Discharges to Storm Drains	

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ♦ Heavy Metals ♦ Nutrients ♦ Oxygen Demanding Substances ♦ Toxic Materials ♦
Oil& Grease ♦ Bacteria & Viruses ♦ Floatable Materials ♦ Construction Waste ◈

Description

Citizens, residents and property owners of Somerset have the largest impact on the local streams and creeks. Most of the creeks, drainage channels and stormwater drains are located on private property. By eliminating pollution and protecting stormwater quality runoff, our streams and creeks will again support fish and other wildlife. It is important to protect stormwater quality since most city parks and recreation areas are located adjacent to streams, creeks, or karst features.

The City of Somerset is required by the Kentucky Division of Water (KDOW) to reduce various types of pollution. KDOW issued a NPDES Phase II permit to the City of Somerset in 2003. Stormwater quality data is reported to KDOW annually. Illicit discharge detection and elimination (non-stormwater discharges) is a control measure regulated by the city.

Objective

Citizens, residents and property owners must be aware that discharges (solid or liquid), other than runoff directly resultant from a wet weather event, to any stormwater conveyance system, or any ground surface that drains to a storm drain system, can be very harmful to the environment, aquatic life, and water supplies and should be avoided.

Approach

The principal goal of this BMP is to eliminate all substances (liquid or solid) that do not belong in stormwater. Severe penalties and fines can be assessed for each incident. Consult with the City of Somerset's Stormwater Management Ordinance (2005-02) for information regarding allowable and prohibited discharges.

For more information on illicit discharges to stormwater drainage systems contact the Somerset City Engineer, or visit the Somerset Stormwater Management website at: http://www.cityofsomerset.com/departments%20main%20cos%20page.htm

Activity: Non-Stormwater Discharges to Storm Drains	RHP-01

Approach (cont'd)

Illegal Discharges

Discharges into the Municipal Separate Sewer System (MS4) of an unapproved substance are considered to be an illicit discharge. This activity is regulated by City Ordinance 2005-02. Contaminants include, but are not limited to the following:

1. Trash or debris
2. Construction materials
3. Petroleum products including but not limited to oil, gasoline, grease, fuel oil, or hydraulic fluids
4. Antifreeze and other automotive products
5. Metals in either particulate or dissolved form
6. Flammable or explosive materials
7. Radioactive materials
8. Batteries, including but not limited to, lead acid automobile batteries, alkaline batteries, lithium batteries, or mercury batteries
9. Acids, alkalis, or bases
10. Paints, stains, resins, lacquers, or varnishes
11. Degreasers and/or solvents
12. Drain cleaners
13. Pesticides, herbicides, or fertilizers
14. Steam cleaning wastes
15. Soaps, detergents, or ammonia
16. Swimming pool backwash including chlorinated swimming pool discharge
17. Chlorine, bromine, and other disinfectants
18. Heated water
19. Animal waste, either from domestic animals or from feeder lot operations
20. Leaking sanitary sewers and connections which have remained uncorrected for more than seven (7) days
21. Recreational vehicle waste
22. Animal carcasses
23. Food wastes
24. Medical wastes
25. Bark and other fibrous materials
26. Collected lawn clippings leaves, or branches
27. Silt, sediment, or gravel
28. Dyes expect with permission from the [Director]
29. Chemicals, not normally found in uncontaminated water
30. Washing of fresh concrete for cleaning and/or finishing, or to expose aggregates
31. Junk motor vehicles
32. Leading solid waste disposal containers
33. Sewage dumping or dumping of sewage sludge
34. Discharge of any polluted household wastewater, such as but not limited to laundry wash water and dishwater, except to a sanitary sewer or septic system
35. Leaking water lines which have remained uncorrected for seven days or more
36. Commercial, industrial or public vehicle wash discharge
37. Garbage or sanitary waste disposal
38. Dead animals or animal fecal waste
39. Dredged or spoil material
40. Wrecked or discarded vehicles or equipment
41. Wash waters to the storm drain system from the cleaning of gas stations, auto repair garages, or other types of auto repair facilities

Approach (cont'd)

42. Wastewater to the storm drain system from mobile auto washing, steam cleaning, mobile carpet cleaning, and other such mobile commercial and industrial operations
43. Waters from areas where repair of machinery and equipment, including motor vehicles, which are visibly leaking oil, fluids or coolants is undertaken
44. Waters from storage areas for materials containing grease, oil, or hazardous materials, or uncovered receptacles containing hazardous materials, grease, or oil
45. Washing of toxic materials from paved or unpaved areas to the storm drain system
46. Discharge from the washing or rinsing of restaurant mats, roof vents, grease traps, equipment or garbage bins or cans in such a manner that causes non-storm water to enter the storm drain system
47. Sewage, industrial wastes, or other wastes into a well or a location that is likely that the discharged substance will move into a well, or the underground placement of fluids and other substances which do or may affect the waters of the state
48. Any hazardous material or waste, not listed above

The following non-stormwater discharges are some of the most commonly observed illicit discharges. These discharges can lead directly to damaging impacts to local water quality. Because of their high frequency and associated water quality impairment, they are expressly prohibited.

- Raw sewage discharges or overflows, including sanitary sewer overflows (SSOs).
- Discharges of wash water from the hosing or cleaning of gasoline stations, auto repair garages, or other types of automotive service facilities.
- Discharges resulting from the cleaning, repair, or maintenance of any type of equipment, machinery, or facility (includes motor vehicles, cement-related construction equipment, portable toilet servicing, etc.)
- Discharges of wash water from mobile operations such as steam cleaning, power washing, pressure washing, carpet cleaning, and mobile carwash facilities.
- Discharges of wash water from the cleaning or hosing of impervious surfaces in industrial and commercial areas including parking lots, streets, sidewalks, driveways, patios, plazas, work yards, and outdoor eating or drinking areas.
- Discharges of runoff from material storage areas containing chemicals, fuels, grease, oil or hazardous materials.
- Discharges of pool or fountain water containing chlorine, biocides or other chemicals, and also discharges of pool or fountain filter backwash water.
- Discharges of water containing sediment or construction-related wastes.
- Discharges of food-related wastes such as grease, oil, fish processing water, kitchen mat wash water, trash bin wash water, pouring liquids into dumpsters, etc. This includes disposing unwanted food or liquid into ditches, creeks or streams.

The only allowable discharges to the stormwater system are the following:

- A discharge or flow of fire protection water that does not contain oil or hazardous substances or materials that the Fire Code requires to be contained and treated prior to discharge;
- A discharge or flow from lawn watering or landscape irrigation;

Approach (cont'd)

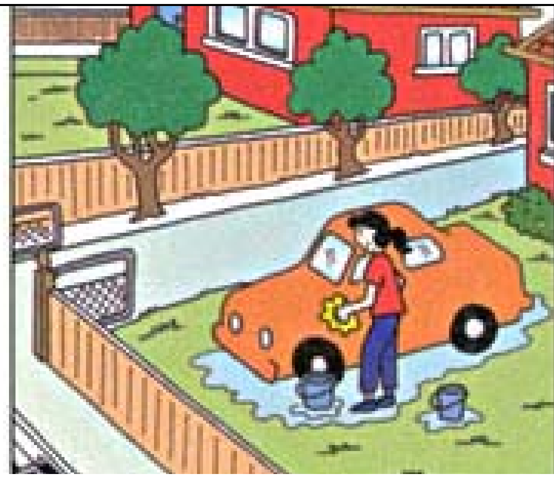
- A discharge or flow from a diverted stream flow or natural spring;
- Uncontaminated discharge or flow from a foundation drain, crawl space pump or footing drain;
- A discharge or flow from air-conditioning condensation;
- A discharge or flow from individual residential car washing;
- A discharge or flow from a riparian habitat or wetland;
- Dechlorinated discharge from a private residential swimming pool containing no harmful quantities of chlorine and other chemicals;
- A discharge or flow from any other water source not containing pollutants; and
- A discharge or flow from dye testing, provided the City Engineer has been given verbal notification prior to the testing.

Even these discharges under this exemption may be regulated if the City Engineer's office determines that they are a source of pollutants to the storm sewer system.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Residential and Homeowners (RHPs)

RHP-02

Activity: Vehicle Washing



Target Pollutants		
Significant ♦	Partial ◈	Low or Unknown ◇

Sediment ◈ Heavy Metals ◈ Nutrients ◈ Oxygen Demanding Substances ◈ Toxic Materials ◈
Oil& Grease ◈ Bacteria & Viruses ◇ Floatable Materials ◇ Construction Waste ◇

Description

Pollutants, such as detergents and dirty washwater, must always be prevented from directly discharging to streams, creeks, ditches and storm drains. Business and property owners can reduce pollutants from cars, trucks and other personal vehicles in order to protect natural streams and creeks. Every effort should be made to prevent pollutants from running off the land and impervious surfaces due to precipitation and stormwater.

Approach

Washing personal vehicles (cars, trucks, vans, motorcycles, etc.) has a high potential for polluting streets, storm drains, streams, creeks, wetlands and other natural water bodies. Vehicles accumulate the various products and emissions generated by gasoline and diesel fuel combustion (particularly in the engine area and underneath the frame). The waste products from these vehicles include:

- Fluids that leak slowly from the engine, or may escape from a rupture, or spill during a vehicle collision, such as engine oil, transmission fluid, radiator coolant, battery acids, and brake fluid all have special properties due to their chemical formulation. All of these fluids are toxic to plants and wildlife.
- The moving parts of vehicles that typically wear down, such as pieces of worn tire, brakes and brake pads that erode and grind in a way to minimize vehicle maintenance, and especially those parts that contain asbestos and metals.
- Detergents and cleaning substances are toxic to aquatic life. Reduce or eliminate the use of detergents and cleaners while washing vehicles. Wash vehicles on lawns or grassy areas to reduce direct discharge of washwater to curbs, inlets, ditches and other waterways.

Activity: Vehicle Washing	RHP-02

Prohibition to Discharge	Due to federal mandates, the City of Somerset has adopted a Stormwater Management Ordinance (2005-02) to prohibit discharge of chemicals and manmade materials into creeks, streams, ditches, swales, pipes, storm drains, and parts of the city drainage system. This prohibition includes all types of automotive fluids, whether discharged directly into a stream or storm drain, or discharged indirectly upon the ground surface. See the BMP entitled RHP-01 (Non-Stormwater Discharges to Storm Drains) for a list of allowable and prohibited discharges.
Vehicle Washing	It is legal to discharge water when washing individual cars on residential property. This is one of the allowable discharges listed in RHP-01 (Non-Stormwater Discharges to Storm Drains) and in the Somerset Stormwater Management Ordinance (2005-02). It is also legal to discharge water when holding a carwash event over a period of two days or less, for the purpose of charity, nonprofit fundraising, or similar noncommercial purpose. However, it is illegal to discharge washwater or rinsewater that adversely affects the water quality of a creek or stream, even if otherwise allowable according to ordinance. Detergents affect the gill membranes of fish and adversely affect other aquatic life. Even phosphate-free, biodegradable soaps have been shown to be toxic to fish before the soap degrades. Residents should attempt to minimize the amount of detergents that are used in wash-water, and dispose of soapy water indoors in a sink or drain. Avoid the use of solvents and other toxic chemicals. Extremely dirty or grimy vehicles should generally be cleaned at a commercial carwash, which is required to treat all washwater and rinsewater to certain standards. City and County residents may want to wash vehicles on lawns or other pervious ground surfaces, or at least direct the discharge of washwater and rinsewater into grassy areas. Avoid discharging large amounts of chlorinated city water directly to storm drains or streams. Reduce the amount of chlorinated water by turning off the hose when not needed. Relatively small amounts of chlorinated water can be toxic to the fish and other aquatic organisms, especially during dry weather. Do not wash engines, undercarriages, transmissions or automotive parts near streams, creeks, storm drains, ditches, or impervious surfaces such as driveways and streets. Carefully control and dispose of engine washwater in a manner that does not pollute Somerset streams or the environment. Dirty engines and undercarriages should generally be cleaned at well-equipped commercial facilities to prevent pollution. A carwash or commercial vehicle washing facility is prohibited from discharging water into streams, creeks, ditches, pipes, culverts or storm drains. This includes, but is not limited to: automobile dealers, automotive repair shops, industrial or commercial plants with vehicle washing stations, construction sites, or any location that is not a personal residence.
Related BMPs	Consult the following list of related BMPs for disposal options and other guidance: ➢ GHP-11 Vehicle and Equipment Washing ➢ RHP-03 Vehicle Maintenance and Repair

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Residential and Homeowners (RHPs)

RHP-03

Activity: Vehicle Maintenance and Repairs

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◇

Sediment ◈ Heavy Metals ♦ Nutrients ◇ Oxygen Demanding Substances ◈ Toxic Materials ♦
Oil& Grease ♦ Bacteria & Viruses ◇ Floatable Materials ◇ Construction Waste ◇

Description

Pollutants and automotive fluids should be prevented from accumulating on impervious surfaces in order to improve stormwater quality and protect natural streams and creeks.

Approach

Personal vehicles (cars, trucks, vans, motorcycles) have a high potential for polluting streets, grassy areas, streams, creeks, and the air that we breathe.

- Vehicles contain large amounts of fluids that could leak slowly from the engine, or may escape from a ruptured hose. Fluids such as engine oil, transmission fluid, radiator coolant, battery acids, and brake fluid all have special properties due to their chemical formulation. All of these fluids are poisonous to plants, trees, insects, wildlife, fish, etc. and should be reduced or eliminated as much as possible. Repairing automotive leaks immediately can prevent environmental problems and help vehicles to run more efficiently.
- Incomplete combustion of gasoline and diesel fuels is a major contributor to air pollution. There is a high level of concern in state and federal governments for air quality and ozone levels throughout the country. Please keep personal vehicles in good condition to reduce air pollution. The Commonwealth of Kentucky currently does not require statewide vehicle inspections or emission testing.
- Vehicles contain moving parts that wear down, such as tires and brake pads. Brakes and brake pads are designed purposely to erode and grind in a way to minimize vehicle maintenance. Small pieces of tires and brake pads (containing asbestos and metals) are continually being deposited on streets and roadways.

Activity: Vehicle Maintenance and Repairs	RHP-03

Installation Procedures

- Due to federal mandates, the City of Somerset has adopted a Stormwater Management Ordinance (2005-02) to prohibit discharge of chemicals and manmade materials into creeks, streams, ditches, swales, pipes, storm drains, and any surface which drains into these waterways. See the BMP entitled RHP-01 (Non-Stormwater Discharges to Storm Drains) for a list of allowable and prohibited discharges.
- One category of prohibited discharges included all automotive fluids, whether discharged directly into a stream or storm drain, or discharged indirectly upon the ground so that the automotive fluid could wash away in stormwater runoff at a later time.
- It is also illegal to discharge automotive fluids into a sinkhole, or to allow these fluids to soak into the ground. It is important to protect this water from contamination because it may be used as a source of drinking water, and once groundwater becomes contaminated it may be impossible to restore.

Disposal Options

- Automotive parts stores and repair shops typically accept engine oil and other fluids for recycling. Ask about recycling when you purchase automotive parts and fluids.

Vehicle Repairs

- It is recommended that most city residents should take advantage of commercial repair shops and oil-change facilities. Home repair and maintenance may be performed if the homeowner/resident has adequate knowledge of materials to control spills and leaks, and proper safeguards to properly protect natural streams, storm drains, drainage ditches and the environment in general, including proper waste fluid disposal.
- Purchase the correct automobile parts when making repairs or performing regular vehicle maintenance. Consult automotive repair manuals in order to perform the work quickly and efficiently. Use a funnel whenever pouring liquids such as motor oil, brake fluid or coolant. Drain hoses prior to removing or adjusting them; in most cases the liquid can be reused. Drain pans and drop cloths are essential items when changing oil or other automotive fluids. In general, use dry methods such as rags and absorbent material (kitty litter) to clean spills and leaks. Do not wash spills onto the ground or any surface that drains to the city stormwater drainage system or to natural creeks and streams. Sweep or mop any spills or leaks promptly. Keep spill containment materials nearby.
- Use non-toxic materials when possible – for instance, baking soda can be used for cleaning battery terminals and clamps. Do not mix used motor oil with solvents. Do not mix chlorinated solvents with non-chlorinated solvents such as kerosene or mineral spirits.

Maintenance

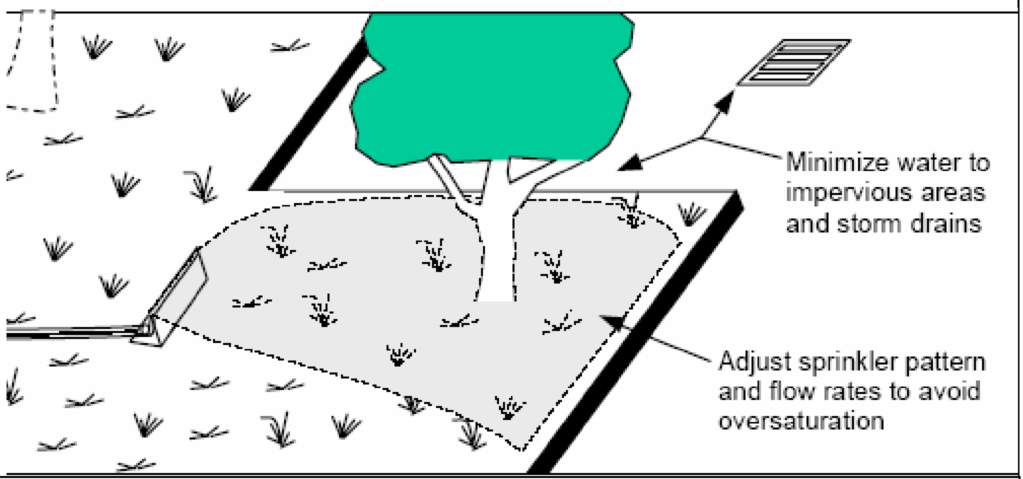
The following GHP (Good Housekeeping Practices) BMPs are applicable to everyone who operates or maintains a vehicle such as businesses, industries, homeowners, automotive dealers, repair shops and garages, etc. They contain many specific requirements and guidelines for care and maintenance of vehicles.

- GHP-05 Spill Prevention and Control
- GHP-12 Vehicle and Equipment Fueling
- GHP-13 Vehicle and Equipment Maintenance
- RHP-02 Vehicle Washing

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Residential and Homeowners (RHPs)

RHP-04

Activity: Landscape Irrigation and Lawn Watering



Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ◊ Heavy Metals ◊ Nutrients ♦ Oxygen Demanding Substances ◈ Toxic Materials ♦
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

Prevent or reduce the discharge of pollutants from sprinklers and landscaping water in order to protect natural streams and creeks. Runoff is reduced by decreasing the flow rate, applying water in a more controlled manner, and by closely monitoring sprinklers.

Approach

During dry summer months in the Somerset area, it is not unusual to go a few weeks without rainfall. Many homes and businesses determine that watering lawns and other vegetation is a necessity. In addition to lawns and trees, water is needed for golf courses, flower and vegetable gardens, nurseries and landscaped parking lot islands.

Pollution can occur when landscaping water produces runoff to the storm drainage system. Typical pollutants include herbicides, pesticides, fertilizers, pet/animal waste and mulch. In addition, most watering is done with chlorinated utility water. Chlorinated water must not be discharged to Somerset's natural creeks, streams, because it kills aquatic life. Runoff from several over-watered lawns will kill fish and other aquatic organisms in a small creek. Over-watering is more likely to occur during the dry summer periods, which is when streams have lower flows and the chlorine dosages have more effect.

Due to federal mandates, the City of Somerset adopted the Stormwater Management Ordinance (2005-02) to prohibit all discharges of chemicals, manmade materials and soils (see RHP-01, Non-Stormwater Discharges to Storm Drains) into streets, ditches, storm drains, and natural streams. This prohibition includes chlorinated water, any soil or mulch, chemicals such as fertilizers and pesticides, and nutrients such as fertilizer and lime. In addition to being toxic, these substances also change the pH and turbidity of natural streams and creeks. Damage from toxic materials is not necessarily immediate but can take months or years to accumulate.

Activity: Landscape Irrigation and Lawn Watering	RHP-04

Guidelines

- Avoid discharging water onto impermeable surfaces such as paved driveways, roads and parking lots. Direct water onto soil and lawns by using a correctly sized sprinkler with the right spray pattern.
- Decrease the flow rate and increase watering time as necessary to avoid discharging water to the stormwater drainage system. High flow rates can also damage the lawn or landscaped area by washing away the nutrients and soil.
- Do not leave watering sprinkling activities unattended. Watering will be effective for a few hours, but the ground usually becomes saturated by nightfall. Afterwards, the sprinklers become ineffective and most of the chlorinated water goes directly to the stormwater drainage system.
- Use herbicides, pesticides and fertilizers in accordance with manufacturer's instructions. Excessive use of these hazardous materials can be toxic to vegetation and wildlife in and near natural streams and creeks. Herbicides and pesticides should be applied after rainfall or watering occurs and a dry period of a few days is expected; otherwise these chemicals will be washed away before they can have an effect. Fertilizer and lime may be applied prior to light watering.
- Construct a small berm, depression area or curb on the lower side of landscaped areas. Minor grading modifications will allow excess water to collect and soak into the soil, instead of being wasted in the storm drains. Use native trees and shrubs when possible; native vegetation is usually more resistant to drought than ornamental trees and will require less watering.
- If possible, avoid using chlorinated water for landscaping. Use rain barrels, cisterns, ponds or other methods for capturing stormwater. Or, allow chlorinated water to stand in an open container for a day or so, prior to being used for landscaping irrigation. Chlorine naturally escapes from chlorinated water as a gas at a rate that is subject to temperature, sunshine and wind conditions. A simple swimming pool test kit can be used to detect chlorine. Once the dechlorination time has been established, further use of the chlorine test kit is usually not needed.

Maintenance

- Monitor watering operations closely. Adjust watering rates and patterns to avoid runoff to storm drainage systems, curb inlets, ditches, natural creeks and streams, ponds, wetlands, etc. Repair damaged or incorrectly installed sprinklers. Repair leaking hoses and valves.

Limitations

- Extra effort and attention is required to monitor landscape watering. Sprinklers and other equipment should have the correct size and configuration to accomplish the intended purpose without excessive watering.
- Berms, curbs or other grading modifications will require additional space for ponding water. Berms and grading modifications may affect the symmetry of landscape designs in very minor ways.

Related BMPs

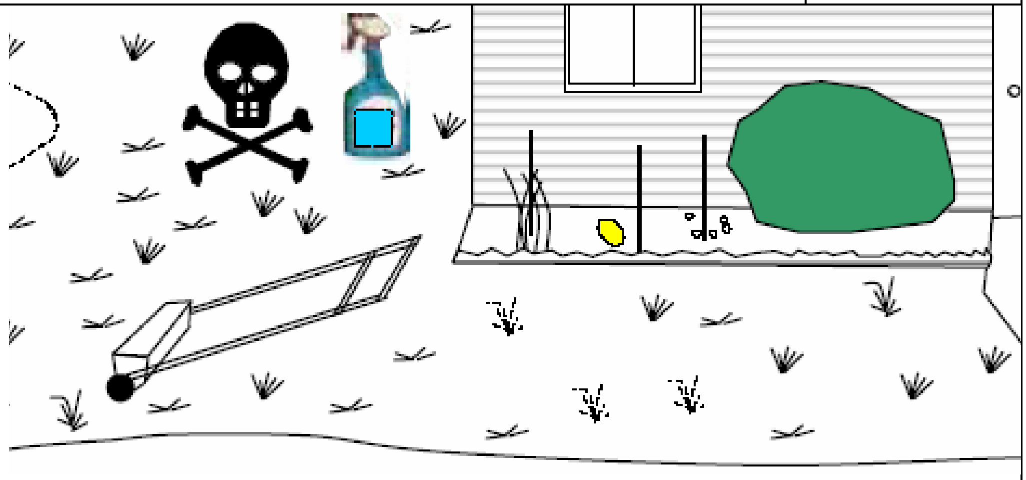
Other topics and aspects of landscape irrigation and lawn watering are included in these related BMPs:

- GHP-14 Employee / Subcontractor Training
- GHP-15 Pesticides, Herbicides, and Fertilizer Use
- EPP-10 Mulching

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Residential and Homeowners (RHPs)

RHP-05

Activity: Pesticides and Fertilizers



Target Pollutants		
Significant ♦	Partial ◈	Low or Unknown ◊

Sediment ◊ Heavy Metals ◈ Nutrients ♦ Oxygen Demanding Substances ♦ Toxic Materials ♦
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

Use efficient and safe housekeeping practices (storage, use, and cleanup) when handling potentially harmful materials such as fertilizers, herbicides, and pesticides. Misuse and overuse leads to stormwater pollution, poisons, and toxic substances in Somerset and Pulaski County creeks and streams. Only use fertilizers and pesticides when necessary, and consider alternative methods and treatments if available.

Approach

Fertilizer management involves control of the rate, timing, and method of application to minimize the chance of polluting surface water or groundwater. Pesticide and herbicide management involves eliminating excessive pesticide use, using proper application procedures, and considering alternatives to chemical control to reduce the amount of pesticides and herbicides in stormwater runoff. The use of fertilizers, herbicides, and pesticides contribute to pollution of stormwater runoff. Residential users of these products tend to overapply by a factor of several times. Carefully read the instructions for application rates, recommended application equipment, and seasonal methods. See GHP-15 (Pesticides, Herbicides, and Fertilizer Use) for additional considerations and application instructions for various types of materials such as dusts, sprays, granular formulations and fumigants. In many cases, these products may not be essential for a productive lawn or garden. Selection of low-maintenance vegetation reduces the need for fertilizers, pesticides, and herbicides. University of Kentucky's Cooperative Extension Service has many brochures and pamphlets concerning fertilizers and pesticides, including various environment-friendly alternatives. These pamphlets are available online at: http://ces.ca.uky.edu/ces/

More information on pesticides is available from the USEPA Office of Prevention, Pesticides & Toxic Substances: http://www.epa.gov/opptsmnt/

Approach (cont'd)

Fertilizers

- Do not apply fertilizer when immediate rainfall is expected – it will wash away before it can have an effect, and end up in local streams. Apply fertilizer only when there is already adequate soil moisture and little likelihood of immediate heavy rainfall. After applying fertilizer, lightly sprinkle the lawn or garden.
- Lawns and gardens are often over-fertilized, which can be harmful to the lawn and to local streams. Follow product directions. A soil test is recommended to determine the optimum lime and fertilizer application rates.Contact the Pulaski County Cooperative Extension Service for information about this free service.

Pesticides and Herbicides

- Excessive application and misuse of pesticides and herbicides results in heavily polluted stormwater runoff – follow product directions. Avoid using pesticides and herbicides when immediate rainfall is expected. Apply pesticides and herbicides in a narrow rather than wide band; do not broadcast them over the entire lawn area. Spot-spray infested areas. Never apply pesticides and herbicides near streams, creeks, ditches, storm drains or on impervious surfaces.
- Examine all alternatives to pesticides and herbicides that, in the long term, may be much less costly than the use of a particular chemical. Use the least toxic chemical pesticide or herbicide that will accomplish the purpose. Pesticides and herbicides that degrade rapidly are less likely to become stormwater runoff pollutants. Use pesticides and herbicides with low water solubility. Granular formulations are generally preferable to liquids because application losses are lower.
- Pesticides and herbicides should be sprayed only when wind speeds are less than 7 mph. Spray in the early morning or at dusk when wind speeds are usually lowest. Air temperature should range between 40-80° F.

Pesticide and Herbicide Types

- Dusts: This type is highly susceptible to wind drift, not only when being applied but also after reaching target. The application should be performed during the early morning or late evening hours when there is little or no air movement. The distance between the application equipment and the target should be minimized.
- Sprays: This type may be in the form of solutions, emulsions, or suspensions. Droplet size is an important factor in determining susceptibility to wind drift. Large droplets fall faster and are less likely to contaminate non-target areas. Sprays should be applied during periods of low air movement. Ground sprays followed by soil incorporation are not likely to be sources of water pollution unless excessive erosion occurs.
- Granular formulations: This type is applied to either the ground surface or below the soil surface. Surface applications may or may not be followed by soil incorporation. Pollution of surface waters from granular formulations is unlikely unless heavy runoff or erosion occurs soon after treatment. However, groundwater pollution may result from excessive leaching due to rainfall after application, depending on the pesticide composition. Loss of granular formulations can be controlled for the most part with adequate soil conservation practices.
- Fumigants: This type must be kept in place for specific lengths of time in order to be effective. Containment methods include soil compaction, water seal, and sealing of the area with a plastic cover. Most fumigants act rapidly and degrade quickly. Consequently, water pollution is usually not a problem.

Approach (cont'd)

- Antimicrobial paints and other surface coatings: This type is designed to resist weathering and is therefore not a likely source of pollution. Empty containers should be disposed in accordance with rules for all pesticide containers. Use extreme care when sanding or scraping surfaces that have been previously treated with these substances. Treat sanded and scraped residue as hazardous waste.
- Pre-plant treatments: Seed, roots, tubers, etc., are frequently treated with pesticides prior to planting. Treatment is usually by dust, slurry, or liquids. Little pollution hazard exists from this application. Care must be taken, however, in disposing of residual treatment materials and with unused plants.
- Organic pesticides: A wide variety of organic pesticides, produced from plants, bacteria, and other naturally-occurring substances, are available in quantities for both commercial and residential use. These substances usually present much less risk for contamination of groundwater and surface water, and much fewer problems for disposal of leftover product or containers.
- Beneficial insects: This management method involves the use of insects in bulk or in amounts suitable for residential use. It can be used alone or in combination with other pesticides to eliminate or minimize the use of toxic substances.

Good Housekeeping and Safety

- Read and follow use instructions provided on packaging, and in material safety data sheets (MSDS) if available.

Disposal Options

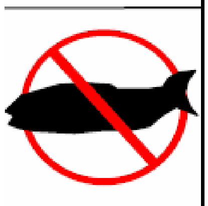
- In general, use the entire product before disposing the container. However, do not overapply the product if it is not needed. Do not dispose of pesticide or fertilizer wastes in any of the following methods:
  - Into trash or waste containers
  - Into storm drains or into creeks
  - Onto the ground
  - By burning

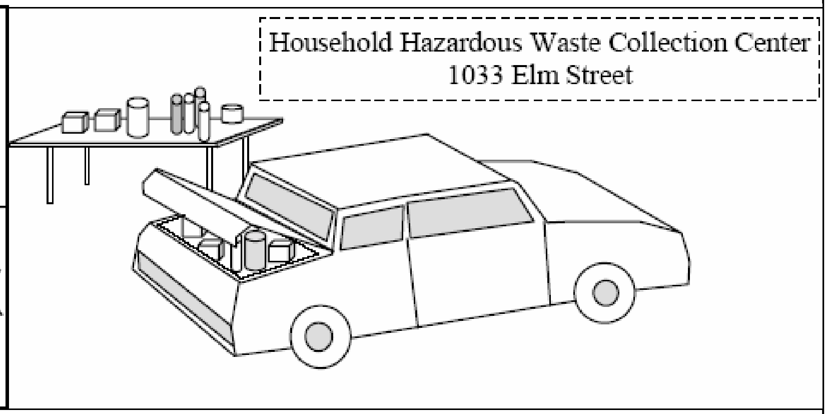
Maintenance

These related BMPs also provide guidance on the correct use and disposal of fertilizers and pesticides:

- GHP-06 Waste Management
- GHP-15 Pesticides, Herbicides, and Fertilizer Use

	Somerset, Kentucky **Stormwater Best Management Practices (BMPs)** **Residential and Homeowners (RHPs)**	RHP-06
	Activity: Household Hazardous Wastes	





Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ◊ Heavy Metals ♦ Nutrients ◊ Oxygen Demanding Substances ◈ Toxic Materials ♦
Oil& Grease ♦ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

A hazardous waste exhibits one or more characteristics of ignitability, corrosivity, reactivity or toxicity which make it dangerous. When disposed of in the municipal solid waste stream or otherwise improperly managed, these materials have the potential of contaminating the ground water.

Approach

A typical home contains many hazardous chemicals commonly used for cleaning, repairs, construction, automobile maintenance, lawn care, or hobbies. Often, household hazardous waste will accumulate on shelves in the garage or basement. The basic definition for a household hazardous substance is that it is toxic, poisonous, corrosive, chemically reactive, flammable or combustible. Some examples of household hazardous waste include:

- Adhesives
- Ammonia or bleach
- Anti-freeze
- Automotive fluids
- Batteries
- Cleaning fluids
- Detergents
- Disinfectants
- Herbicides
- Motor oil
- Oven cleaner
- Paint
- Paint thinner / remover
- Pesticides
- Solvents
- Toilet cleaner
- Wood stains and preservatives
- Fluorescent tubes and lights

Due to poisons and toxic substances, household hazardous waste should not be included in the ordinary weekly garbage collection that is collected curbside. Contact the Sanitation Department for more information.

Activity: Household Hazardous Wastes	RHP-06

Prohibition to Discharge

Due to federal mandates, the City of Somerset has adopted a Stormwater Management Ordinance (2005-02) to prohibit discharge of all chemicals and manmade materials into creeks, streams, ditches, swales, pipes, storm drains, and any surface that drains into these waterways. This prohibition includes all types of hazardous wastes, whether discharged directly into a stream or storm drain, or discharged indirectly upon the ground. See the BMP entitled RHP-01 (Non-Stormwater Discharges to Storm Drains) for a list of allowable and prohibited discharges.

Disposal Options

- A household hazardous waste is any substance that is toxic, poisonous, corrosive, chemically reactive, flammable or combustible. The typical home contains many hazardous chemicals commonly used for cleaning, repairs, construction, automobile maintenance, lawn care, or hobbies. Oftentimes, household hazardous waste will accumulate on shelves in the garage or basement. Locate a household hazardous waste collection facility in your community.
- Whenever possible, purchase nontoxic and biodegradable products or use natural cleaning solutions such as vinegar or lye soap. Always follow the directions on the product label, and clean up any spills immediately. In general, do not purchase more of a hazardous product than can be reasonably used.

Recycling

There are several businesses in the Somerset area that offer recycling services. Check your local listings for more information.

Related BMPs

These BMPs have additional information about waste disposal and alternatives:

- GHP-05 Spill Prevention and Control

	Somerset, Kentucky **Stormwater Best Management Practices (BMPs)** **Residential and Homeowners (RHPs)**	RHP-07
	Activity: Sanitary Sewer Laterals & Septic Tanks	

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ◊ Heavy Metals ◊ Nutrients ♦ Oxygen Demanding Substances ♦ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ♦ Floatable Materials ◊ Construction Waste ◊

Description

Property owners are responsible for the inspection, maintenance and repairs to the sanitary sewer laterals up to the connection with a sanitary sewer collector pipe. Those property owners on septic tank systems are responsible for maintenance and repairs to septic tank systems and associated drainfields.

Approach

The definition of sanitary and septic waste includes, but is not limited to, the following items as listed in the Somerset Stormwater Management Ordinance (2005-02):

- Human wastes
- Wastewater from toilets, sinks, dishwashers, washing machines and other indoor plumbing fixtures
- Wastewater from kitchens and restaurants
- Wastewater from industries and commercial establishments

These types of wastes, as well as animal and pet wastes, carry harmful viruses and bacteria that spread disease. It is important to prevent direct and indirect human contact with these types of waste flows. Sanitary sewers are a vital part of American civilization and community health system but are seldom appreciated, noticed or maintained.

Within the City of Somerset, most waste flows are discharged into sanitary sewers leading to wastewater treatment plants operated by the City of Somerset Utility Department (SUD), a publicly owned utility company. SUD is independent from the City of Somerset government. In addition to wastewater collection and treatment, SUD also operates the water network system. Call SUD at (606) 678-4466 for additional information on wastewater services, fee structures, request for service, etc. SUD is located at 105 College Street, Somnerset, KY, 42501.

Sanitary Laterals

At a minimum, property owners should be aware of where sanitary sewer laterals are found on the property. Do not allow heavy vehicles or construction equipment to drive on top of sanitary sewer laterals. Do not plant large trees directly over or near to sanitary sewer laterals. Large tree roots can infiltrate and eventually break a sanitary sewer lateral so that it will not function.

Inspection and Investigation

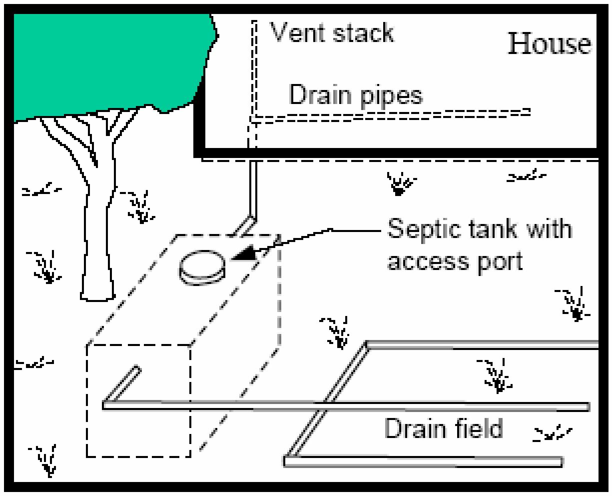
- The following guidelines are helpful for inspecting and maintaining sanitary sewer laterals. These guidelines will help the property owner to protect a valuable utility asset, and will help to improve water quality in Somerset creeks and streams.
  - Find location of sanitary sewer laterals on the property.
  - Find location of sanitary sewer lateral connection to the main sewer.
  - Determine approximate date of construction and materials used.
  - Inspect lateral locations regularly for unusual odor or ground wetness.
  - Inspect lateral locations regularly for subsidence or unusual soil color.
- A leaking sanitary sewer lateral may be contributing flow to a nearby storm drain, ditch or creek. Inspect the nearest storm drain or ditch during dry weather to determine if there is a suspicious flow. Contact the City of Somerset Utility Department to report illicit discharges, spills, leaks, or suspicious sanitary sewer discharges that need to be investigated. Anonymous calls are also handled.

Other Considerations

- All temporary and permanent connections to the municipal sanitary sewer system must be inspected and approved by the SUD plumbing inspector prior to installation. Contact the Inspections Office for construction procedures and testing requirements. Only use licensed plumbing contractors with adequate experience and equipment for each project.
- Older houses throughout the City of Somerset may have illicit connections, where a sanitary sewer line discharges into a storm drain. There are many reasons that this may have occurred, including:
  - Standard practice 50 to 100 years ago, where sanitary sewers did not exist.
  - A building contractor may have misidentified the connection pipe honestly.
  - A building contractor may have taken a shortcut to save time & money.
  - The storm drain contractor may have misidentified the sanitary sewer pipe.
- When found, cross connections must be replaced and repaired to function correctly. See RHP-01 (Non-Stormwater Discharges to Storm Drains) for additional information on locating illicit discharges and cross connections. Smoke testing and dye testing are two common methods for SMU to locate leaks in the main sanitary sewer system.
- Roof drains for older houses typically are connected to the sanitary sewer system (standard practice 50 years ago). Current standard procedures for roof drainage call for roof drains and gutters to be disconnected from the sanitary sewer system. Roof drainage is relatively clean water that should be discharged directly onto the ground.

Activity: Sanitary Sewer Laterals & Septic Tanks

RHP-07



Septic Tank Systems

- Existing privately-owned septic systems must be maintained in good working order. If a private septic system fails to function properly, then the owner may be required to hook into the municipal sanitary sewer system at their cost. Typically a septic tank needs to be inspected every year and pumped out every three years.
- Septic systems are not designed to process large volumes of water in short time periods. Do not wash several loads of clothes consecutively, and do not use excessive amounts of detergents that contain phosphorus. Do not pour household chemicals down the drain into a septic system; chemicals can kill the good microbes within the septic tank. Garbage disposals contribute to an overloading of solids in the septic tank, requiring more frequent cleanouts.
- Keep heavy equipment and vehicles away from septic tank and septic drain field. Do not compact soils in the septic field. Do not pave over the septic drain field. Adequate aeration and evaporation in drain field must occur for proper treatment.
- Inspect the septic tank and septic drainfield regularly to verify that sanitary and septic waste is not being discharged inadvertently. Inspection is normally done during dry weather to determine whether a discharge occurs. See RHP-01 (Non-Stormwater Discharges to Storm Drains) for methods to detect illicit discharges and leaks. Look for unusual odors, wet ground, discolored soil, subsidence or unusual settlement.

Safety Concerns

- Be careful investigating sanitary sewer lines or other confined spaces where sewer gases may exist. Sanitary sewer gases can render a person unconscious before being detected by normal senses. There are many instances of people being killed by falling unconscious into an open manhole due to sewer gases.
- Methane gas, along with other sewer gases, is very explosive. Keep sparks and open flames away from sewers, manholes and septic tanks. Do not smoke near open manholes.

Contacts

- There are several commercial septic maintenance services in the Somerset area. Consult your local listings.
- Lake Cumberland District Health Department Environmental Services
45 Roberts Street, Somerset, KY 42501   Phone: (606) 679-4416
- PRIDE Homeowner Septic System Grants for straight pipe and failing septic system replacement – Applications available at the Health Department or online at http://www.kypride.org/text/grantprograms/septic.php

Related BMPs

- GHP-10 Sanitary and Septic Waste Management

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Residential and Homeowners (RHPs)

RHP-08

Activity: Pet and Animal Wastes

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ◊ Heavy Metals ◊ Nutrients ♦ Oxygen Demanding Substances ◈ Toxic Materials ◊
Oil& Grease ◊ Bacteria & Viruses ♦ Floatable Materials ◊ Construction Waste ◊

Description

Property owners should strive to prevent animal and pet wastes in or near natural streams and creeks, storm drains, sinkholes, ditches, swales or other types of stormwater conveyance systems. This will reduce the amount of bacteria (particularly fecal coliforms), which has been cited as the concern for several creeks within the City of Somerset.

Approach

Sources of fecal coliforms include animals (such as pets, cattle, wild birds) and humans (failing sewers, straight pipes, improper disposal of food products). This BMP addresses animal wastes (domestic and wild) which are a significant source of water pollution. Animal waste may also contain other types of bacteria, viruses and parasites.

When animal waste enters a natural creek, it uses the available dissolved oxygen to create ammonia. The combination of low oxygen, ammonia and warm temperatures is detrimental to the fish and other aquatic life. Animal waste contains nutrients that promote excessive weed and algae growth (eutrophication). Nutrients can make water cloudy and green, which further inhibits aquatic life and decreases the available dissolved oxygen.

Due to federal mandates, the City of Somerset adopted the Stormwater Management Ordinance (2005-02) to prohibit and reduce pollution (see RHP-01, Non-Stormwater Discharge to Storm Drains) into streets, ditches, storm drains, and natural streams. This prohibition specifically includes animal wastes; see the following sections of the Stormwater and Street Ordinance for more details.

Activity: Pet and Animal Wastes	RHP-08

Guidelines

Pets

- Pets can be a very significant source of fecal coliform. A 1982 study of urban watersheds in Baltimore, MD found that dog feces were the single greatest contributor of fecal coliform and fecal strep bacteria (reference 190). A single gram of dog feces can contain 23 million fecal coliform bacteria (reference 199). Dogs can also be hosts for Giardia and Salmonella, two common types of harmful bacteria (reference 191).
- Provide a buffer zone and/or a fence to prevent animals from urinating or defecating into a creek, stream, or other stormwater drainage feature. Do not keep pets immediately adjacent to ditches, swales, storm drains, pipes or culverts.
- Clean up yards or fields that contain pet wastes on a regular basis. Animal waste can be sent to the sanitary landfill as part of the regular weekly garbage pickup. Burying animal waste in the ground is also an acceptable option, away from ditches or stormwater channels.
- Cat litter can be sent to the sanitary landfill as part of the regular weekly garbage pickup. Burying cat litter in the ground is also an acceptable option, away from ditches or stormwater channels. Dumping used cat litter in piles on the ground surface is not an environmentally approved practice.
- When walking dogs, properly dispose of dog feces. Walk dogs in vegetated areas away from streams, creeks, ditches and drainage channels. Disposal options are:
  - Scoop up pet waste and flush down the toilet.
  - Seal pet waste in a plastic bag and throw it in the garbage.
  - Bury pet waste in the yard (at least 6 inches deep) so it decomposes.
  - Add small quantities of pet waste to a compost pile; mix well. Make sure that pet waste is completely decomposed before using compost for gardens.

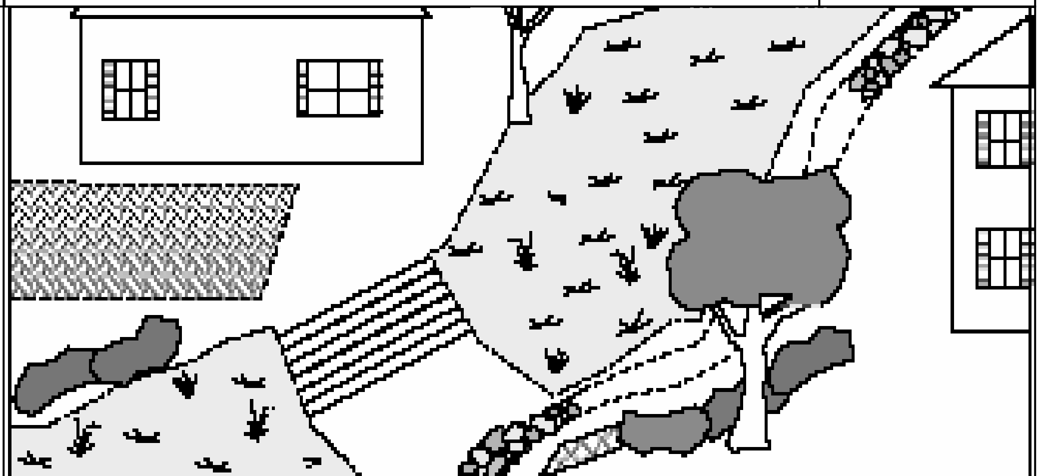
Pastures / Farm Animals / Wildlife

- Provide a buffer zone and/or a fence to prevent livestock from urinating or defecating into a creek, stream, or other stormwater drainage feature. Do not keep animals immediately adjacent to ditches, swales, storm drains, pipes or culverts.
- If it is necessary for pasture animals to cross a stream or creek, limit the access as much as possible. Discourage livestock from standing in a stream or creek by limiting shade.
- Clean up pastures, fields, yards and other open areas that contain animal wastes on a regular basis. Keep compost piles and manure piles as far away from ditches or stormwater channels as possible. Burying animal waste in the ground is an acceptable alternative.
- Do not encourage ducks, geese and other wild birds by feeding birds next to creeks, streams and ponds. Duck and geese waste products are particularly harmful to water quality for creeks and streams. Ponds with regular populations of ducks and geese may need additional water quality treatment, such as sand filtration units.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Residential and Homeowners (RHPs)

RHP–09

Activity: Slope and Streambank Stabilization



Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◇

Sediment ♦ Heavy Metals ◇ Nutrients ♦ Oxygen Demanding Substances ◈ Toxic Materials ◈
Oil& Grease ◇ Bacteria & Viruses ◇ Floatable Materials ◈ Construction Waste ◇

Description

Property owners who stabilize eroding slopes and streambanks in order to protect ditches, swales, storm drains, creeks, lakes and natural waterways will not only improve the appearance of private property but will also substantially reduce sedimentation and flood damage. Streambank stabilization may require a permit from the Kentucky Division of Water (KDOW) prior to grading. See the KDOW website for more information at www.water.ky.gov.

Approach

Homeowners and private property owners can make a big difference in controlling erosion and sediment. The benefits of controlling erosion substantially outweigh the costs involved. Contrary to popular opinion, vegetation does not just grow by itself on disturbed areas and steep slopes. There is a large potential for eroding slopes wherever land is developed or landscaped in Somerset due to hilly topography and native clay soils.

"Green" methods (with permanent vegetation) are the preferable means to fix steep slopes and erosion problems. Green methods help to capture rainfall, thus reducing the amount of runoff and flooding. Green methods are more attractive (and usually more durable) than structure stabilization methods such as gabion walls and riprap.

Overview of Slope Stabilization

First, determine the reason that a slope is unstable. If the slope tends to slide, collapse or slough, then the soil itself is unstable and typically needs a permanent solution. Possible remedies may include:

- Planting hardier and more durable types of vegetation (native trees and vines)
- Regrading the slope so that it is less steep.
- Constructing a retaining wall, crib wall or other structural feature.
- Divert surface water (and possibly groundwater) that tends to saturate soils and makes them heavier.

Overview of Slope Stabilization (cont'd)

If a slope tends to erode or washout in certain spots then the problem may be a combination of inadequate ground cover, poor drainage, no topsoil, wrong plant or some other problem.

- Divert surface water around the slope if possible.
- Improve ground surface by adding topsoil, lime, fertilizer, or mulch.
- Plant long grass, trees, shrubs, vines or another type of ground cover. Select plants that meet sunlight, drainage, and maintenance requirements.

Green methods involving permanent vegetation are preferable to non-green solutions. A common misconception is that gabions and riprap need to be inspected frequently for loose and misplaced stones, vegetation trimming and removal, settlement, etc. Green methods are more likely to be stable and self-maintaining. Specific aspects of slope stabilization are addressed in the following related BMPs:

- EPP-13 Terracing
- EPP-08 Surface Roughening
- SMP-06 Bank Stabilization
- SMP-07 Riprap
- EPP-09 Topsoil
- EPP-10 Mulching
- EPP-05 Temporary Seeding

Retaining walls, crib walls and prefabricated structural walls must be designed by a professional or other qualified expert for specific site conditions. Walls which have a maximum height of at least 4 feet must be reviewed as part of a site development permit issued by either the City County Planning Commission or City of Somerset.

Overview of Streambank Stabilization

KDOW will require a property owner to obtain a Water Quality Certificate and/or a Floodplain Construction Permit for any grading in or near waters of the State. Here are two quick definitions used to specify waters of the State:

- Somerset Engineering Department defines this as a blue-line stream on a USGS quadrangle map, or any point downstream from where a blue-line stream begins.
- The KDOW typically defines a channel as carrying water for longer than one week after a heavy rainfall. The local KDOW office can send a field inspector to make difficult judgments when requested.

The KDOW allows a property owner to clear downed trees and brush from a stream. The property owner should also unblock any culverts or pipes to prevent flooding. Live trees, shrubs, brush and other vegetation (when adjacent to channel) are usually necessary to anchor and protect streambanks. To complete this type of construction a property owner may be required to get a Floodplain Construction Permit and a Water Quality Certificate to ensure that Kentucky's water quality standards will not be violated. See the KDOW website for further information on permits, channelization, streambank protection, and allowable activities.

It is important not to alter the hydraulic stream cross sections. Changing the channel hydraulics at one location (flow width, flow depth, velocity, channel roughness) will affect the channel hydraulics elsewhere. Specific aspects of streambank stabilization are addressed in these related BMPs:

- SMP-06 Bank Stabilization
- SMP-08 Channel Linings

	Somerset, Kentucky **Stormwater Best Management Practices (BMPs)** **Residential and Homeowners (RHPs)** **Activity: Swimming Pools and Spas**	RHP–10

Target Pollutants

Significant ♦	Partial ⟐	Low or Unknown ◊

Sediment ◊ Heavy Metals ◊ Nutrients ◊ Oxygen Demanding Substances ♦ Toxic Materials ♦
Oil& Grease ◊ Bacteria & Viruses ◊ Floatable Materials ◊ Construction Waste ◊

Description

Chemical treatment of swimming pools and spas may prevent health concerns to bathers by killing organisms that live in the water. However, the chemicals that kill such organisms in pools and spas also kill aquatic life (fish, minnows, salamanders, crayfish) in creeks and streams that receive water with chemicals such as chlorine.

Approach

Due to federal mandates, the City of Somerset adopted a Stormwater Management Ordinance (2005-02) to prohibit discharge of non-stormwater materials (see RHP-01, Non-Stormwater Discharges to Storm Drains) such as chlorine, Baquacil, and other treatment chemicals into streets, ditches, storm drains, and natural streams. Since a wide variety of pool and spa treatment chemicals exist, it would be impossible to address proper disposal methods for every available chemical used in the treatment of pool and spa water. The packaging for most chemicals includes proper disposal methods which should be followed.

The most common pool treatment is chlorine, which dissolves in water, then slowly released to the atmosphere as chlorine gas. This process is usually inhibited by the addition of other chemicals. Bromine is another type of pool chemical that is also commonly used. There are a variety of chemical products which are frequently used to reduce algae growth, adjust pH, remove hardness or metals, remove stains, etc. Somerset swimming pool and spa owners should use pool testing kits to monitor water conditions, and choose environmentally friendly products if available.

Swimming pool water will naturally release chlorine gas at a rate that is dependent upon water and air temperature, presence of chemical inhibitors, amount of sunlight, amount of wind, water depth and circulation, etc. The process typically takes many days and requires that water should be periodically tested to monitor chlorine levels.

Approach (cont'd)

Reducing or Eliminating Discharges

- Before buying chemicals, select a method of pool treatment that has been successfully used in the Somerset area. Investigate and compare products to ensure that a proven method is selected. Select a method with the least toxic chemicals or chemicals that can be easily neutralized and removed from water.
- Retailers and manufacturers must make information readily available to customers, such as material safety data sheets (MSDS), with each chemical product to cover proper use of chemicals, safety issues, and safe disposal methods. All users of pool and spa chemicals should verify that the discharge and disposal process for any water treated with chemical products will be able to comply with federal and state regulations in addition to the manufacturer's recommendation.

Recommended Disposal Alternatives

- Any swimming pool or spa water that has been treated by chlorine only and dechlorinated may be discharged to grassy yards, streets or stormwater systems at a controlled rate. Before discharging dechlorinated pool or spa water, check the water with pool test kit to verify that it is completely dechlorinated. Dechlorinated discharges to streets and driveways should occur in dry weather when it will not contribute to flooding neighbors who live downstream. For safety reasons, water should not be discharged during winter months if there is a potential for water freezing in the streets, curbs and gutters.
- Any swimming pool or spa water that has been treated by chemicals other than chlorine is prohibited from discharge to the storm drain system, even if the chemical has been neutralized. Disposal options include:
  1. Discharge to the sanitary sewer system.
  2. Drain pool and spa water at a very slow rate to grassy yards where the water will soak into the ground, and
  3. Construct an infiltration well or trench to allow water to soak into ground.
- The connection to sanitary sewer system must be approved by the City of Somerset Utilities Department (SUD) prior to discharging. Do not discharge water onto or through neighbor's yard or property. Infiltration rates in some soils can be slow; a percolation test may be necessary. An infiltration system may dissolve underlying natural limestone rock; geological information and advice should be consulted.
- Backwash water cannot be discharged directly to the stormwater system unless it is completely dechlorinated and not treated with any other chemicals. Typical disposal method for backwash is to connect backwash hose from swimming pool or spa to the sanitary sewer system using a licensed plumbing contractor to install backflow prevention devices.
- Note that any connections to sanitary system must be approved by SUD prior to installation. Call the SUD offices at (606) 678-4466 for more information.

Limitations

Disposal methods that comply with the City of Somerset Stormwater Management Ordinance, latest version, may not necessarily comply with federal, state, and county regulations. Resolve compliance issues prior to discharging water from swimming pool or spa.

	Somerset, Kentucky **Stormwater Best Management Practices (BMPs)** **Residential and Homeowners (RHPs)**	RHP-11
	Activity: Boating	

Target Pollutants

Significant ♦ Partial ◈ Low or Unknown ◊

Sediment ◊ Heavy Metals ◈ Nutrients ♦ Oxygen Demanding Substances ♦ Toxic Materials ◈
Oil& Grease ◈ Bacteria & Viruses ♦ Floatable Materials ♦ Construction Waste ◊

Description

Prevent or reduce the discharge of pollutants to rivers, lakes and streams by proper disposal of wastes, minimizing repairs and maintenance, cleaning up spills and wastes immediately, and improved boating equipment and methods. Protect our natural resources and environment by following guidelines from the National Clean Boating Campaign. Use common sense to protect water quality of Somerset lakes and streams.

Approach

Federal, state and municipal regulations prohibit the discharge of any waste or litter into Cumberland River, Sinking Creek, or any of the various tributaries. It is also illegal to discharge raw sewage from a vessel within U.S. territorial waters.

In addition to government agencies and authorities, fishing organizations and tournaments promote responsible boating and care for the environment. Brochures and fact sheets from the National Clean Boating Campaign for sewage pumpout, fueling, bilge water, litter and boat maintenance are available at www.cleanboating.com/research/boatingpublic.html.

Boating Activities

Boat Sewage and Pumpouts

- Properly dispose of domestic and sanitary wastewater by using holding tanks. Empty holding tanks at approved wastewater collection facilities at marinas and boatyards. Verify ballast water is clean before discharging to natural body of water. Remove or permanently lock Y-valve on holding tanks to prevent accidental discharge of untreated sewage to lakes, rivers and streams. Comply with all laws regarding use and maintenance of a marine sanitation device (MSD). Guidelines and regulations are summarized on a Coast Guard website (http://www.uscg.mil/hq/g-m/mse/msd.htm).

Boating Activities (cont'd)

- Comply with all federal and state laws for MSD equipment. MSD equipment is regulated and certified by the U.S. Coast Guard to meet certain treatment standards. Type I and Type II MSD equipment is usually a combination of physical treatment (grinder) and chemical treatment (chlorinator) prior to discharge. Post operating instructions near the MSD, and keep MSD maintenance guide and user's manual on the boat.

MSD	Fecal coliform limits	Discharge criteria
Type I	< 1000 / 100 ml	No visible floating solids
Type II	< 200 / 100 ml	Suspended solids < 150 mg/l
Type III	--------------------	No discharge (holding tank)

- Do not use boat toilets for disposal of fats, solvents, oil, emulsifiers, paint, poison, disposable diapers or sanitary napkins. As a general rule, keep a supply of bags and containers ready for disposal of any conceivable item. Whenever possible, buy fast-dissolving marine toilet tissue for use in MSD equipment.
- Portable toilets shall not be discharged into U.S. territorial waters, which includes all lakes, rivers and streams within Kentucky. Empty portable toilets at shoreside dump stations or at home.
- Use a pumpout station to empty holding tanks (and also MSD Type III equipment).

Fuel and Oil

- Prevent fuel and oil from being discharged into the water or into the bilge by every means available. Use oil-absorbent pads and booms to contain any spilled fuel or oil. Boats with inboard engines should have oil absorption pads in bilge areas. The pads should be changed at least once a year or as needed. Do not pump bilge water if it is oily or has a sheen.
- Fuel, fluids and oil should be kept in secure containers. Recycle used fuels in properly labeled containers. Inspect and repair engine valves, pipes, hoses as necessary. Use drip pans when conducting maintenance and repair.
- Notify KDOW and the City of Somerset or Pulaski County in the event of major leaks and spills (as described in GHP-05, Spill Prevention and Control). Use oil-absorbent pads and booms to contain the spill. Do not use any detergent, soap, cleaner or emulsifier on a fuel spill, oil spill or bilge water. These substances temporarily dissolve oil and grease, but do not actually remove the pollution from the water.

Litter and Fish Waste

- Do not discharge anything into the water, including excess food. Place all litter and waste into trash bags for disposal onshore. Retrieve any trash which falls overboard.
- Do not throw cigarettes (or other smoking materials) overboard. Use an ashtray when smoking. Do not spit chewing tobacco overboard.
- Do not discharge fish waste overboard. Place fish waste into trash bags for disposal onshore, or use a fish cleaning station onshore. Small amounts of fish parts may be used for bait or chum. Fish wastes should not be recycled in any dead-end lagoons or other poorly flushed areas. Restaurants are specifically prohibited from discharging fish wastes into the water.

Boating Activities (cont'd)

Boat Cleaning and Maintenance

- Plan all cleaning and maintenance activities beforehand. Use the proper equipment to perform the activity efficiently and swiftly, while minimizing pollution. Use phosphate-free and biodegradable detergents for hull washing. Limit the amount of detergents used by first scrubbing and cleaning with water.
- Perform all hull scraping, sanding, chemical stripping and painting onshore. Place boat over a drop cloth, and prevent the discharge of any chemicals or particles. Properly dispose of surface chips, used blasting sand, residual paints, and other materials. Use temporary storage containment that is not exposed to rain. Sweep dry-docks each day or after maintenance is completed.
- Limit over-water hull surface maintenance to minor sanding and minor painting using hand tools and a small can of paint or other surface agent. In general, conduct most boat repair and maintenance items by removing the boat from the water into an organized maintenance area.
- Painting should be limited to spot work. Paint mixing should not occur on the dock. Use secondary containment on paint cans. Have available spill containment and cleanup materials. Use tarps, ground cloths or plastic sheeting when sandblasting or painting boats on land. Spray applicators may be used when painting on land.
- Dispose of cleanup materials properly. Consult GHP-05 (Spill Prevention and Control) for emergency telephone numbers.

Limitations

- Private tenants at marinas may resist restrictions on shipboard painting and maintenance. Existing contracts with tenants should be updated to require that tenants abide by new rules that benefit water quality.
- Even small amounts of biodegradable cleaning agents have been found to be toxic to fish. Disposal of small amounts of cleaning agents should be done through the sanitary sewer system.

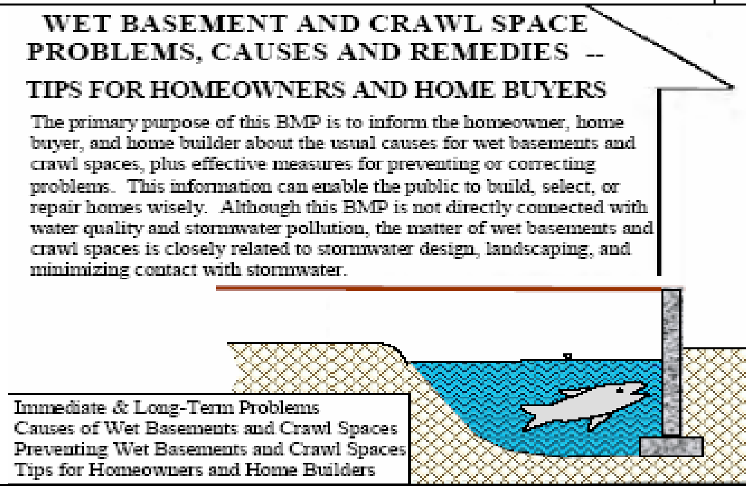
Links

- National Clean Boating Campaign http://www.cleanboating.com/research/boatingpublic.html
- National Clean Boating Campaign http://cleanboating.org/bibliography/index.html

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Residential and Homeowners (RHPs)

RHP-12

Activity: Tips for Wet Basements and Crawlspaces



Target Pollutants

Significant ♦ | Partial ◈ | Low or Unknown ◊

Sediment ♦ | Heavy Metals ♦ | Nutrients ♦ | Oxygen Demanding Substances ♦ | Toxic Materials ♦
Oil& Grease ♦ | Bacteria & Viruses ♦ | Floatable Materials ♦ | Construction Waste ◈

Immediate and Long Term Problems

Standing water or seepage inside residential crawl spaces and basements can cause frustrating problems for the homeowner. These problems can be both immediate and long-term. For example, standing water and mud inside crawl spaces make it very difficult and messy to gain access under the house for inspecting, maintaining, and servicing electrical circuits, drains and water lines, heating and air conditioning, and other utilities. Wet basements and crawl spaces are sources of high humidity, which can produce surface condensation, mildew and fungi, musty odors, and an unhealthy environment. Such moisture can cause deterioration of floor joists, beams, subflooring, insulation, and electrical-mechanical systems. Prolonged water around the footer and foundation wall can soften the soil and weaken its bearing capacity, increasing the possibility of wall settlement and cracking. Serious seepage under the foundation footer may erode soil away and cause sinkhole collapse. Excessive moisture can eventually penetrate the subflooring and buckle the flooring or cause warping, making doors and cabinets difficult to close or open. Since crawl space or basement dampness always moves toward the drier upstairs areas, higher humidity will result in costlier heating and air conditioning bills. In the case of crawl spaces, if the underflooring insulation collects moisture, or sags from excessive wetness, the heating and air conditioning costs are driven even higher.

Finally, wet basements and crawl spaces reduce the value of the house – at least by the amount that would be required to repair the damage and to eliminate the cause of the problem. Homeowners in these situations should immediately seek professional assistance in assessing the source and extent of the problem and in finding a remedy.

Activity: Tips for Wet Basements and Crawlspaces	RHP-12

Cause of Wet Basements and Crawl Spaces

Most wet basements or crawl spaces are caused by surface water that is not adequately drained away from the foundation wall. Sources of this water may include the following:

- Roof water, if no guttering is present or if the guttering leaks and overflows due to leaves and obstructions. Concentrated roof water, when falling from a height of one or two stories, can cause erosion along the foundation wall and exacerbate the problem of stormwater infiltration.
- Roof water, if the downspouts are clogged or do not have sufficient means to drain water away from the foundation wall. Frequently, a downspout ends at the corner of the house without a splash pad (splash block) or shoe (sometimes called an elbow), leaving roof water to concentrate at that point and seep into the soil next to the foundation wall. A typical 2000 square foot roof can produce almost 1250 gallons of water during just 1 inch of rainfall. If rainfall is steady and prolonged, roof water is even more likely to soak into the ground next to the foundation wall.
- Excessive watering of flower beds and shrubbery around the foundation wall. Once the upper soil layer or mulch bed is filled with water, the excess water either runs off or seeps into the ground next to the wall. Prolonged watering can contribute large amounts of water to crawl spaces or basements.
- Rainwater runoff from the adjacent lawn, walks, or driveway areas if the landscaping slopes water to drain toward the house instead of away. If surface runoff is directed toward foundation wall, water will pond and then soak into the soil, thus becoming a potential source of basement or crawl space water. Downspout splash pads are not very effective if the lawn drains back to the foundation wall.

Water or dampness problems in basements or crawl spaces are sometimes caused by other factors:

- Subsurface or groundwater may be intercepted or dammed up by a basement or foundation wall. Houses which are built on a hillside are particularly vulnerable. Foundation walls act like dams to intercept and trap this subsurface water, causing pressure to build up on the outside of the wall, which forces water through joints and cracks in basement walls or as seepage under the footer.
- Nearby springs may have been filled in or covered up by the others. Unless the springs were properly drained away from the lot or subdivision, such water will eventually seep into the surrounding fill, become a pool of groundwater, and eventually force itself laterally and upwardly into basements and crawl spaces.
- Nearby creeks may overflow during storm runoff and either directly flood basement or crawl space areas, or contribute to the groundwater, which may become sufficiently high to cause seepage into the basement or crawl space area. Homeowners may not experience the effects of groundwater seepage or overflowing creeks for months or years after purchasing a house because of drought or infrequent out-of-bank flooding. However, when such conditions do occur, they may come suddenly without warning and cause serious problems after the warranty period has expired.
- Improperly installed, clogged, collapsed, or leaky drains may not allow water to escape. Perimeter, footer, or foundation drains are installed around the exterior of a house below basement floor level to intercept groundwater build-up and seepage under the house. If drains are improperly installed or become clogged with silt or roots, they will not operate as intended. Sometimes an otherwise good perimeter drain gets covered up or crushed during the final backfilling or landscaping stages of construction, and the intercepted water will backup into a foundation wall and eventually to seep into the basement or crawl space.

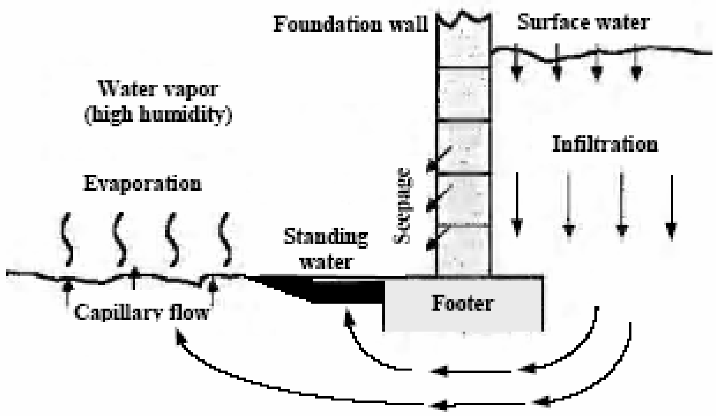


Figure 1. Typical paths of water and moisture entering into a crawl space area.

Cause of Wet Basements and Crawl Spaces (cont'd)

- Soil continuously draws water up from subsurface groundwater sources in a crawl space by capillary attraction. The finer the soil (e.g. clays), the more aggressive the capillary pumping action. As the water rises to the surface, it evaporates into the crawl space. This ground moisture is a significant source of dampness and humidity under a house, even without standing water. The presence of capillary water is often indicated by a whitish residue, left on the ground surface of the crawl spaces, resulting from evaporation of water containing minerals and salts. Lack of a moisture barrier, such as a plastic sheet, will allow capillary action and evaporation to contribute unlimited moisture to crawl space areas. Figure 1 illustrates how surface water and moisture can enter a crawl space area.
- Closed, inadequate, ineffective, or no crawl space venting around foundation walls will force the buildup of humidity in the space beneath a house. Given the combination of high humidity and low temperature, condensation can form on heating/AC ducts, joists, underflooring, and insulation. This environment, together with likely darkness, encourages mildew and other fungi to form.
- Damp or wet basements and crawl spaces may be caused by ruptured water or sanitary lines either just outside the wall or under the house. If a crawl space is unusually wet and muddy, inside leaks may be difficult to find and repair. Outside pipe leaks may be even more difficult to find, since water may appear several feet away from the actual leak. Old field drains under a house may also be a source of unwanted water.

Preventing Wet Basements and Crawl Spaces

Many construction complaints about new homes arise from inadequate site drainage and water problems. Proper drainage of surface water is a primary element in preventing wet basements, damp crawl spaces, eroded banks, muddy yards, and possible failure of a foundation system. The City of Somersetrequires that new construction or alteration of houses must conform to the requirements of the Southern Building Code Congress International, Inc. (SBCCI). Generally, surface water drainage should be directed from all sides of the house and off the lot in a manner that will:

- Minimize possibility of dampness in basements and crawl spaces.
- Prevent standing or ponding water on the site.
- Prevent soil erosion.
- Not adversely affect the supporting foundation soil behavior.

Preventing Wet Basements and Crawl Spaces (cont'd)

Walks, driveways, retaining walls and other landscape improvements should be constructed so as not to interfere with drainage. Walks should not be used as drainage channels. Site grading plans should specify minimum slopes from the house (usually 2 to 5%), depending on location, type of soils, frost depth, and soil moisture, to ensure water drainage for some specified distance (usually 6 to 25 feet) away from supporting foundations. In cases where minimum slopes or distances cannot be attained, paved gutters or other drainage structures acceptable to the Building Inspector may need to be installed. Maximum slopes are specified to prevent erosion or unstable banks around the house and yard.

Roof water should be directed to a downspout and away from the foundation wall toward a suitable ditch, swale, or drainage pipe to prevent ponding or backflow as shown in Figure 2. All drainage structures should be properly connected to adequate outlets that are protected, where necessary, by recorded permanent easement. House plans and landscaping should be developed to prevent "dead" drainage areas around the foundation wall -- areas where rainfall has no place to flow away except by ponding and soaking into the soil near the foundation wall. Areas bounded by the front entrance / sidewalk/garage / driveway are especially vulnerable to trapped pockets of surface water.

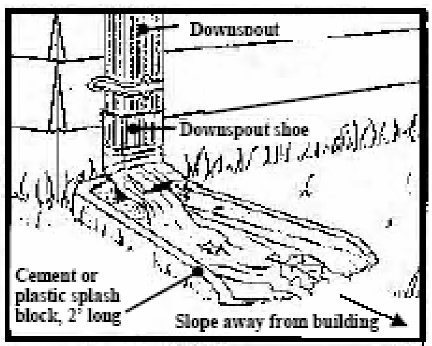


Figure 2. Correct installation of downspout shoe and splash block at foundation wall.
(Note that the ground surface slopes away from house.)

Another vital step in preventing water in basements and crawl spaces is to intercept outside subsurface or groundwater with a perimeter drain at the footer base level around all sides of the house where the exterior ground surface is higher than the inside floor or crawl space level. While foundation drains are clearly necessary for houses with basements or potentially habitable living space below exterior ground surface, they may also be used in crawl spaces where water, soil, and/or earth floor elevation conditions warrant. The drains should discharge by gravity to a positive outfall such as an approved drainage ditch, swale or storm system. In some cases, sump pits and pumping with automatic float actuation may be required.

Specifications for waterproofing and damp-proofing foundation walls are found in SBCCI. Building codes specify the materials, maximum vapor transmission rate, venting, etc., appropriate for construction. Excessive moisture vapor can be prevented from entering a crawl space area with the use of an effective and correctly installed vapor barrier (typically polyethylene sheeting) over the ground surface. Torn pieces, poor or non-overlapping joints, missing sections, or improperly sealed corners and edges at the walls, fireplaces, and interior piers must be avoided to produce an effective vapor barrier.

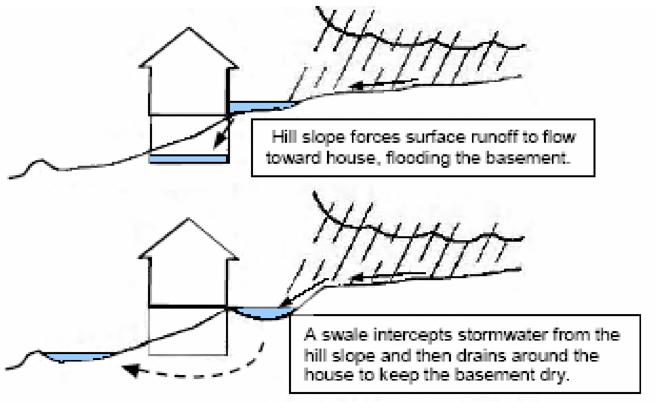


Figure 3. Correction of typical slope drainage problem using swale or ditch.

Preventing Wet Basements and Crawl Spaces (cont'd)

Crawl space areas should have adequate wall ventilation openings around the foundation walls to provide cross ventilation for preventing the buildup of water vapor inside the crawl space. Building codes specify minimum vent opening areas (usually 1 square foot of net opening for each 150 square feet of crawl space), opening location or arrangement, corrosion-resistant wire mesh screen, and any reduction in ventilation opening area allowance if an approved vapor barrier is used.

In older houses where any of the above moisture control methods are missing, measures should be taken to install appropriate drainage facilities, vapor barriers, or ventilation openings. Installing any of these elements after a house has been built will be more costly than while the house is constructed. A combination of remedial measures is often necessary. If the yard area slopes toward the house and surface water collects or ponds near the foundation wall, a V-ditch or swale should be constructed around the house to allow surface drainage from both the foundation wall and the other yard areas to an adequate ditch or storm drain. Such cases often exist where the front street is higher than the first floor of the house, or when the house is built on the side of a hill. Figure 3 illustrates how this problem can be solved.

If a flower bed or garden is next to the foundation wall, it may be a significant source of water for the basement or crawl space. Consider relocating the flower bed or shrubbery, or install heavy plastic sheets with drains beneath the flower bed. Then any water which soaks deeply into the soil is intercepted and carried safely away by gravity at least six to eight feet from the house to a gravel collection drain or swale.

Tips for Homeowners and Homebuilders

"A teaspoon of prevention is worth a gallon of cure" certainly applies to new homebuilders – at least in avoiding water problems in basements or crawl spaces. Buyers of new or older houses should be cautious about drainage. The best time to sign a contract is on a rainy day!"

Tips for buying or building a new house

The following tips are suggested to avoid water problems when building or buying a new house:

Work with a professional to help locate the new house on the lot and at an elevation which minimizes the potential for surface or groundwater drainage problems. If a flowing stream or creek is nearby (especially if bordering the lot), check with local planning agency authorities or a hydrologic engineer for potential flooding, whether in a designated 500-year flood hazard zone or in an area where that may be affected by nuisance flooding.

Tips for Homeowners and Homebuilders (cont'd)

Work with a reputable homebuilder that can supply reference names and projects for houses that he has built. Visit these sites and check for patterns of any drainage problems. Contact the Better Business Bureau and other organizations to see if there are complaints and outstanding issues.

It may be beneficial to hire an engineer or architect to check slopes, foundation wall waterproofing and dam-proofing, underground drains, general surface and roof water drainage, and general quality of construction. If you suspect a potential problem, ask the local building inspector for advice.

Check to make sure that the perimeter foundation drain, basement drain, or crawl space drain has an unobstructed outlet to a ditch or swale leading away from the house. Pay special attention around the outside and the basement or crawl space for: (1) back sloping lawns and landscaping toward foundation walls; (2) back sloping driveways toward garage, stoops, walks or patios which force surface water toward the foundation wall; (3) very flat property; (4) standing water inside of crawl space next to foundation wall; (5) pattern of wet concrete blocks inside basement walls, particularly with whitish salt deposits on inside foundation walls as a result of leaching from moisture seepage and evaporation; (6) downspouts which drain to the foundation wall without any clear path for water to escape; and (7) depressions or settlement near the foundation. If necessary, use a level to check the slope direction.

Section 4

Post-Construction Best Management Practices

This section contains fact sheets for the following BMP categories:

- Section 4.1: Stormwater Pollution Prevention (Non-structural) - SPP
- Section 4.2: Stormwater Pollution Treatment Practices (Structural) - PTP

	Somerset, Kentucky **Stormwater Best Management Practices (BMPs)** **Stormwater Pollution Prevention (Non-Structural)**	SPP-01
	Activity: Education	

PLANNING CONSIDERATIONS:

Design Life:
Program life

Acreage Needed:
N/A

Estimated Unit Cost:
Varies

Training Programs:
Annual/biannual, new employee training

Description

Education is a key nonstructural BMP that supports both structural and nonstructural practices. Education programs are the first step in achieving proper operational procedures and incorporating practices into daily activities to minimize the potential for contributing pollutants to become incorporated into stormwater runoff. Nonstructural practices such as this can cost-effectively compliment other BMPs and reduce pollutant loads that contribute to stormwater pollution. Two educational practices discussed in this fact sheet include:

- Training
- Standard operating procedures

Suitable Applications

A stormwater education program can have a wide range of applications and audiences. Any homeowner or municipal, commercial or industrial facility that impacts stormwater could benefit from practices achieved by this BMP. Examples of suitable applications include the following:

- Schools
- Public service organizations
- Municipal employees
- Commercial or industrial businesses
- Facilities with outdoor storage
- General Public

Activity: Education	SPP-01

Approach

The effectiveness of an education program stems from the leadership of government departments and the involvement and proactive participation of individuals and target audiences. Government departments such as the Public Works Department perform highly visible activities in the community such as maintaining roadways, sewers, and sinkholes. If municipal departments such as this take on a leadership role, it can improve the community-wide acceptance of adopting and implementing educational program.

Educational programs can facilitate employee awareness of stormwater pollutants, runoff flow characteristics, spill prevention and control measures and proper operation and maintenance practices. Education is generally most effective when a target audience can clearly see the relationship between their daily activities and the associated stormwater quality impacts. Making this connection can result in changed habits and behaviors that can improve water quality in and outside of the workplace. Employee education programs should not only focus on workplace activities, but should also include ways that employees can reduce the potential water quality impacts in their homes and communities. Public education programs can also enhance community responsiveness, which may increase inquiries or reporting when spills or illicit discharges occur.

Training as part of an educational program can take many forms, including the following:

- Municipal/commercial training
- New staff training
- Refresher training

Standard operating procedures consist of choices that public (or private) employees make that can reduce the impact that pollutants have on local streams and waterways. Standard operating procedures can be incorporated by:

- Adding to daily/routine activities
- Supplying the BMP reference manual for frequent and infrequent activities available for employees
- Encouraging employees and target groups to adopt standard operating procedures

Training

Stormwater education programs should be conducted in a variety of forms, and at regular intervals throughout an individual's employment. Possible program activities may include:

- A stormwater briefing session held for approximately a half-hour to update employees on proper practices, reflect on a recent incident or discuss a case study/what-if scenario.
- Partnering with local volunteer groups or schools to provide tours of the Department of Public Works facilities with a focus on practices that minimize stormwater quality impacts.
- Distributing or making brochures or stormwater information available on a periodic basis.
- Local TV or radio PSA's.

Standard Operating Procedures

Standard operating procedures should be integrated into daily tasks to reduce the potential for stormwater pollution. Standard operating procedures should not only be adopted by municipal facilities, but also by private businesses. They can include moving or cleaning equipment to prevent rainfall from washing pollutants into streams, clearing litter or debris from parking lots storing potential pollutants under cover, and educating to not over-use pesticides or herbicides.

Activity: Education	SPP-01

Standard Operating Procedures (cont.)	The following activities can impact stormwater quality and should have associated standard operating procedures to control the source of the pollutant before it comes in contact with runoff: ➢ Vehicle and equipment maintenance or washing ➢ Cleaning tools and equipment ➢ Roadside litter and street sweeping ➢ Storage yards ➢ Mowing and landscaping ➢ Pesticide and herbicide use, delivery, and storage ➢ Sand, salt, or chemical storage and loading ➢ Use of floor drains ➢ Hazardous material storage ➢ Handling bulk liquids ➢ Septic system maintenance ➢ Solid waste and dumpster use ➢ Disposal of waste oils, filters, fuels, and tires ➢ Disposal of concrete and metal waste ➢ Annual surveys of employee practices meeting/not meeting standard operating procedures.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Stormwater Pollution Prevention (Non-Structural)

SPP-02

Activity: Low-Impact Development

PLANNING CONSIDERATIONS:

Design Life:
Permanent

Acreage Needed:
Varies

Estimated Unit Cost:
Varies

Annual Maintenance:
Varies

LID

LID

Target Pollutants

Estimated Bioretention Pollutant Removal Rates:
Total Suspended Solids (TSS); 91%
Nutrients – Total Phosphorous/Total Nitrogen removal; 67/92%
Metals – Cadmium, Copper, Lead, and Zinc removal; 80-90%

General Description

Low-impact development integrates a variety of small-scale measures to closely maintain pre-development hydrology and reduce nonpoint source pollution caused by development. It is based on controlling runoff volume and mimicking the original hydrologic regime.

Low-impact Development includes:

- Landscaping and vegetative control practices;
- Disconnecting impervious surfaces;
- Bioretention and infiltration techniques;
- Alternative pavements that promote infiltration;
- Impervious surface area reduction; and
- Urban Forestry.

The basis for design is hydrology. Low-impact development applications have shown to be cost effective and cheaper than using traditional stormwater management alternatives. For additional information on low-impact development, visit http://www.epa.gov/nps/lid.

Applications

These practices are applicable to most land uses, and can be very efficient in the following applications:

- In conjunction with structural stormwater BMPs.
- Storage practices that contain runoff until it can be used for other purposes.
- Areas where visual enhancement is desired.

Siting & Design Considerations

Landscaping and Vegetative Control Practices

Landscaping and vegetative control practices can be applied to any land use type, but the following site-specific criteria should be considered to properly select a plant species or landscape options:

Siting & Design Considerations (Cont.)

- Climate
- Topography
- Soil Types
- Wind exposure
- Soil drainage and moisture conditions
- Available light or shade tolerance
- Planned use of the area
- Degree of maintenance desired
- Planting season

Certain criteria may be targeted for landscaping and vegetative control practices for their added stabilization benefits or support of other BMPs. Targeted areas may include:

- Steep Slopes
- Drainage channels with natural cover
- Streams and creeks (nearby)
- Areas connected to catch basins
- Buffer zones
- In conjunction with various structural BMPs (i.e., detention/retention ponds, wetlands, swales, etc.)

Bioretention and Infiltration Techniques

Suitable for nearly all residential, commercial or industrial lots.

- Storage Practices
  - Cisterns and rain barrels have the fewest site constraints.
  - Design and use should have some contingency for overflow or freezing.
  - Best suited for applications with an interest in reusing the water.
  - Pretreatment usually requires a wire mesh filter at the top of the cistern or barrel.
- Infiltration
  - Bioretention and grassed swales are common infiltration techniques.
  - Design and use should consider the peak flow demands, topography, and soil types.
  - In areas where local soils do not readily support infiltration, sand filtration systems can be used to discharge treated stormwater to a stream or storm sewer.
- Rain Gardens
  - Rain gardens are landscaped bioretention facilities that soak up runoff displaced by the impervious area of a structure. Runoff is trapped during a storm event, infiltrating slowly into the soil where it is treated by vegetation and microbes. Rain gardens can increase the aesthetic qualities of a development, and offer a greater benefit than traditional gardens. Rain gardens can have substantial environmental and water quality benefits.
  - Infiltration requires layers of soil, sand and organic mulch. In areas where local soils do not readily support infiltration, rain gardens can be modified to be underlain with a sand filtration system and underdrain that discharges treated stormwater to a storm sewer.
  - Rain garden vegetation should include indigenous plants and can be integrated into current or future landscaping using grasses, ferns or flowering plants.
  - Rain gardens should be at least 10 feet away from a structure to prevent groundwater seepage into the foundation. Rain gardens should be built level into a gentle slope that drains runoff.
  - Do not place rain garden directly over septic system.
  - Build the rain garden in areas of full or partial sun.

Siting & Design Considerations (Cont.)

Impervious Surface Area Reduction

Applying techniques to reduce the impervious surface area of new development and redevelopment is often dependent on the applicability, cost, and maintenance of those techniques. Green Parking techniques reduce the impervious area of parking lots and consequently, the amount of stormwater runoff. Likewise, Green Rooftop reduces the impervious area of rooftops and consequently, the amount of stormwater runoff.

Green Parking techniques include:

- Shared parking in mixed use areas and structured parking.
- Building additional parking upwards or downwards (ie., parking garages).
- Design around average parking demands instead of conventional parking requirements. Provide an overflow lot utilizing grass or alternative pavers for peak demand parking. For more information on alternative pavers, visit http://www.stormwatercenter.net.
- Minimizing parking space dimensions by reducing the length and width of spaces.
- Parking areas restricted to compact cars.
- Incorporate bioretention areas in parking lot design to effectively treat stormwater runoff.
- Use pervious surfaces.

Green Rooftop is a layer of vegetation, shrubs, or trees planted on rooftops to absorb stormwater runoff. In the summer, Green Rooftops retain approximately 70 to 100% of the precipitation that falls on them. In the winter, they retain approximately 40 to 50%. A green rooftop generally consist of:

- A waterproofing membrane
- Insulation
- Protection layer
- Drainage layer
- Filter mat
- Soil layer
- Vegetation
- The load-bearing capacity of the rooftop should be identified prior to green rooftop design. It is recommended to consult a structural engineer before designing or installing a green rooftop. If the projected live load of a green rooftop is greater than 17 lbs per square foot, consultation with a structural engineer is required.
- An internal drainage network that directs flow away from the roof to inhibit ponding should be included in the design.
- Green rooftops can be successfully built on slopes up to 30 degrees.

Urban Forestry

Urban Forestry is frequently engineered to treat stormwater before it enters streams, lakes, or wetlands and is designed from a combination of vegetation, shrubs, and trees. Advantages of urban forestry include:

- Cover and absorption during precipitation events.

Siting & Design Considerations (Cont.)

- Filter pollutants from stormwater runoff or groundwater.
- Recycle carbon dioxide into oxygen.
- Provide shade along waterways and sustain the integrity of stream ecosystems and habitats.

Forestry is commonly used as an aquatic buffer. The benefits of buffers are increased in a forested condition.

Costs

Low-impact development costs vary depending on the application, area, and land use. A few general guidelines used to estimate costs are listed below.

- Approximately $100 for a rain barrel and up to $200 for a dry well.
- Bioretention areas cost about $6.40 per cubic foot of quality treatment.
- Initial costs of a green roof can be 30% greater than a conventional roof. However, long-term maintenance, energy cost and stormwater utility savings can offset initial costs and increase the lifespan by as much as 50%. Green rooftops can be warranted up to 15 years.

Maintenance

Landscaping and Vegetative Control Practices

- Irrigation, fertilization, and mulching are variable maintenance practices dependant on the plant species, soil conditions, and topography.
- Established vegetation and landscaping may need periodic seasonal trimming to maintain aesthetic appearance.
- Mow or weed as necessary.

Bioretention and Infiltration Techniques

- Practices require frequent, but small efforts to maintain, such as draining a rain barrel after a large wet weather event, cleaning debris out of the infiltration practices, or keeping the vegetation in the rain garden from overgrowing. Weeding and watering will be needed in the first two years of establishing a rain garden, and thinning of plants in the following years as they mature.
- Maintenance is dependent on the owner’s efforts. Can be maintained by commercial landscaping firms.

Impervious Surface Reduction

- Alternative pavers generally have a moderate cost of maintenance associated with them and snow removal can be difficult.
- Clear debris or blockage from internal drainage network to prevent overflow and ponding on green roofs.
- Established vegetation on green roofs may need periodic seasonal trimming to maintain aesthetic appearance.

Urban Forestry

- Established vegetation, shrubs and trees may need periodic seasonal trimming or pruning to maintain aesthetic appearance.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Stormwater Pollution Treatment Practices (Structural)

PTP-01

Activity: Filtration Systems

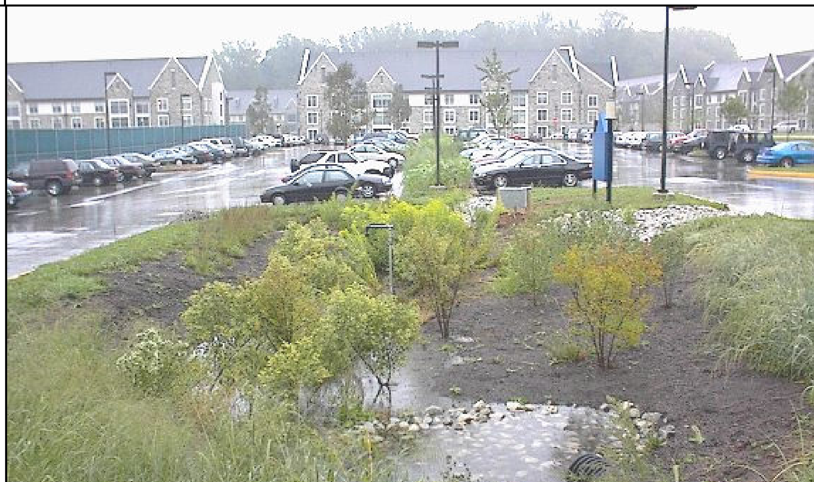
PLANNING CONSIDERATIONS:

Design Life:

Acreage Needed: Minimal

Estimated Unit Cost: Moderate

Annual Maintenance: Moderate to High; Low (Bio-retention)



FS

FS

Target Pollutants; Pollutant Removal

Total Suspended Solids (TSS); 80%
Nutrients – Total Phosphorous/Total Nitrogen removal; 50/25%
Metals – Cadmium, Copper, Lead, and Zinc removal; 50%
Pathogens – Coliform, Streptococci, E.Coli removal; 40%

Description

Filtration systems are structural water quality control devices that capture and temporarily store, treat, and release stormwater runoff. Filtration systems consist of two main components: a pretreatment basin and filtration chamber. The pretreatment basin removes floatable materials and heavy sediments, and helps reduce flow velocities. The filtration chamber traps and strains pollutants, and allows the microbial removal of pollutants. Target pollutants for filtrations systems include suspended solids, suspended particulates, biochemical oxygen demand (BOD), fecal coliform bacteria, and others. Filtration devices may also employ organic materials such as peat or compost combined with sand, and others add plantings and mulch to the surface layer. This may allow additional pollutant removal via bacterial decomposition and vegetation uptake of nutrients. The two main structures of filtration systems (the pretreatment basin and filtration chamber) may include or be enhanced by the following components:

- Grass buffer strips
- Ponding area
- Surface of mulch and plantings
- Sand bed
- Organic layer
- Plant material
- Exfiltration zone or collection system to return stormwater to a conveyance system

Filtration systems documented in this fact sheet include:

- Surface sand filters
- Underground sand filters
- Perimeter sand filters
- Organic sand filters
- Pocket sand filters
- Bioretention systems (shown above)

Activity: Filtration Systems | PTP-01

Suitable Applications

Filtration systems are often used to manage stormwater runoff from urban areas where space is limited, and can be applied to areas where retrofit is needed, and are typically suitable in the following applications:

- Small drainage areas (2 to 10 acres maximum)
- Typically requires 2 to 6 feet of head
- Impervious area runoff
- Retrofit applications

Filtration systems should only be applied to stabilized drainage areas, as heavy sediment loads from construction areas will clog and disable the filter. Likewise, they should not be used in areas where stormwater has potential for high silt or clay content, and areas with a high water table. As a guide, sites implementing filtration systems should have over 50% impervious cover in the drainage area.

Filtration systems should typically be designed for off-line use to capture the first flush of runoff. A diversion structure such as a flow splitter or weir may be necessary to separate and route the first flush to the filtration system for water quality control, and route the remaining stormwater to a water quantity control device downstream. Filtration systems are most effective when turbulent flow is minimized and the flow is spread uniformly across the filter media.

Installation Procedures

- Site slope should be less than 6% across the filter location
- The minimum head (or elevation difference on the site from the point of inflow to point of outflow) required is:
    - 5 feet for surface sand filters
    - 2-3 feet for perimeter sand filters
- Allow at least 2 feet between the bottom of the sand filter to the high water table elevation
- Variable soils can be used, but Group A soils generally require exfiltration (surface sand filter earthen structures)
- Hotspot runoff requires an impermeable liner to protect groundwater
- In karst areas, an impermeable membrane should be used to seal the bottom of an earthen surface sand filter, or alternatively, a watertight filtration system structure may be used

Maintenance

Maintenance access should be provided for appropriate equipment, vehicles, and personnel. Filtration systems installed below grade should have access grates available to inspect and maintain the filter bed. For bioretention systems, additional maintenance considerations are listed in the biofiltration section of this fact sheet.

Monthly

- Remove trash or debris
- Inspect the filter for clogging (sand filters – rake the first inch of sand)

Quarterly/After Major Storm Events

- Monitor water level in sand filter chamber (underground sand filter)

Activity: Filtration Systems	PTP-01

Maintenance (cont.)

Annually

- Remove sediment as necessary
- Repair or replace any damaged structural parts
- Stabilize any eroded areas

As Needed

- Replace sand filter media or filter fabric
- Clean out sedimentation chamber when sediment depth reaches 12 inches (underground sand filter)
- Remove accumulated oil and floatables from the sedimentation chamber (underground sand filter)
- For clogged or partially clogged sand beds, remove the first 3 inches of sand from the surface, till, or cultivate the bed, and replace with fresh sand meeting the appropriate design specifications
- Properly dispose of any material generated during maintenance activities.

Inspection Checklist

Monthly

- [ ] Contributing area, facility, inlets, and outlets are clear of debris
- [ ] Contributing area is stabilized and mowed, with clippings bagged or removed
- [ ] Filter surface is not clogging – also inspect after moderate/major storm events
- [ ] Activities in the drainage area minimize oil/grease and sediment entering the system
- [ ] Permanent water level is not present (for perimeter sand filter)
- [ ] For filtration systems utilizing a permanent pool, chamber or vault does not leak, and normal pool water surface elevation is retained

Annually

- [ ] Filter bed is clean of sediment, and the sediment chamber contains no more than 6 inches or 50% depth of sediment, whichever is less (or 12 inches for underground sand filters)
- [ ] No evidence of deterioration, spalling, or cracking is present on concrete
- [ ] Inspect grates, where applicable
- [ ] Inlets, outlets, and overflow spillways or diversion structures show no evidence of erosion or deterioration
- [ ] Flow is not bypassing the filtration system
- [ ] No noticeable odors are detected outside of the facility

As Needed

- [ ] Filtration system (sand bed, filter fabric, etc.) is not clogged or partially clogged

Activity: Filtration Systems / Surface Sand Filters

PTP-01.1

Surface Sand Filters

Surface sand filters are open-air structures constructed level with the grade primarily to serve as off-line water quality systems. The two main system components include a pretreatment sediment forebay and filter bed chamber. Flow is routed to the sediment forebay where settlement of heavier sediment particles occurs. A perforated standpipe is used to move pretreated runoff to the filtration chamber. The runoff passes through the filter bed and is collected by the perforated pipe and gravel underdrain system.

Drainage areas can range up to 10 acres for surface sand filters to effectively remove pollutants. Designs vary from riprap to an excavation with earthen embankments to a concrete or block structure. See Figures PTP-01-01 and PTP-01-02 for the typical surface sand filter schematics. Surface Sand Filters should not be used for residential applications.

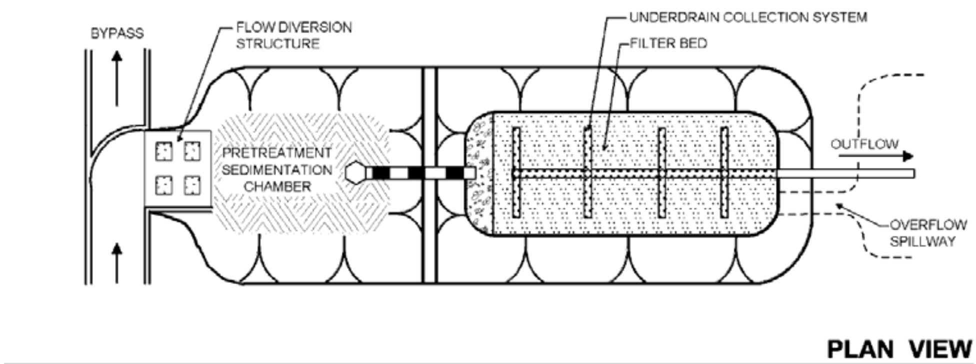


Figure PTP-01-01
Source, Georgia Stormwater Management Manual

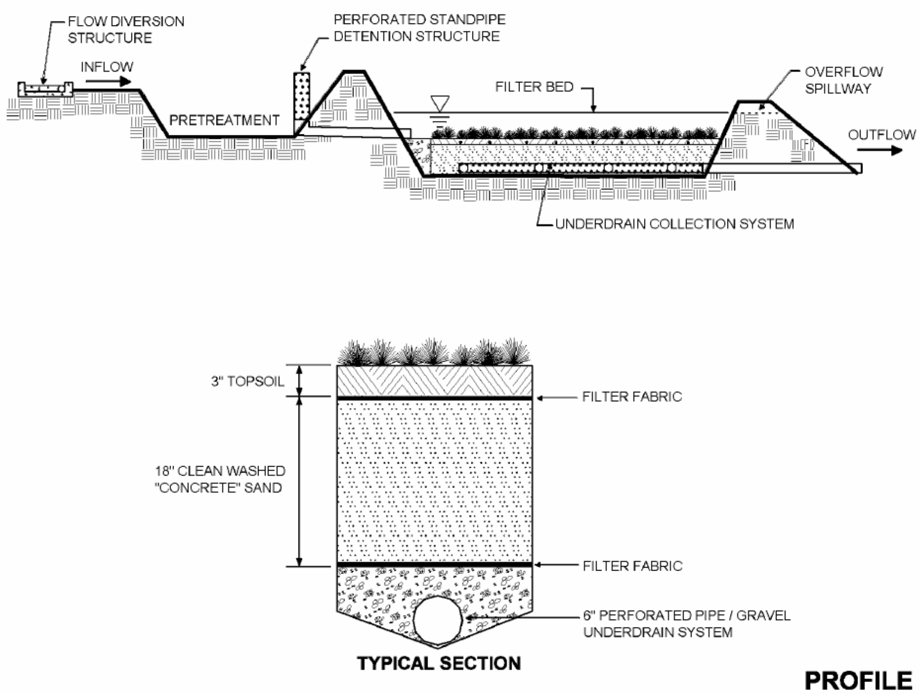


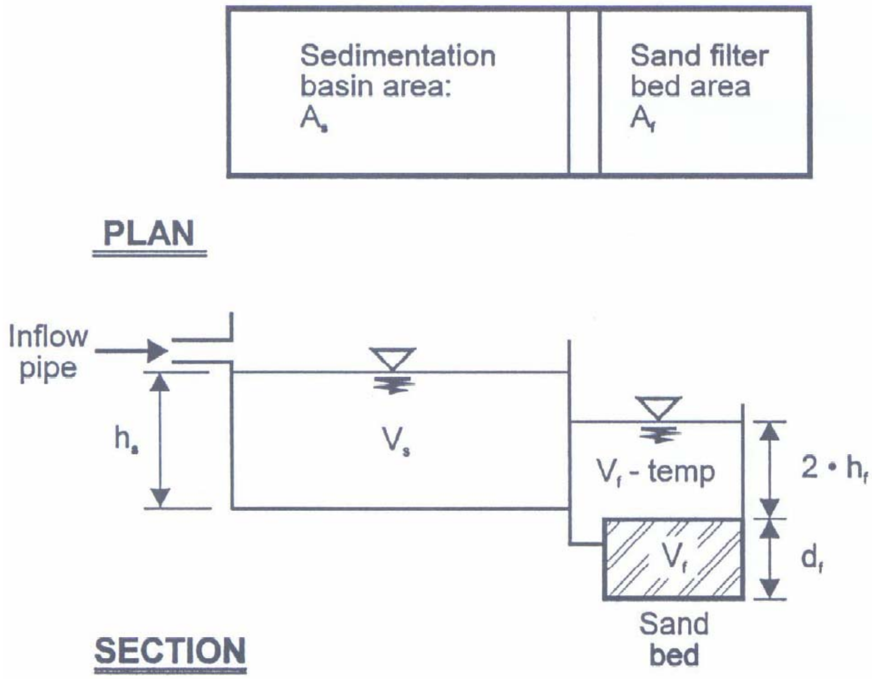
Figure PTP-01-02
Source, Georgia Stormwater Management Manual

Surface Sand Filters (cont.)

Design Criteria

- Contributing drainage area should be less than 10 acres
- Use in areas with urban land uses and high percentage of impervious area (greater than 50% impervious)
- Disturbed areas draining to the sand filter should be identified and stabilized as soon as possible as they may clog the filter bed
- Surface sand filters should be configured off-line, so that flows greater than the water quality volume (WQ_v) capacity can be diverted downstream
- Flow should not be continuous, and the filter should be designed to drain completely and reaerate between rainfall events
- The filtration system must be designed to temporarily hold a capacity equal to or greater than 75% of the water quality volume (WQ_v) of the system prior to filtration. Figure PTP-01-03 shows the distribution of treatment volume (0.75 WQ_v).
- The sedimentation chamber must have a capacity to hold 25% of the water quality volume (WQ_v), and have a ratio of 2:1 (H:V)
- Inlet and outlet structures should be constructed at opposite ends of the sedimentation chamber
- Use Darcy's law to size the filter bed area, using a coefficient of permeability, k, of 3.5 ft/day for sand. Typically, filter beds should drain within 40 hours.
- The filter media should be placed around the underdrain system, and should include an 18-inch layer of clean, washed, medium sand (ASTM C-33 concrete sand). A layer of permeable filter fabric should be placed both above and below the sand layer to prevent clogging of the sand filter and underdrain system.
- The surface sand filter should incorporate a 6-inch perforated PVC pipe (AASHTO M 252) underdrain in a gravel layer. Requirements for the underdrain include:
    - A minimum grade of $^1/_8$-inch per foot (1% slope)
    - Holes spaced approximately 6 inches apart with diameters of $^3/_8$-inch
    - Gravel specifications are clean, washed aggregate at a diameter no greater than 3.5 inches and no less than 1.5 inches. Voids should make up approximately 40% of space. Do not use gravel that has been contaminated with soil.
- The outer structure of the surface sand filter can vary. Concrete or earthen embankments are common. If earthen embankments are used, a permeable filter fabric should be used to line the bottom and side slopes of the earthen walls before installing the underdrain and other filtration system components.

Surface Sand Filters (cont.)



V_s = Sedimentation basin volume
V_f = Volume of voids in the filter bed
$V_{f\text{-}temp}$ = Temporary volume stored above the filter bed
A_s = Surface area of the sedimentation basin
A_f = Surface area of the filter media
h_s = Depth of water in the sedimentation basin
h_f = Average depth of water above the filter media
d_f = Depth of the filter media

Figure PTP-01-03
Source, Georgia Stormwater Management Manual

Perimeter Sand Filter

Perimeter sand filters are constructed just below grade with two enclosed parallel chambers. Typically, perimeter sand filters are installed along the perimeter of a parking lot for off-line treatment. Runoff from impervious area enters the sedimentation chamber via an inlet grate and spills through a weir and into the filtration chamber. The sand bed filters runoff, and runoff is then collected by the perforated pipe and gravel underdrain system. See Figures PTP-01-04 and PTP-01-05 for typical perimeter sand filter schematics.

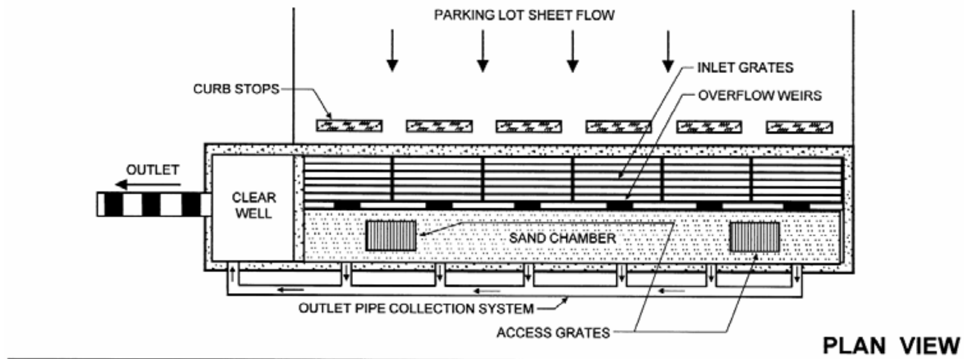


Figure PTP-01-04
Source, Georgia Stormwater Management Manual

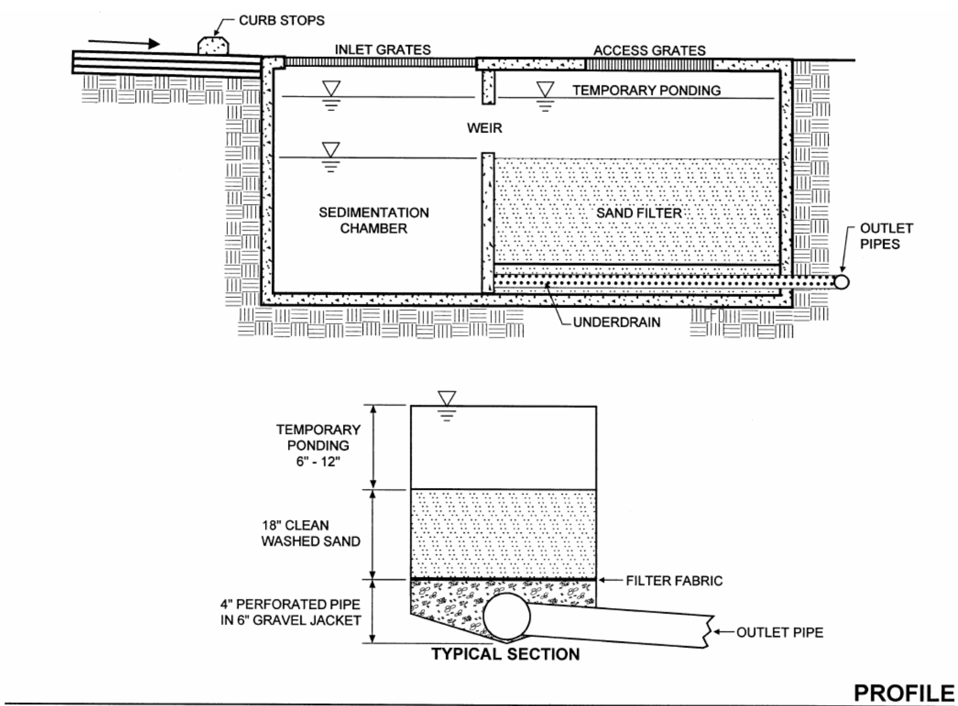
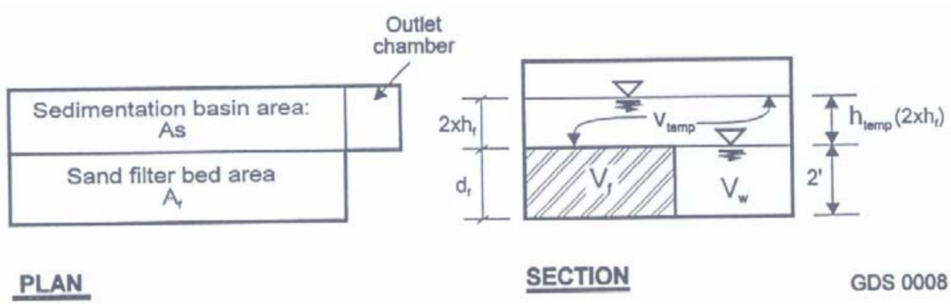


Figure PTP-01-05
Source, Georgia Stormwater Management Manual

Perimeter Sand Filter (cont.)

Design Criteria

- Contributing drainage area should be less than 2 acres
- Use in areas with urban land uses and high percentage of impervious area (greater than 50% impervious)
- Disturbed areas draining to the sand filter should be identified and stabilized as soon as possible as they may clog the filter bed
- Perimeter sand filters should be configured off-line, so that flows greater than the water quality volume (WQ_v) capacity can be diverted to an overflow conveyance
- Construct perimeter sand filters along the boundary, or perimeter, of an impervious area, i.e., a parking lot
- Flow should not be continuous, and the filter should be designed to drain completely and reaerate between rainfall events
- The filtration system must be designed to temporarily hold a capacity equal to or greater than 75% of the water quality volume (WQ_v) of the system prior to filtration. Figure PTP-01-06 shows the distribution of treatment volume (0.75 WQ_v).
- The sedimentation chamber should be sized to accommodate at least 50% of the calculated WQ_v.
- Use Darcy's law to size the filter bed area, using a coefficient of permeability, k, of 3.5 ft/day for sand. Typically, filter beds should drain within 40 hours.
- The filter media should be placed above the underdrain system, and should include a 12- to 18-inch layer of clean, washed, medium sand (ASTM C-33 concrete sand). See Figure PTP-01-07 for a typical perimeter sand filter cross section of media placement.



o

V_w = Wet pool volume of the sedimentation basin
V_f = Volume of voids in the filter bed
V_{temp} = Temporary volume stored above the filter bed
A_s = Surface area of the sedimentation basin
A_f = Surface area of the filter media
h_s = Depth of water in the sedimentation basin
h_f = Average depth of water above the filter media (½ h_{temp})
d_f = Depth of the filter media

Figure PTP-01-06
Source, Georgia Stormwater Management Manual

Perimeter Sand Filter (cont.)

Design Criteria (cont.)

- The perimeter sand filter should incorporate a 4-inch perforated PVC pipe (AASHTO M 252) underdrain in a gravel layer. Requirements for the underdrain include:
  - A minimum grade of $^1/_8$-inch per foot (1% slope)
  - Holes spaced approximately 6 inches apart with diameters of $^3/_8$-inch
  - A permeable filter fabric should be placed between the gravel layer and the filter bed material.
  - Gravel specifications are clean, washed aggregate at a diameter no greater than 3.5 inches and no less than 1.5 inches. Voids should make up approximately 40% of space. Do not use gravel that has been contaminated with soil.

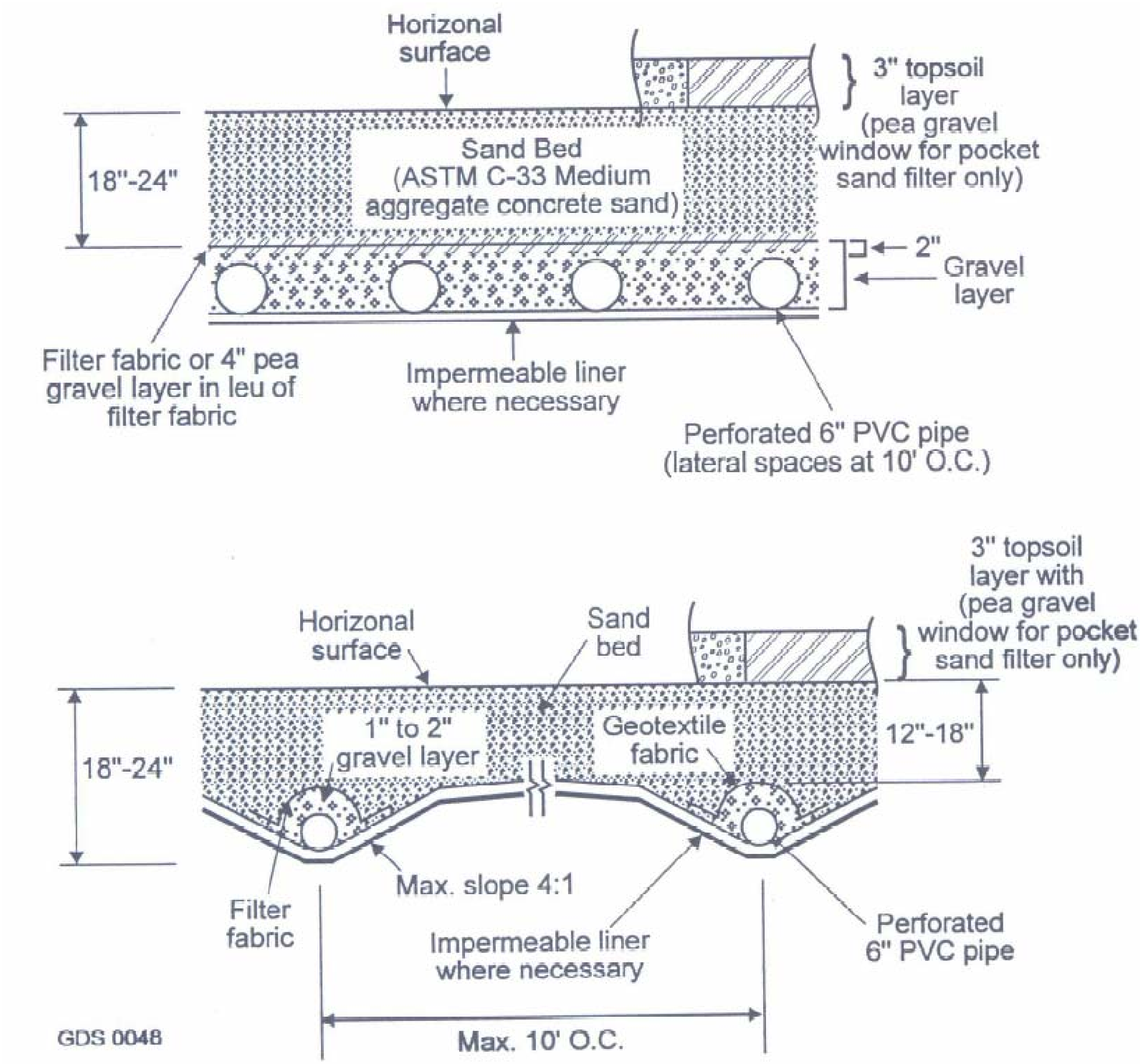


Figure PTP-01-07

Source, Georgia Stormwater Management Manual

Activity: Filtration Systems / Underground Sand Filter	PTP-01.3

Underground Sand Filter

Underground sand filters are designed for applications with extreme space constraints or high density areas where a surface sand filter cannot be constructed due to space limitations. They are typically used as on-line systems for impervious areas of 1 acre or less. An underground sand filter should not be designed to treat a drainage area greater than 5 acres.

This type of filtration system utilizes a three-chamber vault, where the first two chambers temporarily store and treat runoff, and the third chamber collects filtered runoff. This first chamber is a sedimentation chamber with a wet pool that stores and pretreats runoff. This is connected to the second chamber, the sand filter, by a submerged wall which provides an obstruction for oil and floatables. The filter bed should be approximately 18 to 24 inches deep. Permeable geotextiles or a gravel screen can be used to prevent clogging of the sand bed. The second chamber also contains a perforated drain pipe to collect the filtered runoff. This underdrain system transfers the filtered runoff to the third chamber, where runoff is collected. An overflow weir is necessary to divert excess flow through the system. See Figures PTP-01-08 and PTP-01-09 for schematics of a typical underground sand filter.

Design Criteria

- Contributing drainage area should be less than 5 acres. Underground sand filters are commonly used for impervious areas of approximately 1 acre.
- Typically constructed as on-line systems, but can be off-line systems. Off-line construction omits the overflow structure between the second and third chambers.
- The minimum wet pool volume required in the sedimentation chamber should be calculated using the following equation:

$$V_w = A_S * 3 \text{ feet minimum}$$

Where V_W = wet pool storage
A_S = area from Camp-Hazen equation

Please reference perimeter sand filter design criteria for remaining requirements of filter sizing and system design.

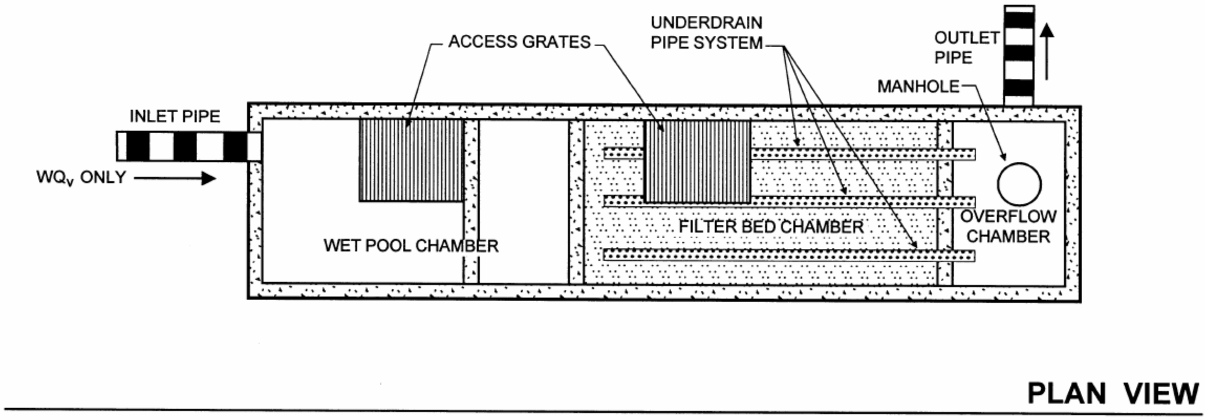


Figure PTP-01-08
Source, Georgia Stormwater Management Manual

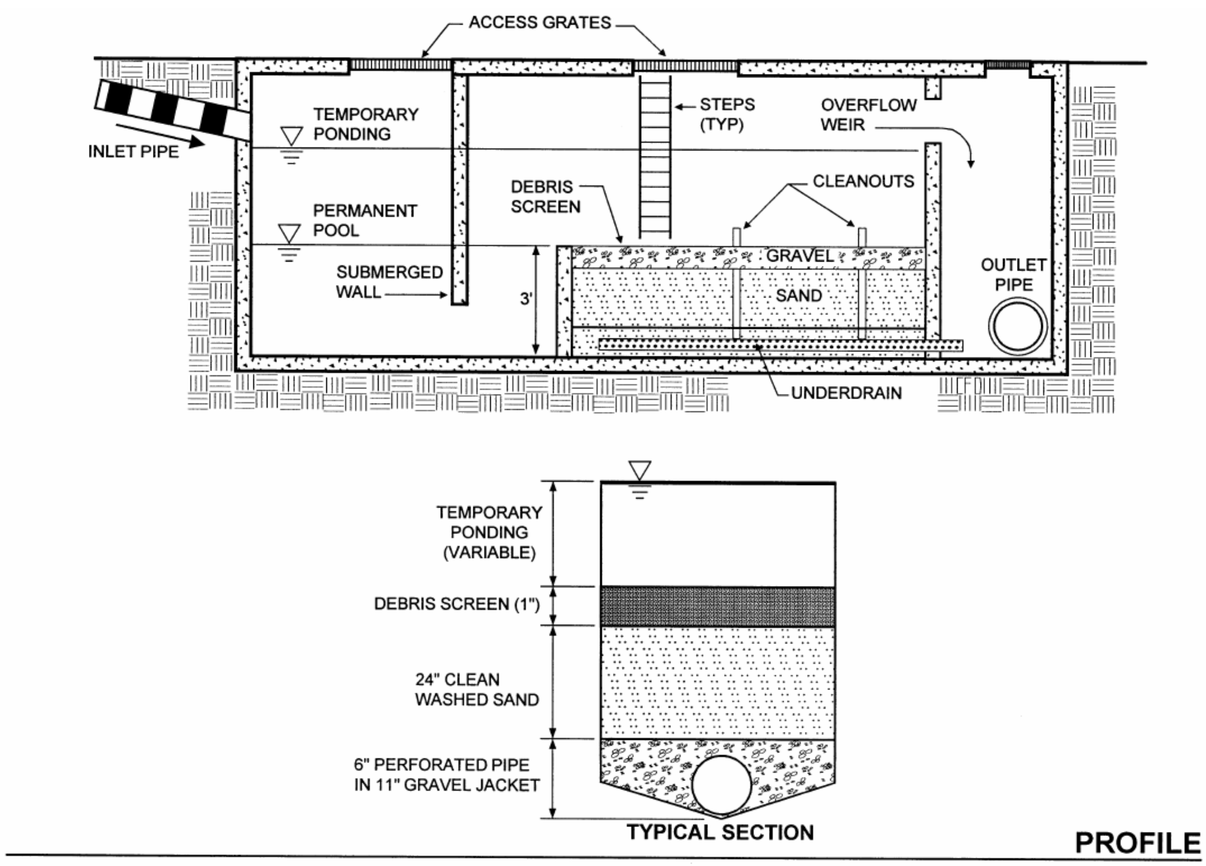


Figure PTP-01-09
Source, Georgia Stormwater Management Manual

Organic Sand Filter

The organic sand filter is a variation of the surface sand filter, utilizing organic materials in the filter media. Organic materials typically used are leaf compost or a peat/sand mixture. These materials enhance pollutant removal capabilities, absorbing soluble metals, hydrocarbons, and other organic chemicals.

The organic sand filter system is constructed with a layer of organic material placed above permeable filter fabric and the gravel and perforated underdrain system. The filter bed should be separated from soil layer by an impermeable layer such as a concrete structure or impermeable liner to prevent groundwater contamination.

Organic filters, like surface sand filters, are typically used in highly urban areas, most notably where enhanced pollutant removal is needed. Maintenance for organic sand filters is generally more tedious than surface sand filters due to higher propensity to clog the degredation of the organic filter media. See Figures PTP-01-010 and PTP-01-011 for schematics of a typical organic sand filter.

Design Criteria

- Minimum head required is 5 to 8 feet (the difference in elevation between the point of inflow to the point of outflow)
- Drainage area should be designed to serve a maximum of 10 acres
- Organic materials can vary, but typical filter media composition are:
  - Peat/sand filter – 18-inch 50/50 ratio of peat/sand mix over a 6-inch layer of sand. Can also be covered by a layer of sopsoil and vegetation
  - Compost filter – an 18-inch compost layer
- Peat types used impact the pollutant removal efficiency of the system. Fibric peat, where undecomposed fibrous organic material is easily seen within the peat mixture, is preferred. Hemic peat, which contains more decomposed material, may also be used. Sapric peat, which is almost fully decomposed matter, should not be used, and is not suited for this application.
- Organic sand filters remove dissolved pollutants more effectively than other sand filters. Pollutant removal capability is listed below:
  - TSS; 80%
  - Nutruents – Total Phosphorous/Total Nitrogen; 60/40%
  - Fecal Coliform; 50%
  - Heavy Metals; 75%
- Organic sand filters are generally constructed as off-line systems, diverting the water quality volume (WQ_v) into the filtration system, and the remaining volume downstream.

Please reference the design criteria from the surface sand filter for detailed sizing and design requirements.

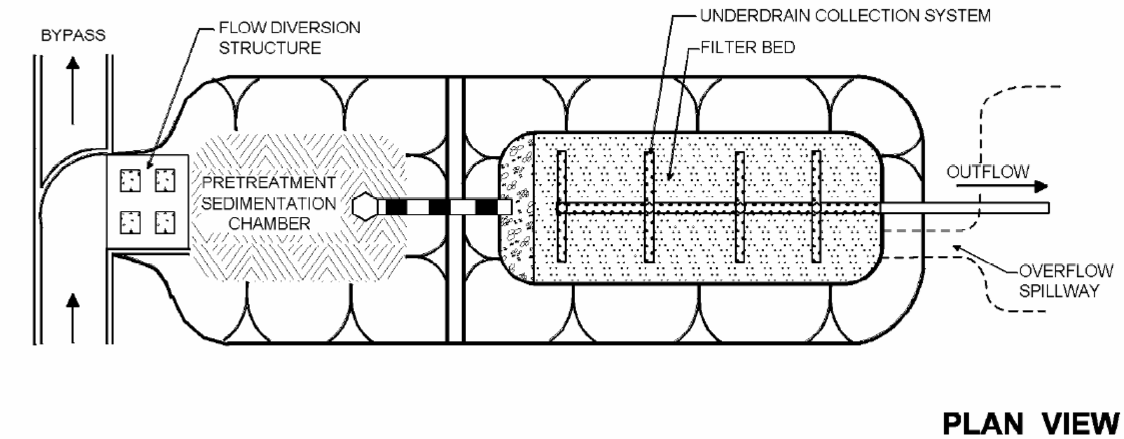


Figure PTP-01-010
Source, Georgia Stormwater Management Manual

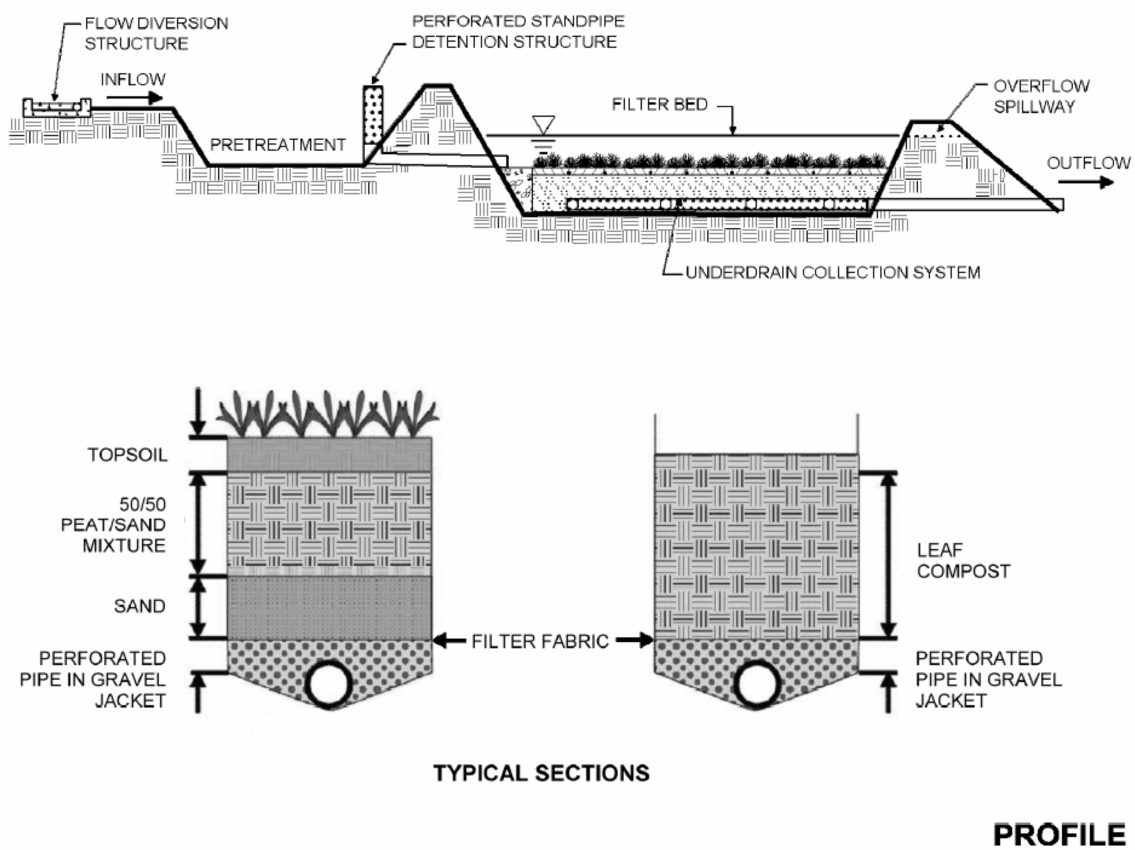


Figure PTP-01-011
Source, Georgia Stormwater Management Manual

Activity: Filtration Systems / Pocket Sand Filter	PTP-01.5

Pocket Sand Filter

Pocket sand filters utilize a more simplified design, allowing them to be used on smaller sites. Runoff is typically diverted into the filtration system via a manhole and pipe where the runoff is pretreated by a concrete flow spreader, a grass filter strip, and a plunge pool. The filter bed is constructed by a shallow excavation where the sand layer is placed. On the surface, a soil layer with grasses is placed above the sand layer. A pea gravel "window" should be constructed, as well as a cleanout/observation well to facilitate maintenance and inspection of clogging.

Design Criteria

- Pocket sand filters are off-line systems, constructed with a diversion structure to separate the water quality volume (WQ_v) and route it to the filter, while directing the remaining flow downstream.
- Drainage area should be designed to serve a maximum of 2 acres
- A gravel layer with an underdrain system should be constructed to facilitate drainage.
- A permeable filter fabric should be placed between the filter bed material and soil layer.

Activity: Filtration Systems / Bioretention Systems	PTP-01.6

Bioretention Systems

Bioretention practices are water quality control devices that capture, temporarily store, treat, and release stormwater runoff. A properly designed area will replicate a small, dense forest floor.

Bioretention is typically used for drainage areas from 1 to 5 acres. Such suitable applications include, but are not limited to:

- off-line facilities adjacent to parking lots
- along road drainage swales
- within larger landscaped pervious areas
- landscaped islands in impervious or high-density environments (i.e. parking lots)
- retrofitting exiting parking lot islands/off-line facilities

Biofiltration systems should **not** be placed in areas with mature trees, sites with slopes greater than 5:1 (H:V), areas that experience continuous or frequent flows, or locations with unstable soil. When considering this control for a karst area, use a collection system to carry flow to another conveyance element.

Design Criteria

- The size of the drainage area typically dictates the size of the bioretention practice. These areas should be limited to a maximum contributing drainage area of five (5) acres. One-half to two acre areas are preferred. Multiple bioretention areas may be required for larger drainage areas.
- Bioretention areas should be at least 10-feet wide and 15 feet long.
- The area should be designed such that it is drained within 48 hours
- The maximum recommended ponding depth is 6-inches.
- See Figure PTP-01-06 for a typical detail

Design Components

- *Grass Buffer Strip* - Reduces velocity of runoff and filters particles in the stormwater.
- *Sand Bed* – Reduces runoff velocities and spreads over perimeter of basin. Filters water as it seeps through sand
- *Ponding Area or Pretreatment Basin* – Runoff is detained to settle particulates suspended in stormwater.
- *Organic Layer* – A layer of mulch or another organic cover filters pollutants out of the stormwater and protects soil from eroding. Layer can also sustain a nutrient rich environment with microbes that can break down petroleum-based contaminants.
- *Planting Soil Layer* – Used to provide nutrients and store water for the areas plantings. Clay material can absorb heavy metals, hydrocarbons and other pollutants.
- *Plant Material* – Consider surrounding environment, climate, maintenance requirements and types of pollutants that the plants must withstand and treat, while maintaining a positive aesthetic enhancement.
- *Underdrain/Collection System* – Necessary to collect and send flows to a stormwater conveyance system.

Bioretention Systems (cont.)

Landscaping & Maintenance

- Consult with a landscaping professional to select vegetation which fits into the landscape, is appropriate for the hardiness zone, and can tolerate conditions found in bioretention areas (short durations of 6 inch ponding water).
- A dense and vigorous vegetative cover should be established over the contributing pervious drainage areas BEFORE runoff can be accepted into the facility.
- The bioretention area should be vegetated to resemble a terrestrial forest ecosystem, with a mature tree canopy, subcanopy of understory trees, scrub layer, and herbaceous ground cover. Three species each of both trees and scrubs are recommended to be planted.
- The tree-to-shrub ratio should be 2:1 to 3:1. On average, the trees should be spaced 8 feet apart. Plants should be placed at regular intervals to replicate a natural forest. Woody vegetation should not be specified at inflow locations.
- After the trees and shrubs are established, the ground cover and mulch should be established.
- Choose plants based on factors such as resistance to drought and inundation, cost aesthetics, maintenance, etc. Planting recommendations for bioretention facilities are as follows:
    - Native plant species should be specified over non-native species.
    - Vegetation should be selected based on a specified zone of hydric tolerance.
- A selection of trees with an understory of shrubs and herbaceous materials should be provided.
- Pruning and weeding to maintain appearance.
- Mulch replacement when erosion is evident.
- Remove trash and debris.

As needed

- Inspect inflow points for clogging (off-line systems). Remove any sediment.
- Inspect filter strip/grass channel for erosion or gullying. Re-seed or sod as necessary.
- Trees and shrubs should be inspected to evaluate their health and remove any dead or severely diseased vegetation.

Semi-annually

- The planting soils should be tested for pH to establish acidic levels. If the pH is below 5.2, limestone should be applied. If the pH is above 7.0 to 8.0, then iron sulfate plus sulfur can be added to reduce the pH.

Annually

- Replace mulch over the entire area.
- Replace pea gravel diaphragm if warranted every 2 to 3 years.

Bioretention Systems (cont.)

Cost Considerations

Bioretention areas can be expensive. However, costs can be offset if the bioretention area meets multiple uses, such as open space requirements or landscaping requirements. The following equation has been used to calculate and approximate cost for this practice.

$C = 7.30\ V^{0.99}$

Where,
C = Construction, design, and permitting cost ($)
V = Volume of water treated by the practice (ft^3)

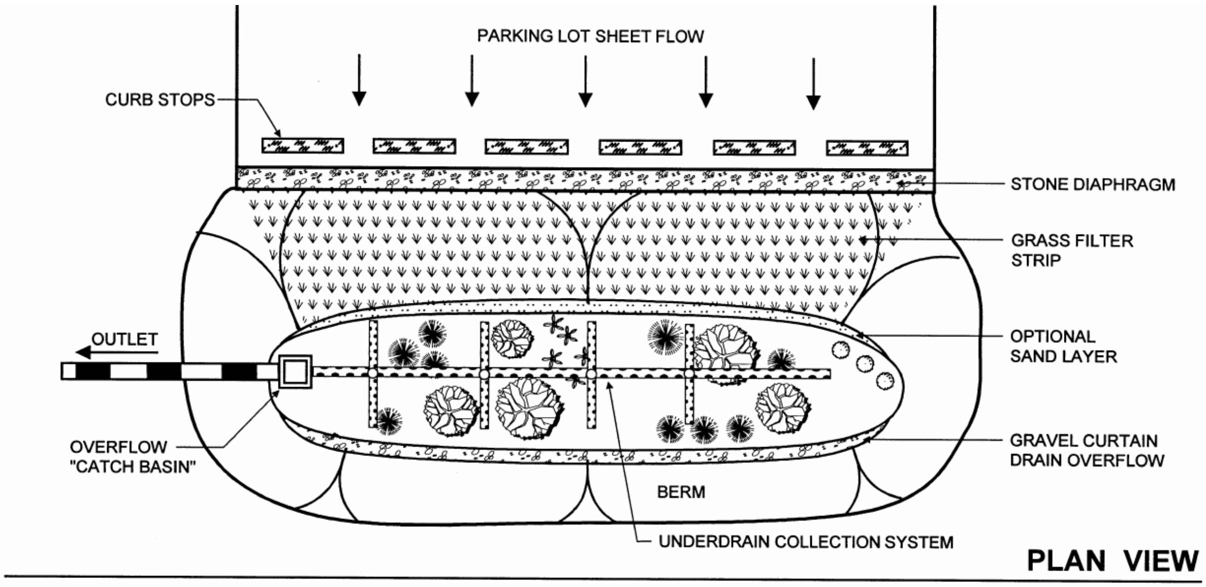


Figure PTP-01-012
Typical Bioretention Area
(Source, Georgia Stormwater Management Manual)

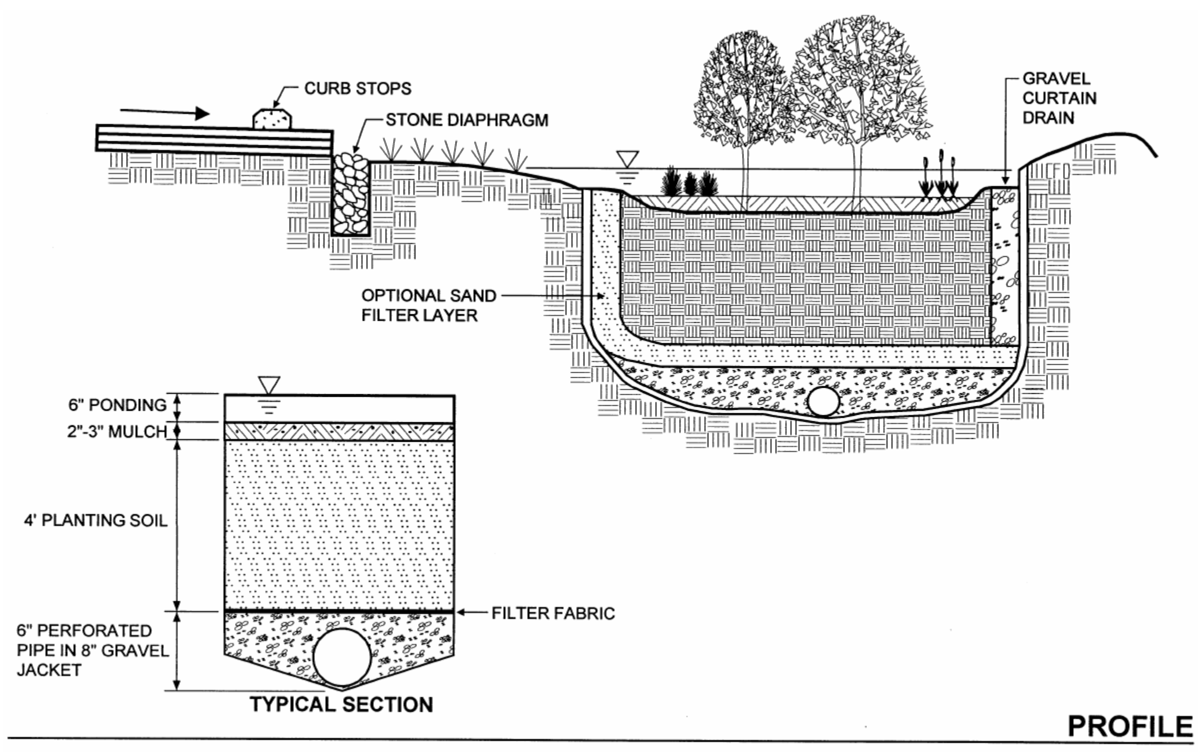


Figure PTP-01-013
Typical Bioretention Area
(Source, Georgia Stormwater Management Manual)

Activity: Filtration Systems	PTP-01

Sand Filter Design Procedures

Step 1. Compute runoff control volumes.

Calculate the Water Quality Volume (WQ_v), Channel Protection Volume (C_{pv}), Overbank Flood Protection Volume (Q_p), and the Extreme Flood Volume (Q_f).

Step 2. Determine if the development site and conditions are appropriate for the use of a surface or perimeter sand filter.

- Soil Type
- % Impervious Area
- Intermittent Flow
- Sufficient Flow Elevation Difference
- Is development commercial, industrial, or institutional

Step 3. Confirm local design criteria and applicability

Consider any special site-specific design conditions/criteria (Additional Site-Specific Design Criteria and Issues). Check with local officials and other agencies to determine if there are any additional restrictions and/or surface water or watershed requirements that may apply.

Step 4. Compute WQ_v peak discharge (Q_{wq})

The peak rate of discharge for water quality design storm is needed for sizing of off-line diversion structures.

- Using WQ_v, compute CN
- Compute time of concentration using TR-55 method
- Determine appropriate unit peak discharge from time of concentration
- Compute Q_{wq} from unit peak discharge, drainage area, and WQ_v.

Step 5. Size flow diversion structure, if needed

A flow regulator (or flow splitter diversion structure) should be supplied to divert the WQ_v to the sand filter facility.

Size low flow orifice, weir, or other device to pass Q_{wq}.

Step 6. Size filtration basin chamber

The filter area is sized using the following equation (based on Darcy's Law):

$$A_f = (WQ_v)\ (d_f)\ /\ [(k)\ (h_f + d_f)\ (t_f)]$$

where:

A_f = surface area of filter bed (ft^2)
d_f = filter bed depth (typically 18 inches, no more than 24 inches)
k = coefficient of permeability of filter media (ft/day) (use 3.5 ft/day for sand)
h_f = average height of water above filter bed (ft) (1/2 h_{max}, which varies based on site but h_{max} is typically 6 feet)
t_f = design filter bed drain time (days) (1.67 days or 40 hours is recommended maximum)

Sand Filter Design Procedures (cont.)

Set preliminary dimensions of filtration basin chamber. See Design Criteria for filter media specifications.

Step 7. Size sedimentation chamber

Surface sand filter: The sedimentation chamber should be sized to at least 25% of the computed WQ_v and have a length-to-width ratio of 2:1. The Camp-Hazen equation is used to compute the required surface area:

$$A_s = -(Q_o/w) * \ln(1\text{-}E)$$

Where:

A_s = sedimentation basin surface area (ft2)
Q_o = rate of outflow = the WQ_v over a 24-hour period
w = particle settling velocity (ft/sec)
E = trap efficiency

Assuming:

- 90% sediment trap efficiency (0.9)
- particle settling velocity (ft/sec) = 0.0033 ft/sec for imperviousness < 75%
- particle settling velocity (ft/sec) = 0.0004 ft/sec for imperviousness 75%
- average of 24 hour holding period

Then:

As = (0.066) (WQ_v) ft2 for I < 75%
As = (0.0081) (WQ_v) ft2 for I 75%

Set preliminary dimensions of sedimentation chamber.

Perimeter sand filter: The sedimentation chamber should be sized to at least 50% of the computed WQ_v. Use same approach as for surface sand filter.

Step 8. Compute V min

$V_{min} = 0.75 * WQ_v$

Step 9. Compute storage volumes within entire facility and sedimentation chamber orifice size

Surface sand filter:

$$V_{min} = 0.75\ WQ_v = V_s + V_f + V_{f\text{-}temp}$$

- Compute V_f = water volume within filter bed/gravel/pipe = $A_f * d_f * n$, where: n = porosity = 0.4 for most applications
- Compute $V_{f\text{-}temp}$ = temporary storage volume above the filter bed = $2 * h_f * A_f$
- Compute V_s = volume within sediment chamber = $V_{min} - V_f - V_{f\text{-}temp}$
- Compute h_s = height in sedimentation chamber = V_s/A_s
- Ensure h_s and h_f fit available head and other dimensions still fit – change as necessary
- in design iterations until all site dimensions fit.
- Size orifice from sediment chamber to filter chamber to release V_s within 24-hours average release rate with 0.5 h_s as average head.

Sand Filter Design Procedures (cont.)

- Design outlet structure with perforations allowing for a safety factor of 10.
- Size distribution chamber to spread flow over filtration media – level spreader weir or orifices.

Perimeter sand filter:

- Compute V_f = water volume within filter bed/gravel/pipe = A_f * d_f * n
- Where: n = porosity = 0.4 for most applications
- Compute V_w = wet pool storage volume As * 2 feet minimum
- Compute V_{temp} = temporary storage volume = V_{min} – (V_f + V_w)
- Compute h_{temp} = temporary storage height = V_{temp} / (A_f + A_s)
- Ensure h_{temp}. 2 * h_f, otherwise decrease h_f and re-compute. Ensure dimensions fit available head and area – change as necessary in design iterations until all site dimensions fit.
- Size distribution slots from sediment chamber to filter chamber.

Step 10. Design inlets, pretreatment facilities, underdrain system, and outlet structures according to Design Criteria.

Step 11. Compute overflow weir sizes

Surface sand filter:

- Size overflow weir at elevation h_s in sedimentation chamber (above perforated stand pipe) to handle surcharge of flow through filter system from 25-year storm.
- Plan inlet protection for overflow from sedimentation chamber and size overflow weir at elevation h_f in filtration chamber (above perforated stand pipe) to handle surcharge of flow through filter system from 25-year storm.

Perimeter sand filter: Size overflow weir at end of sedimentation chamber to handle excess inflow, set at WQ_v elevation.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Stormwater Pollution Treatment Practices (Structural)

PTP-02

Activity: Open Channel Systems

PLANNING CONSIDERATIONS:

Design Life:
Life

Acreage Needed:
High

Estimated Unit Cost:
Moderate

Annual Maintenance:
Low

Target Pollutants; Pollutant Removal

Total Suspended Solids (TSS); 75% (Wet Swale), 90% (Dry Well)
Nutrients – Total Phosphorous/Total Nitrogen removal; 50/50%
Metals – Cadmium, Copper, Lead, and Zinc removal; 50%
Pathogens – Coliform, Streptococci, E.Coli removal; 40%

Description

Open channel systems are vegetated swales that are designed to capture, treat, and release stormwater runoff. Open channel systems consist of treatment via dry or wet cells created through the installation of check dams or berms. Wet swales and dry swales are two types of open channel systems. Dry swales typically utilize a permeable soil layer, and wet swales typically have wetland plants. Open channel systems treat stormwater while also acting as a stormwater runoff conveyance system. They incorporate water quality features that typical drainage channels do not offer. Installation costs are less expensive than a curb and gutter system, although maintenance costs are typically higher.

Open channel systems must be designed with limited longitudinal slopes to reduce runoff velocities and allow particulates to settle. Berms or check dams placed perpendicular to the flow path also aid in reducing velocities and promoting infiltration.

Inlets to open channel systems can be enhanced through the use of the following options:
- Riprap or other energy dissipaters
- Pretreatment through a sediment forebay
- Flow spreader for situations of direct and concentrated flow

Outlet structures for open channel systems should discharge into the storm drainage system or a stable outfall. For wet swales, outlet protection should be used to prevent scour and downstream erosion.

Activity: Open Channel Systems	PTP-02

Suitable Applications	Open channel systems are designed to manage stormwater runoff in water quality situations, with the limited ability to provide benefits of channel protection. Open channel systems are typically suitable in the following applications: ➢ Residential subdivisions of low to moderate density (dry swales) ➢ Small impervious area in the contributing drainage area ➢ Along roads and highways (off right-of-way) ➢ Adjacent to parking lots ➢ Small drainage areas (less than 5 acres) ➢ Landscaped commercial areas (wet swales)
Installation Procedures	➢ Longitudinal slopes should be less than 4%, with a 1-2% slope recommended. ➢ Bottom width should be approximately 2 to 8 feet. ➢ Side slopes should be 3:1 (H:V) or less, where 4:1 (H:V) is recommended. ➢ Design should convey the 25-year storm event with a minimum of 6 inches of freeboard. ➢ Geotextile fabric should be placed around underdrain.
Maintenance	Adequate access should be provided to allow for inspection and maintenance. ➢ Grass heights should be maintained at heights of approximately 4 to 6 inches for dry swales ➢ Sediment should be removed from forebay and channel regularly and disposed of properly
Dry Swale	Dry swales are open channel systems that convey stormwater runoff through vegetation and a filter bed. Sizing for dry swales should allow the entire water quality volume to be filtered or infiltrated through the swale, such that there is no standing water between rain events. Dry swales are the preferred option in residential areas. Dry swales are made up of an open conveyance channel with a filter bed of prepared soil that overlays an underdrain system. Flow is conveyed into the main channel of the swale where it is filtered by the soil bed. Runoff is then collected and passes into a perforated pipe and gravel underdrain system to the outlet. Design Criteria ➢ Size to store a water quality volume with less than 18 inches of ponding ➢ Maximum ponding time is 48 hours, design for 24 hours ➢ Bed material should be permeable soil at least 30 inches deep, with an infiltration rate of at least 1 foot per day (1.5 feet per day maximum) ➢ Soil should have a high organic content to allow pollutant removal ➢ Underdrain should consist of a 4 inch diameter PVC pipe, installed longitudinally in a 6 inch gravel layer ➢ Permeable filter fabric installed encompassing the stone underdrain ➢ Channel excavation should not result in soil compaction See Figures PTP-02-01 and PTP-02-02 for example drawings of a dry swale.

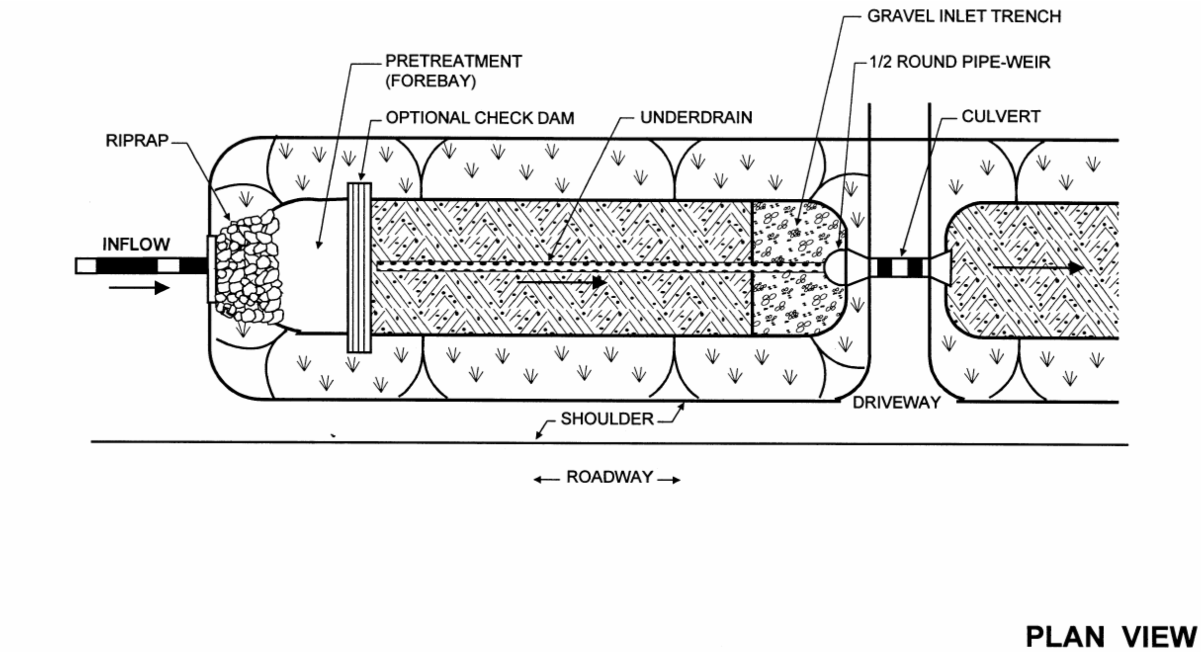


Figure PTP-02-02
Source, Georgia Stormwater Management Manual

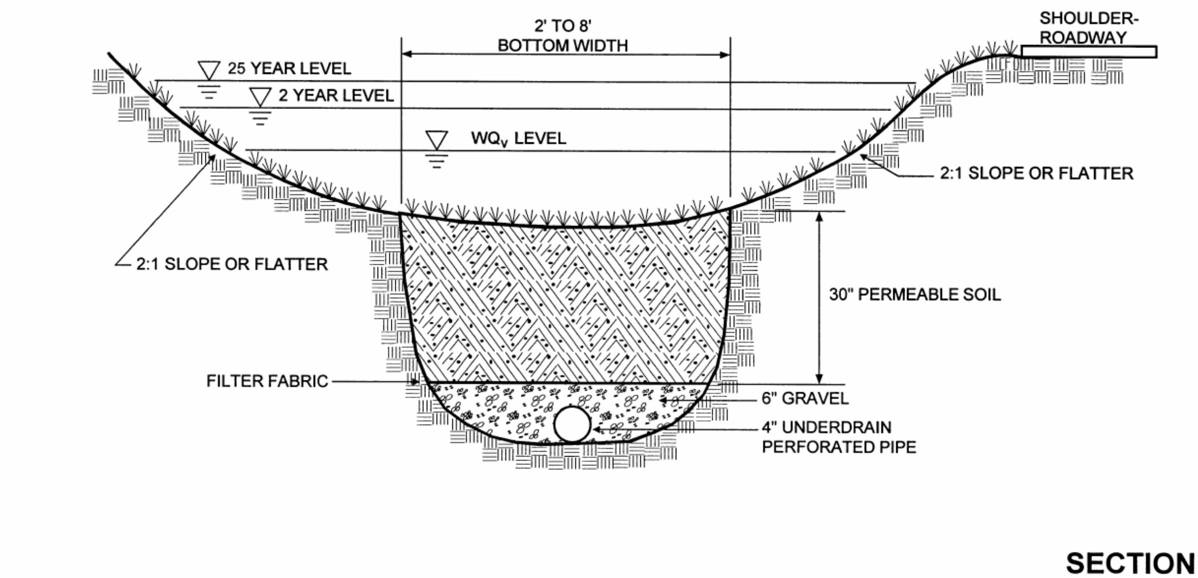


Figure PTP-02-02
Source, Georgia Stormwater Management Manual

Wet Swale

Wet swales are also referred to as wetland channels. Like the dry swale, wet swales are vegetated channels that treat stormwater runoff. They differ in that wet swales are designed to retain water, imitating marshy conditions and supporting wetland vegetation. A high water table or soils that retain water are necessary to retain water in the system. In these regards, a wet swale is much like a wetland, with a shallow and linear design.

Wet swales are constructed by excavating the channel to the water table or to poorly drained soils. Check dams are installed to create wetland "cells". These cells contain the runoff similar to a shallow wetland.

Design Criteria

- Size to store the entire water quality volume with less than 18 inches of ponding at the maximum depth point.
- Check dams and wetland plantings should be installed to form wetland cells. Flow direction can be achieved through the use of V-notch weirs in the check dams.

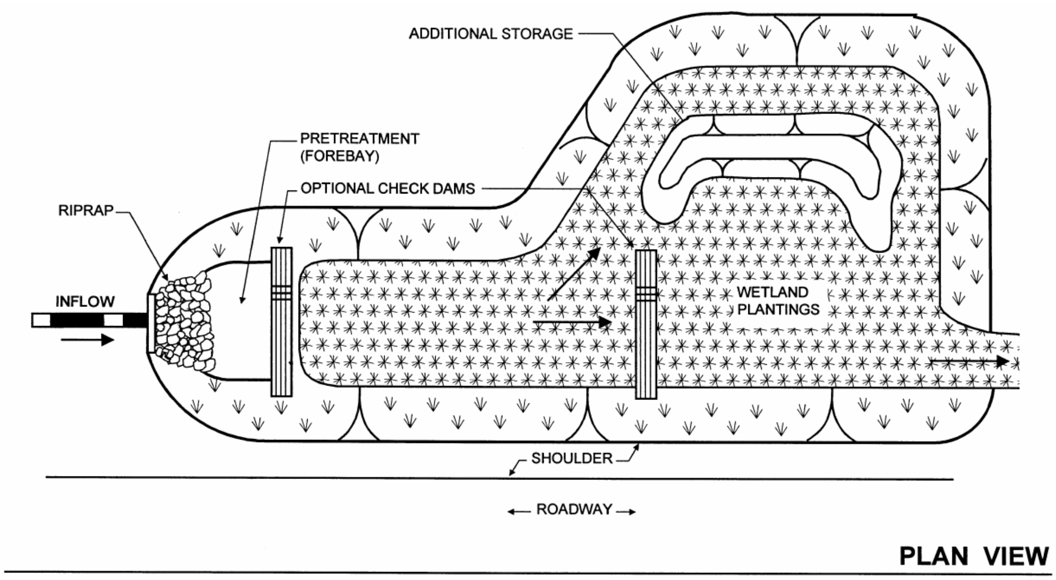


Figure PTP-02-03
Source, Georgia Stormwater Management Manual

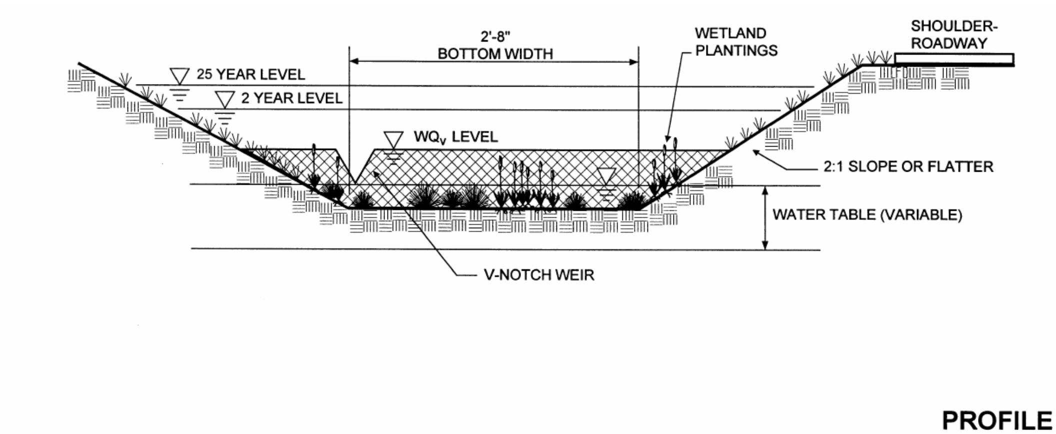


Figure PTP-02-04
Source, Georgia Stormwater Management Manual

Swale Design Procedures

Step 1. Compute runoff control volumes.

Calculate the Water Quality Volume (WQ_v), Channel Protection Volume (Cp_v), Overbank, Flood Protection Volume (Q_p), and the Extreme Flood Volume (Q_f).

Step 2. Determine if the development site and conditions are appropriate for the use of an enhanced swale system (dry or wet swale).

- Topography?
- % Impervious Area?
- Low to moderate density area?
- Type of development?

Step 3. Confirm local design criteria and applicability.

Consider any special site-specific design conditions/criteria (Additional Site-Specific Design Criteria and Issues). Check with local officials and other agencies to determine if there are any additional restrictions and/or surface water or watershed requirements that may apply.

Step 4. Determine pretreatment volume.

The forebay should be sized to contain 0.1 inches per impervious acre of contributing drainage. The forebay storage volume counts toward the total WQ_v requirement, and should be subtracted from the WQ_v for subsequent calculations.

Step 5. Determine swale dimensions

Size bottom width, depth, length, and slope necessary to store WQv with less than 18 inches of ponding at the downstream end.

- Slope cannot exceed 4% (1 to 2% recommended)
- Bottom width should range from 2 to 8 feet
- Ensure that side slopes are no greater than 2:1 (4:1 recommended)

See Design Criteria for more details.

Step 6. Compute number of check dams (or similar structures) required to detain WQ v

Step 7. Calculate draw-down time

Dry swale: Planting soil should pass a maximum rate of 1.5 feet in 24 hours and must completely filter WQ_v within 48 hours.

Wet swale: Must hold the WQ_v.

Activity: Open Channel Systems

PTP-02

Swale Design Procedures (cont.)	**Step 8.** Check 2-year and 25-year velocity erosion potential and freeboard Check for erosive velocities and modify design as appropriate. Provide 6 inches of freeboard. **Step 9.** Design low flow orifice at downstream headwalls and checkdams. Design orifice to pass WQv in 6 hours. Use Orifice equation. **Step 10.** Design inlets, sediment forebay(s), and underdrain system (dry swale). See Design Criteria for more details. **Step 11.** Prepare Vegetation and Landscaping Plan A landscaping plan for a dry or wet swale should be prepared to indicate how the enhanced swale system will be stabilized and established with vegetation. The appropriate grass species and wetland plants should be chosen based on the site location, soil type, and hydric conditions.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Stormwater Pollution Treatment Practices (Structural)

PTP-03

Activity: Stormwater Ponds

W

SP

PLANNING CONSIDERATIONS:

Design Life:
Life

Acreage Needed:
Moderate to High

Estimated Unit Cost:
Low

Annual Maintenance:
Low

Target Pollutants

Total Suspended Solids (TSS); 80%
Nutrients – Total Phosphorous/Total Nitrogen removal; 50/30%
Metals – Cadmium, Copper, Lead, and Zinc removal; 50%
Pathogens – Coliform, Streptococci, E.Coli removal; 70%

Description

Stormwater ponds are detention ponds containing a permanent pool (or micropool) that allows the treatment of stormwater runoff, while also contributing to the aesthetic value of the area. Stormwater ponds addressed in this fact sheet include micropool extended detention ponds, wet ponds, wet extended detention ponds, multiple pond systems, and pocket ponds.

Stormwater ponds enhance water quality through settling and biological uptake, and offer a control for sediment, heavy metals, and floatables. They also may provide benefits in reducing impacts due to nutrients, oxygen demanding substances, oil and grease, and bacteria and viruses.

Stormwater ponds consist of the following components: a sediment forebay, permanent pool, runoff control volume storage, and a shallow littoral zone, or aquatic bench, along the edge of the permanent pool. Other design considerations include an emergency spillway, maintenance access and landscaping.

Suitable Applications

- Areas where high particulate control is needed
- Suitable for large, regional tributaries; minimum contributing drainage area is 25 acres, or 10 acres for a micropool extended detention pond
- Provides multiple benefits for passive recreation such as bird watching, and wildlife habitat
- To control both stormwater quantity and quality issues

Typically, stormwater ponds are not feasible for dense or urban land uses due to large land requirements and areas with steep or unstable slopes.

Activity: Stormwater Ponds	PTP-03

Maintenance

Frequently (3-4 times a year)

- Clean and remove debris from inlet and outlet structures.
- Remove floatables and sediment build-up.
- Mow side slopes (more often if needed).

As Needed

- Repair undercut or eroded areas
- Pond vegetation need to be trimmed or harvested as appropriate, grassy areas frequently mowed and repairs made to signage, walkways, picnic tables, or any other public recreation equipment.

Annual

- Remove invasive vegetation.
- Inspect for damage to the embankment and inlet/outlet structures.
- Monitor and record sediment accumulation.

Sediment Removal

- The sediment accumulation rate is dependant on a number of factors including watershed size, facility sizing, construction upstream, industrial or commercial activities upstream, etc. Sediment contents should removed and disposed of properly.
- Most sediment collected is innocuous (free of pollutants other than "clean" soil) and can be used as fill material, cover or land spreading. It is important that this material not be placed in a way that will promote or allow resuspension in storm runoff. The sediment should not be placed within the high water level area of the stormwater pond or another BMP, creek, waterway, buffer, runoff conveyance device, or other infrastructure. Some demolition or sanitary landfill operators will allow the sediment to be disposed at their facility for use as cover.
- Sediment should be removed when 10 to 15% of the storage capacity has been lost.

Inspection Checklist

- ☐ Concern for mosquito population growth and maintaining oxygen in ponds
- ☐ In cases where a stormwater pond is used for large detention facilities, the structural integrity of the impounding embankment should also be evaluated. The embankment should be protected against catastrophic dam failure and comply with any required dam permit.
- ☐ Maintenance of vegetation
- ☐ Inlet pipe condition
- ☐ Evidence of scouring
- ☐ Removal of trash and sediments

Wet Pond

Wet ponds maintain a permanent pool to treat incoming stormwater. Treatment occurs through settlement of suspended particles and uptake of dissolved contaminants by aquatic plants between storm events. Wet ponds are constructed with two storage area. A permanent pool, or "dead" storage area is based on the water quality volume calculation. During storm events, runoff displaces the water existing in the permanent pool. A temporary, or "live" storage area can be provided above the permanent pool to accommodate larger flows and control erosion.

Design Criteria

The following sizing design considerations should be made for wet ponds:

- The permanent pool should have a hydraulic residence time of at least 2 to 4 weeks
- The maximum depth of the permanent pool is generally less than 12 feet, although greater depths are possible with artificial mixing or aerators at maximum depth. The objective is to avoid thermal stratification that could result in odor problems associated with anaerobic conditions. Gentle artificial mixing may be needed in small ponds because they are effectively sheltered from the wind.
- The outlet of the facility should be restricted so as to detain a treatment design storm in a "live" pool on top of the permanent pool for 24 to 60 hours. The effect of restricting the outflow is to reduce the overflow rate during the storm reducing downstream erosion, flood control and slightly increasing the capture of settleable solids.
- Water quality detention ponds should be sized to collect the first flush of stormwater runoff. For this area, the first flush is generally the first 0.5 to 1.1 inches of runoff over the tributary area.
- About 10 to 25% of the surface area determined in the above procedure should be devoted to the forebay. The forebay can be distinguished from the remainder of the pond by one of several means: a lateral sill with rooted wetland vegetation, two ponds in series, differential pool depth, rock-filled gabions or retaining wall, or a horizontal rock filter placed laterally across the pond. A baffle box or water quality inlet(s) can be used in lieu of a forebay.

Sizing the "Live" Pool

The following two methods should be used to calculate the "live" pool volume. The most conservative (largest volume) should be selected.

- The recommended performance goal is at least 85 to 95% capture of the annual average runoff volume. The live pool may be calculated using long-term hourly hydrologic data and runoff capture simulation curves that consider a runoff coefficient for land use to determine a unit basin storage volume (v).

$$V_L = (A_T * v)/12$$

where: V_L = pond volume (acre-feet);
A_T = Total Tributary Area (acres); and
v = unit basin storage volume – taken from Figure STP-02-03 (0.5 to 1.1 inches)

Wet Pond (cont.)

- Alternatively, the live pool portion of the wet pond can also be designed to capture the "maximized storm runoff capture volume," and drain over a 24-60 hour period. The maximized storm runoff capture volume can be calculated by:

$$V_L = (a \cdot C) \cdot P_6$$

where:

V_L = maximized capture volume determined using either the event capture ratio or the volume capture ratio as its basis, watershed in.;

a = regression constant from least-square analysis;

Event capture ratio: 1.299 for 24-hour drain time,

Volume capture ratio: 1.582 for 24-hour drain time (for approximately 85th percentile runoff event – 82-88%).

C = runoff coefficient

P_6 = mean storm precipitation volume, watershed in.

- Using this technique, the desired removal efficiency and land use characteristics can be applied to local hydrologic data to determine the optimal live pool volume. Note that A_T and the runoff coefficient selected can be modified to consider Directly Connected Impervious Area (DCIA) if the data is available.
- This live pool volume will add to the overall volume and will benefit the downstream waterways by reducing erosive velocities, providing flood control and an incremental increase in treatment.

Sizing the Permanent Pool

- Two methods are available for the sizing of the permanent pool portion of the wet detention ponds, with one proposed on the removal of phosphorus (Florida, 1988; Maryland, 1986). It provides a detention time of 14 days based on the wettest month to allow sufficient time for the uptake of dissolved phosphorus by algae and the settling of fine solids where the particulate phosphorus tends to be concentrated. The following two methods should be used to calculate the permanent pool volume. The most conservative (largest volume) should be selected.
- Size the permanent pool portion of the wet pond using the wettest 14-day period using the following formula:

$$V_p = (CA_TR)/12$$

Where: V_p = permanent pool volume (acre-ft)

C = contributing area weighted average runoff coefficient

A_T = Total Tributary Area (acres)

R = 14 day wet season rainfall (inches)

The second method predicts the removal of particulate contaminants only (USEPA, 1986). It relates the removal efficiency of suspended solids to pond volume. Using this method, the volume of the permanent pool may be calculated as follows:

$$V_P = V_{B/R}S_dA_i43560/12 = 10890S_dA_i$$

Wet Pond (cont.)

where: V_P = permanent pool volume (ft^3)
$V_{B/R}$ = Ratio of Basin to Runoff Volume (Figure PTP-03-06)
(a value of at least 4.0 should be used)
S_d = mean storm depth (inches)
A_i = impervious acres in the tributary watershed

- For A_i the engineer may use directly connected impervious acres because it more correctly represents the area being treated and would allow a smaller facility. Although impervious area and directly connected impervious area are not the same, they are reasonable given the uncertainty of the methodology and expected pond performance.
- Wetland vegetation, occupying 25-50% of water surface area.
- Side slopes should be 6:1 (H:V) or flatter to provide a littoral shelf and safety bench from the side of the facility out to a point 2 to 3 feet below the permanent pool elevation. Side slopes above the littoral zone should be no steeper than 4:1 (H:V). Side slopes below the littoral zone can be 2:1 (H:V) to maximize permanent pool volumes where needed. A short (1.0 ft) drop-off can be constructed at the edge of the pond to control the potential breeding of mosquitoes.
- Pretreatment – Facilities that receive stormwater from contributing areas with greater than 50 percent impervious surface or that are a potential source of oil and grease contamination must include a baffle, skimmer, and grease trap to prevent these substances from being discharged from the facility.
- The permanent pool may be excavated into bedrock for a wet or dry detention pond, but the cost may be prohibitive. Furthermore, if there is highly fractured bedrock or karst topography, then the modification of a detention pond should be carefully considered because it may not hold water and the additional water flow and/or weight could intensify karst activity.
- The interaction with other utilities must be considered as it may not be practical to develop a permanent pool in an area that is needed by another utility. Furthermore, the cost of designing around utilities or utility relocation must be considered.
- A 5:1 (H:V) access must be considered to account for maintenance crews and public interaction. Maintenance crews must have access to the site for proper maintenance. Ponds that are not designed with access for maintenance crews often become more of a nuisance than a beneficial part of a stormwater management program. It may also be desirable to encourage or discourage access for the public. Public education and recreation may be facilitated by access to the pond, provided public safety is sufficiently addresses.
- Design to minimize short-circuiting by including energy dissipaters on inlets, shape the pond with at least a 3:1 length to width ratio, and locate the inlets as far away from the outlet as possible. It should be noted that a length to width ratio of up to 7:1 is preferred. The inlet and outlet can be placed at the same end if baffling is installed to direct the water to the opposite end before returning to the outlet. If topography or aesthetics requires the pond to have an irregular shape, the pond area and volume should be increased to compensate for the dead spaces.

Wet Pond (cont.)

- Except for very small facilities, include a forebay, baffle box, or other pretreatment BMPs to facilitate maintenance. However, note that a forebay will require less frequent maintenance.
- To maintain the wet pool to the maximum extent possible, excessive losses by infiltration through the bottom must be avoided. Depending on the soils, this can be accomplished by compaction, incorporating clay into the soil, or an artificial liner.
- Place an antiseep collar around the outlet pipe with an earthen embankment.
- The outlet should incorporate an antivortex device if the facility is large (a 100-year storm must safely pass through or around the device).
- The slope of an earthen embankment should be vegetated to avoid erosion. Drought tolerant groundcover species should be used if irrigation can not occur during the summer.
- Ponds that serve smaller local site runoff do not offer as much recreational benefit as ponds serving larger regional runoff. Regional facilities can often be landscaped to offer recreational and aesthetic benefits. Jogging and walking trails, picnic areas, ball fields, and canoeing or boating are some of the typical uses. For example, portions of the facility used for flood control can be kept dry, except during floods, and can be used for exercise areas, soccer fields, or football fields. Wildlife benefits can also be provided in the form of islands or preservation zones, which allow a view of nature within the park schemes.
- The public's safety must be a foremost consideration. For the design of wet detention ponds, this usually takes place in the grading, fencing, landscaping, pipe cover, grating and signage. The most important design feature affecting public safety during a pond's operation is grading. The contours of the pond should be designed to eliminate "drop-offs". When possible, terraces or benches are used to transition into the permanent pool. Within the permanent pool, it is desirable to have a wet terrace 12 to 18 inches below the normal pool level. In some cases there is not sufficient room for grading of this type and the pond may require a perimeter fence.

Outlet Design

- Proper hydraulic design of the outlet is critical to achieving good performance of the stormwater pond. The two most common outlet problems that occur are: 1) the capacity of the outlet is too great resulting in partial filling of the basin shorter drawdown time and reduced pollutant removal and 2) the outlet clogs because it is not adequately protected against trash and debris. To avoid these problems, two alternative outlet types are recommended for use: 1) V-notch weir, and 2) perforated riser. The V-notch weir will not clog as easily.

Wet Pond (cont.)

Flow Control Using a "V" Notch Weir

- The outlet control "V" notch weir should be sized using the following formula (Merritt et.al., 1996).

$$Q = C_1 H^{5/2} \tan\left(\frac{\theta}{2}\right)$$

Where

θ = notch angle

H = head or elevation of water over the weir, ft

C_1 = discharge coefficient (see Figure PTP-03-06)

The notch angle should be 20° or more. If calculations show that a notch angle of less than 20° is appropriate, then the outlet should be designed as a uniform width notch. This will generally necessitate some sort of floatables control such as a skimmer on the outlet or trash rack on the inlet.

Flow Control Using a Single Orifice

- The outlet control orifice should be sized using the following equation (GKY, 1989).

$$a = \frac{2A(H-H_o)^{0.5}}{3600CT(2g)^{0.5}} = \frac{(7x10^{-5})A(H-H_o)^{0.5}}{CT} \qquad (1)$$

where: a = area of orifice (ft2)
A = average surface area of the pond (ft2)
c = orifice coefficient
T = drawdown time of full pond (hrs.)
g = gravity (32.2 ft/sec2)
H = elevation when the pond is full (ft)
Ho = final elevation when pond is empty (ft)

With a drawdown time of 40 hours the equation becomes:

$$a = \frac{(1.75x10^{-5})A(H-H_o)^{0.5}}{CT} \qquad (2)$$

Table PTP-03-01
Perforated Outlet Riser Pipe Orifices
(Source: Austin, 1988)

Riser Pipe	Vertical Spacing Between Rows (center to center)	Number of Perforations	Perforation Diameter
6 in.	2.5 in.	9 per row	1 in.
8 in.	2.5 in.	12	1 in.
10 in.	2.5 in.	16	1 in.

Wet Pond (cont.)

Flow Control Using the Perforated Riser

- For outlet control using the perforated riser as the outflow control, it is recommended that the procedure illustrated in PTP-03-03 and PTP-03-04. This design incorporates flow control for the small storms in the perforated riser but also provides an overflow outlet for large storms. If properly designed, the facility can be used for both water quality and drainage control by: 1) sizing the perforated riser as indicated for water quality control; 2) sizing the outlet pipe to control peak outflow rate from the 2-year storm; and 3) using a spillway in the pond berm to control the discharge from larger storms up to the 100-year storm.

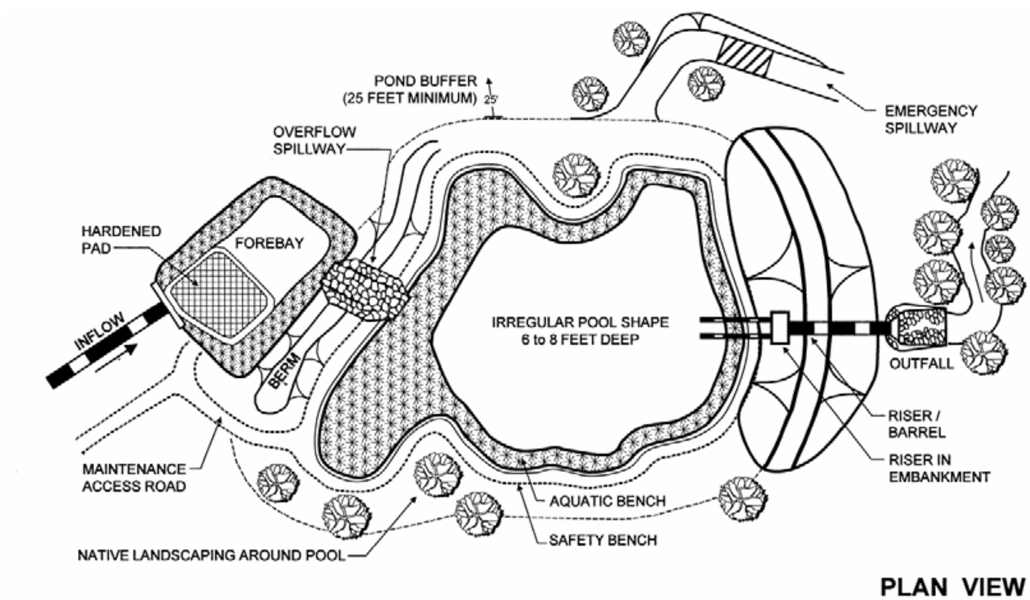


Figure PTP-03-01
Source, Georgia Stormwater Management Manual

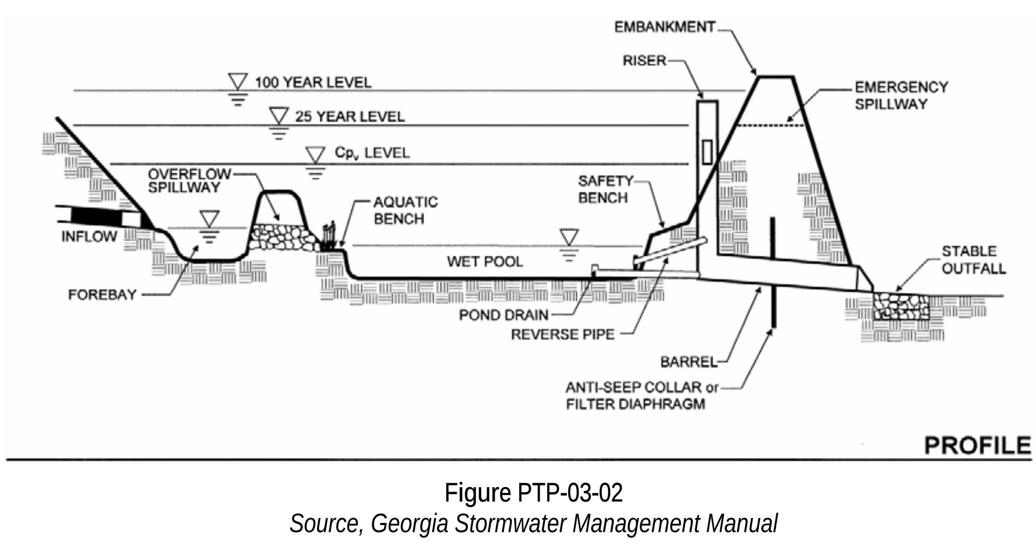
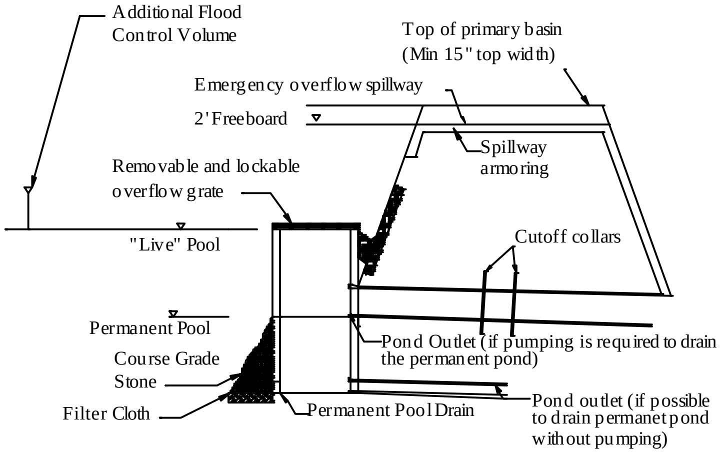
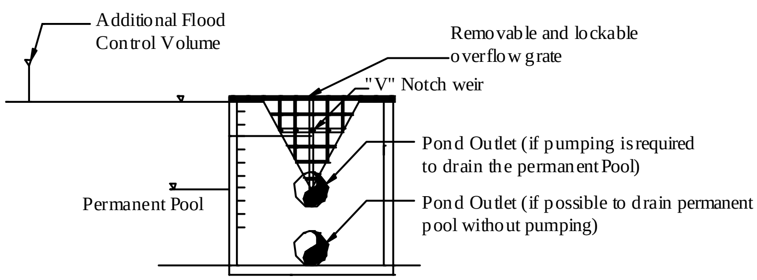


Figure PTP-03-02
Source, Georgia Stormwater Management Manual



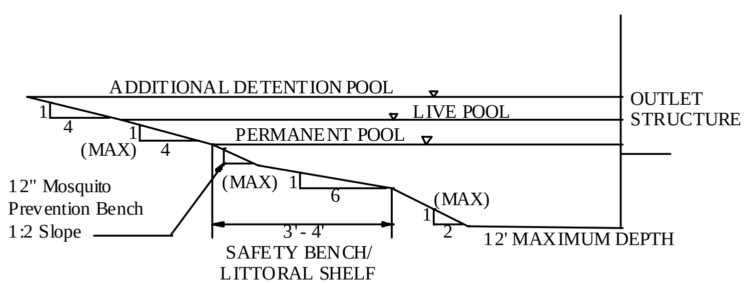
SECTION OUTLET STRUCTURE

NTS



PROFILE OUTLET STRUCTURE

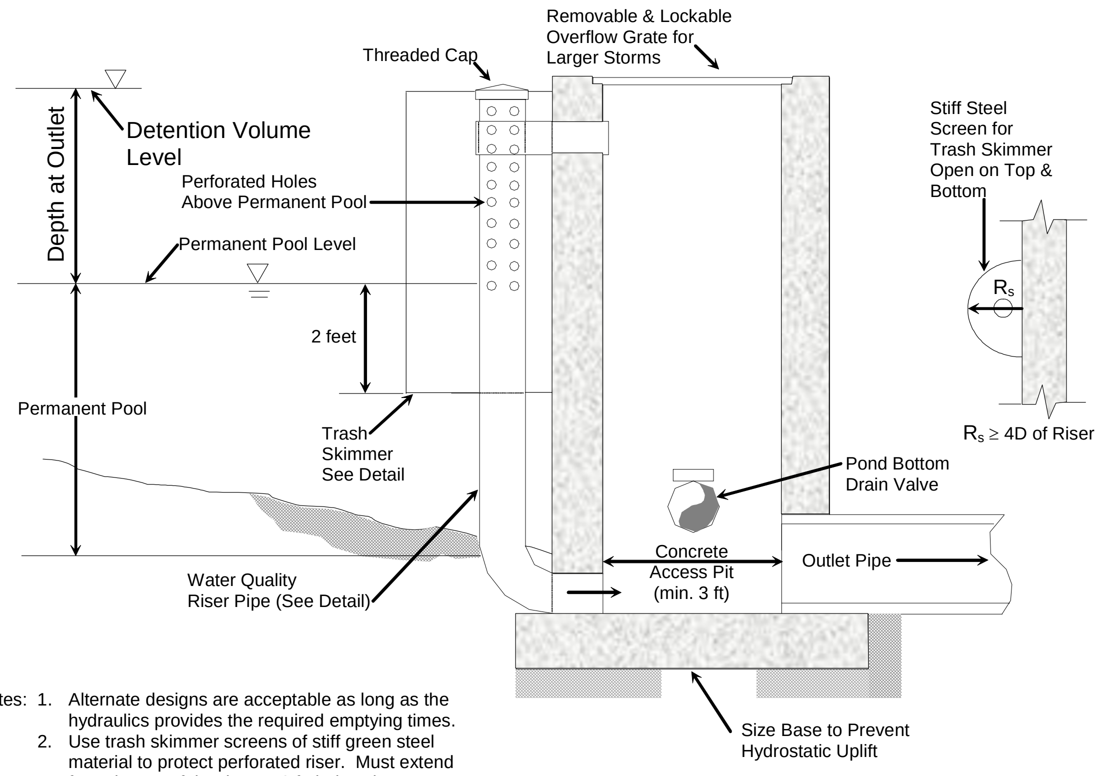
NTS



POND GRADING

NTS

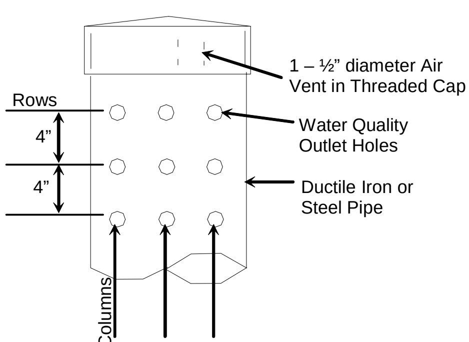
Figure PTP-03-03
"V" Notch Weir Outlet Structure



Notes: 1. Alternate designs are acceptable as long as the hydraulics provides the required emptying times.
2. Use trash skimmer screens of stiff green steel material to protect perforated riser. Must extend from the top of the riser to 2 ft. below the permanent pool level.

OUTLET WORKS
NOT TO SCALE

Notes: 1. Minimum number of holes = 8
2. Minimum hole diameter = 1/8" Dia.



WATER
QUALITY
RISER PIPE

Maximum Number of Perforated Columns				
Riser Diameter (in.)	Hole Diameter, inches			
	¼"	½"	¾"	1"
4	8	8	-	-
6	12	12	9	-
8	16	16	12	8
10	20	20	14	10
12	24	24	18	12

Hole Diameter (in.)	Area (in.^{2})
1/8	0.013
1/4	0.049
3/8	0.110
1/2	0.196
5/8	0.307
3/4	0.442
7/8	0.601
1	0.785

Figure PTP-03-04
Perforated Riser Pipe Outlet Structure

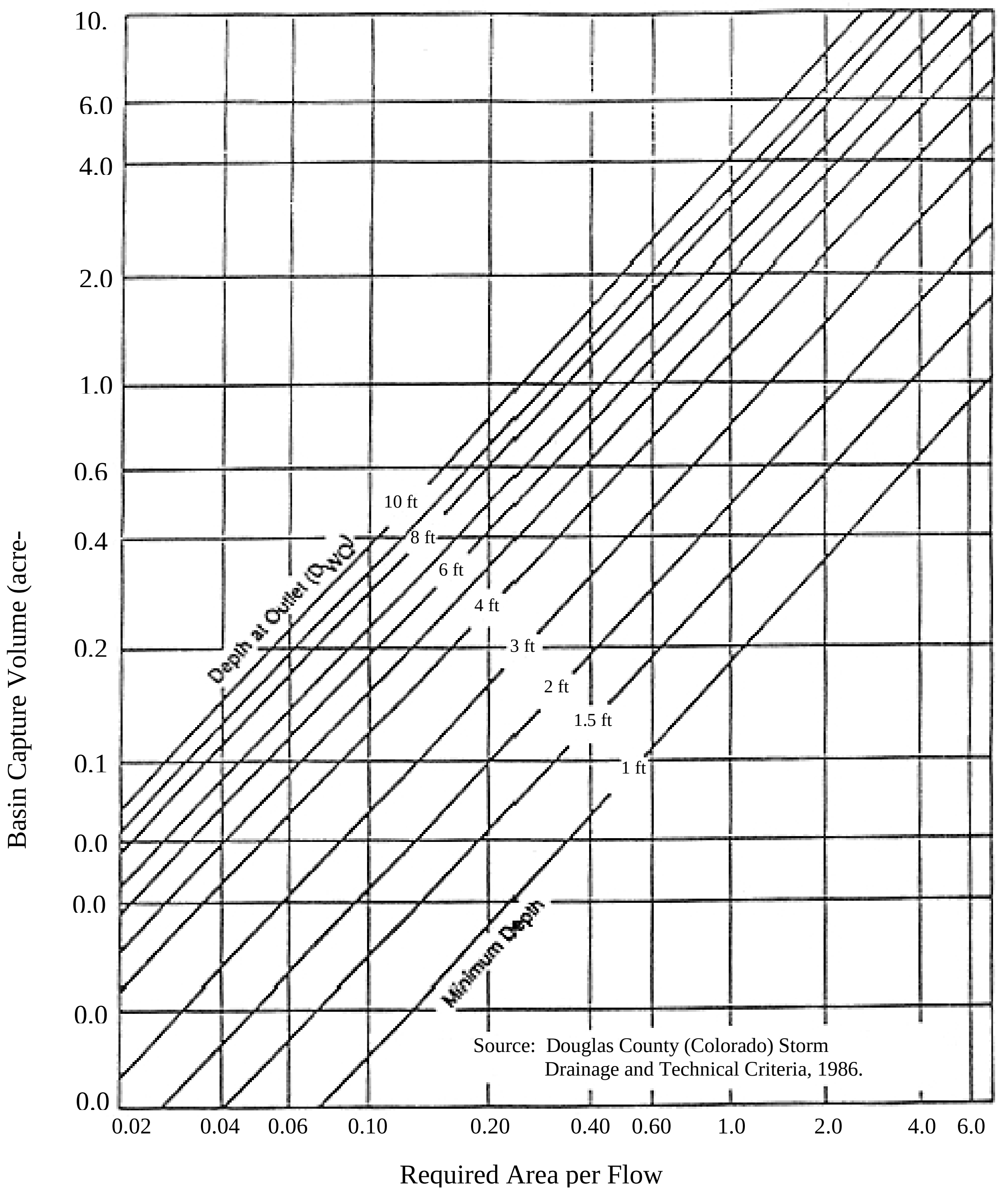
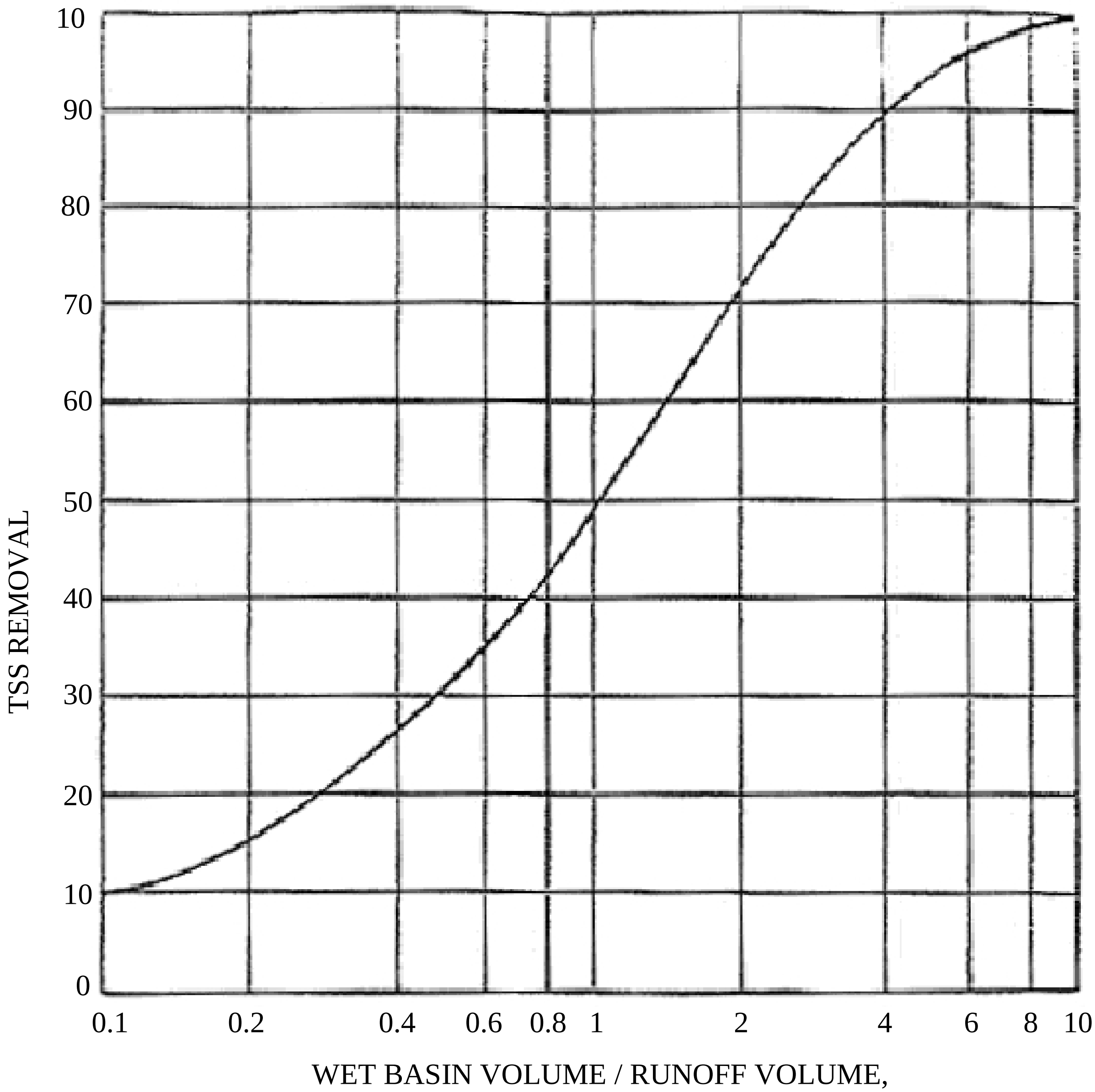


Figure PTP-03-05
Water Quality Outlet Sizing, Extended Detention Basin
(40-hour drain time of capture volume)



Source: FHWA

Figure PTP-03-06
TSS Removal Efficiency vs. V_B/V_R Ratio

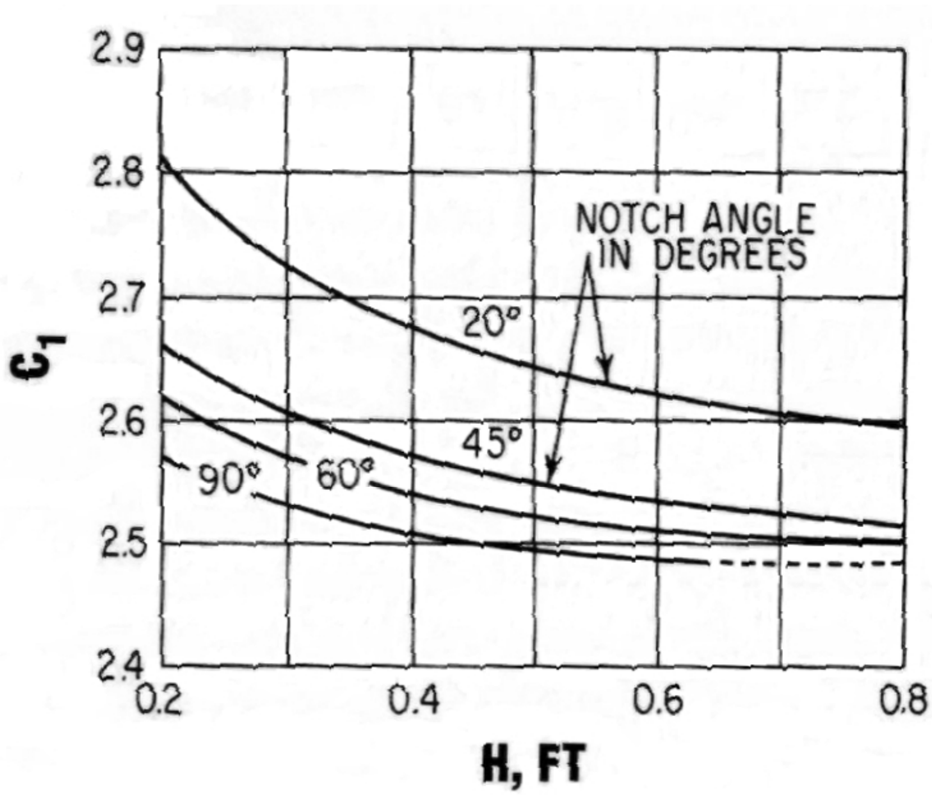


Figure PTP-03-07
Sharp Crested V-Notch Weir Discharge Coefficients

Wet Extended Detention Pond

A wet extended detention (ED) pond is a wet pond where the basin is designed to hold the water quality volume divided evenly permanent pool and the extended detention area. During a rain event, water is held in the extended detention area and released over a 24 hour period. Wet ED ponds typically have smaller land area requirements compared to wet ponds.

The permanent pool volume for a micropool extended detention pond should be sized to contain 50% of the water quality treatment volume. See PTP-03-08 and PTP-03-09 for a schematic of a typical wet ED pond. See Wet Pond for more detailed design parameters.

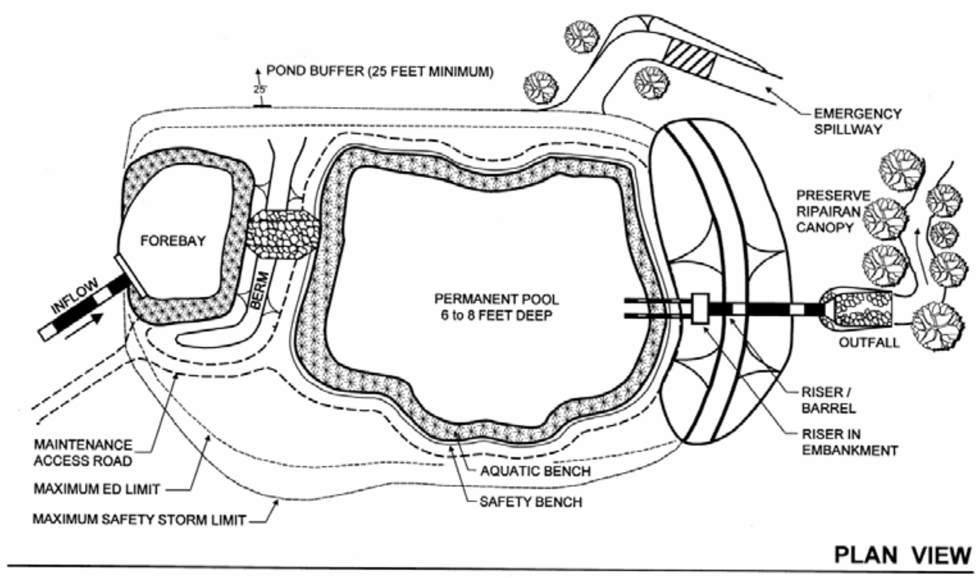


Figure PTP-03-08
Source, Georgia Stormwater Management Manual

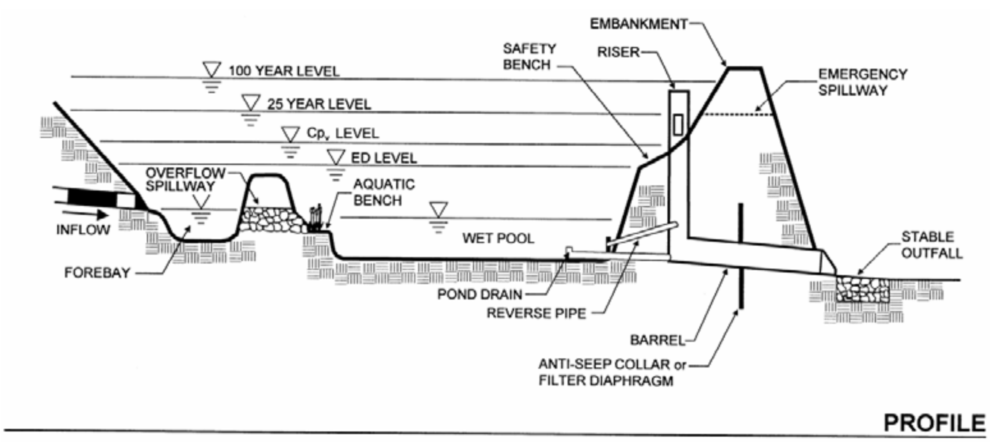


Figure PTP-03-09
Source, Georgia Stormwater Management Manual

Micropool Extended Detention Pond

A micropool extended detention pond is a basin where a small micropool is permanently maintained at the outlet. The outlet structure is designed to detain the water quality volume for 24 hours and prevents resuspention of sediment particles and clogging of the low flow orifice.

Larger stormwater ponds provide more pollutant removal efficiency than micropool extended detention ponds. However, micropools are ideal for areas where large open stormwater ponds cannot be used. Large open stormwater ponds may be undesirable due to thermal impacts on receiving streams, safety concerns in residential areas, or limited contributing drainage area.

The permanent pool volume for a micropool extended detention pond should be sized to contain 0.1 inch per impervious acre of contributing drainage. See PTP-03-10 and PTP-03-11 for schematics of a micropool ED pond. See Wet Pond for more detailed design parameters.

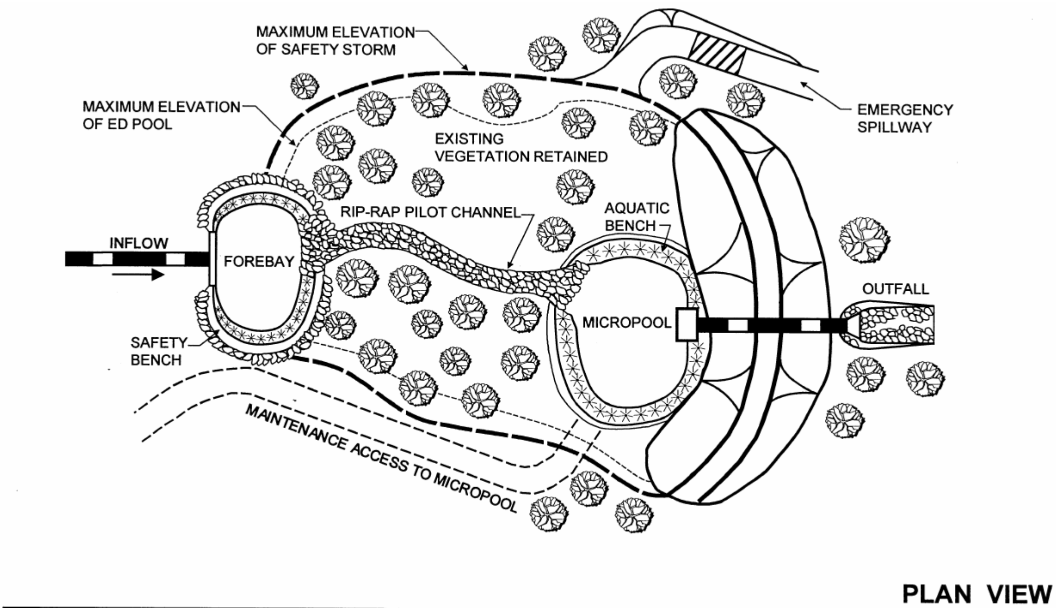


Figure PTP-03-10
Source, Georgia Stormwater Management Manual

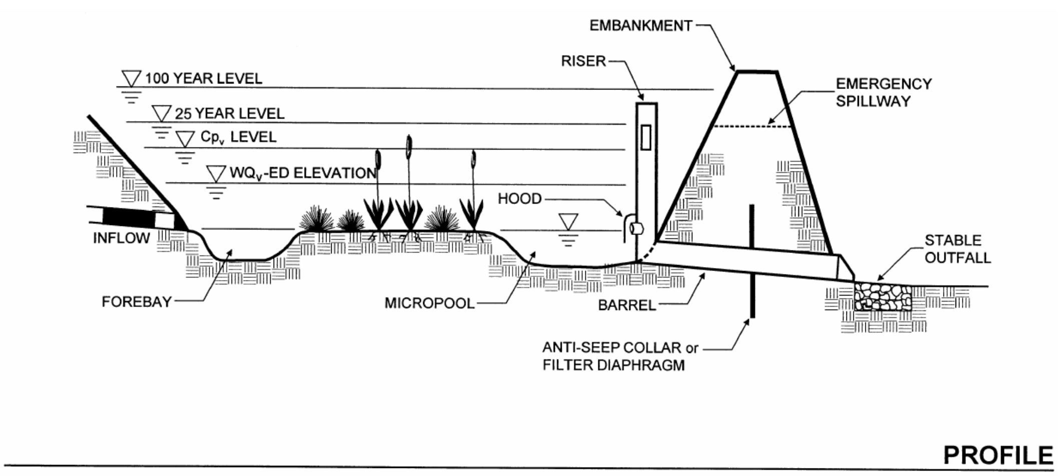


Figure PTP-03-11
Source, Georgia Stormwater Management Manual

Multiple Pond System

A multiple pond system provides water quality treatment as well as water quantity storage facilities through the use of multiple cells. The combination of two or more stormwater ponds in series can extend the pollutant removal pathway and treatment time and improve downstream channel protection.

The permanent pool volume for a multiple pond system should be sized according to the specific cell types used. See PTP-03-12 and PTP-03-13 for schematics of a typical multiple pond system. See Wet Pond for more detailed design parameters.

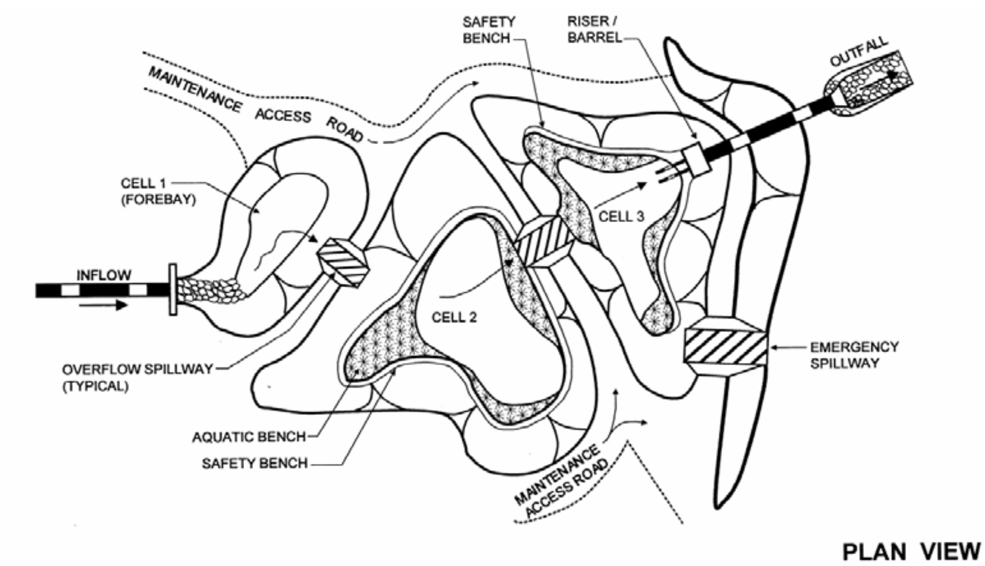


Figure PTP-03-12

Source, Georgia Stormwater Management Manual

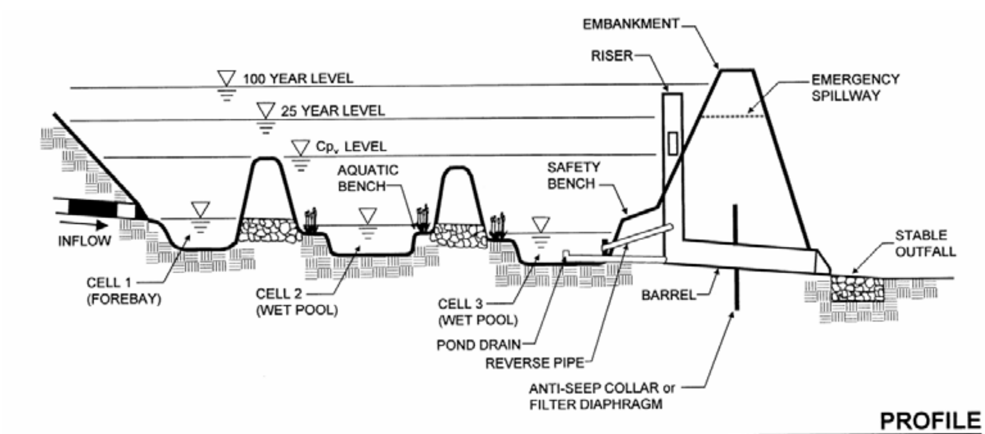


Figure PTP-03-13

Source, Georgia Stormwater Management Manual

Pocket Pond

Pocket ponds are designed to have smaller contributing drainage areas than traditional stormwater ponds. This results in little or no base flow during dry weather. Normal pool elevations are maintained through interaction with the water table. Pocket ponds do not have the pollutant removal capabilities that traditional stormwater ponds do, but they may be better suited for a location with limited available land area. If excavation to groundwater could impact drinking water supplies due to surrounding land use drainage, avoid connecting the pond to groundwater sources. See PTP-03-13 and PTP-03-14 for schematics of a typical pocket pond. See Wet Pond for more detailed design parameters.

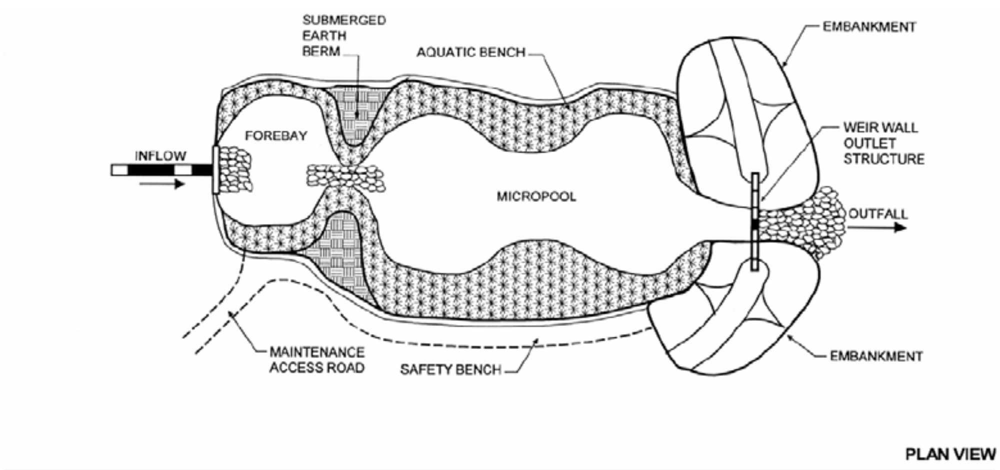


Figure PTP-03-14
Source, Georgia Stormwater Management Manual

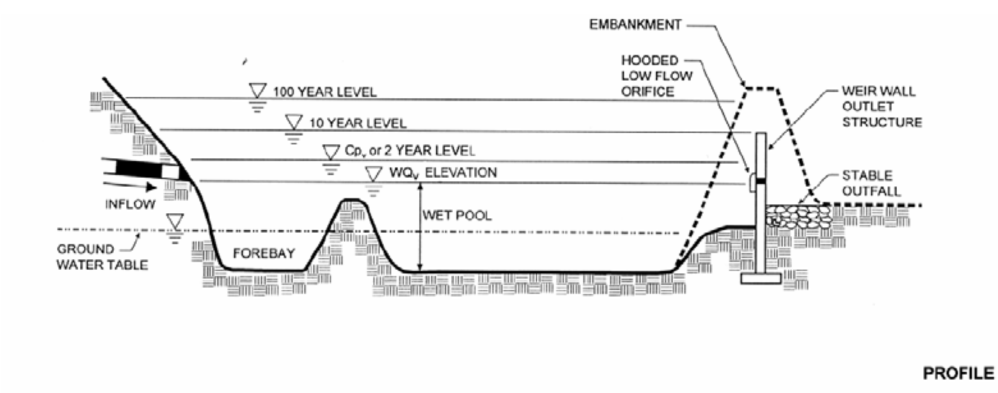


Figure PTP-03-15
Source, Maryland Stormwater Design Manual

Activity: Stormwater Ponds	PTP-03

Wet Pond Design Procedures

Step 1. Compute runoff control volumes.

Calculate the Water Quality Volume (WQ_v), Channel Protection Volume (Cp_v), Overbank, Flood Protection Volume (Q_p), and the Extreme Flood Volume (Q_f).

Step 2. Determine if the development site and conditions are appropriate for the use of a stormwater pond.

- Type of development?
- Greater than 25 acre watershed?
- Stable slopes < 15% Grade?
- Does pond location utilize natural topography at site and setback requirements for stormwater pond facilities?
- Are utilities located outside pond site?

Step 3. Confirm local design criteria and applicability.

Consider any special site-specific design conditions/criteria such as soils, topography constraints, groundwater, and downstream conditions. Check with local officials and other agencies to determine if there are any restrictions and/or surface water or watershed requirements that may apply.

Step 4. Determine pretreatment volume.

A sediment forebay must be provided at each inlet, unless the inlet provides less than 10% of the total design storm inflow to the pond. The forebay should be sized to contain 0.1 inches per impervious acre of contributing drainage and should be 4 to 6 feet deep. The forebay storage volume counts toward the total WQv requirement and may be subtracted from the WQ_v for subsequent calculations.

Step 5. Determine permanent pool volume (and water quality ED volume)

- Wet Pond: Size permanent pool volume to 1.0 WQ_v
- Wet ED Pond: Size permanent pool volume to 0.5 WQ_v. Size extended detention volume to 0.5 WQ_v.
- Micropool ED Pond: Size permanent pool volume to 25 to 30% of WQ_v. Size extended detention volume to remainder of WQ_v.
- Pocket Pond: Dependent on ground water connection.

Step 6. Determine pond location and preliminary geometry.

Conduct pond grading and determine storage available for permanent pool (and water quality extended detention if wet ED pond or micropool ED pond). This step involves initially grading the pond (establishing contours) and determining the elevation-storage relationship for the pond.

- Include safety and aquatic benches and access.
- Set WQ_v permanent pool elevation (and WQ_v-ED elevation for wet ED and micropool ED pond) based on volumes calculated earlier.

See Design Criteria for more details.

Wet Pond Design Procedures (cont.)

Step 7. Compute extended detention orifice release rate(s) and size(s), and establish Cp v Elevation.

Wet Pond: The Cp_v elevation is determined from the stage-storage relationship and the orifice is then sized to release the channel protection storage volume over a 24-hour period (12-hour extended detention may be warranted in some cold water streams). The channel protection orifice should have a minimum diameter of 3 inches and should be adequately protected from clogging by an acceptable external trash rack. A reverse slope pipe attached to the riser, with its inlet submerged 1 foot below the elevation of the permanent pool, is a recommended design. The orifice diameter may be reduced to 1 inch if internal orifice protection is used (i.e., an over-perforated vertical stand pipe with ½-inch orifices or slots that are protected by wirecloth and a stone filtering jacket). Adjustable gate valves can also be used to achieve this equivalent diameter.

Wet ED Pond and Micropool ED Pond: Based on the elevations established in Step 6 for the extended detention portion of the water quality volume, the water quality orifice is sized to release this extended detention volume in 24 hours. The water quality orifice should have a minimum diameter of 3 inches and should be adequately protected from clogging by an acceptable external trash rack. A reverse slope pipe attached to the riser, with its inlet submerged 1 foot below the elevation of the permanent pool, is a recommended design. Adjustable gate valves can also be used to achieve this equivalent diameter. The Cp_v elevation is then determined from the stage-storage relationship. The invert of the channel protection orifice is located at the water quality extended detention elevation, and the orifice is sized to release the channel protection storage volume over a 24-hour period (12-hour extended detention may be warranted in some cold water streams).

Step 8. Calculate Q_{p25} (25-year storm) release rate and water surface elevation.

Set up a stage-storage-discharge relationship for the control structure for the extended detention orifice(s) and the 25-year storm.

Step 9. Design embankment(s) and spillway(s).

Size emergency spillway, calculate 100-year water surface elevation, set top of embankment elevation, and analyze safe passage of the Extreme Flood Volume (Q_f). At final design, provide safe passage for the 100-year event.

Step 10. Investigate potential pond hazard risks and regulatory classifications.

Step 11. Design inlets, sediment forebay(s), outlet structures, maintenance access, and safety features. See Design Criteria for more details.

Step 12. Prepare Vegetation and Landscaping Plan.

A landscaping plan for a stormwater pond and its buffer should be prepared to indicate how aquatic and terrestrial areas will be stabilized and established with vegetation.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Stormwater Pollution Treatment Practices (Structural)

PTP-04

Activity: Stormwater Wetlands

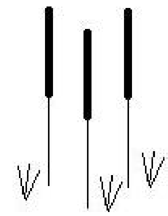
PLANNING CONSIDERATIONS:

Design Life:
Life

Acreage Needed:
Moderate to High (Minimum - 1% of total drainage area)

Estimated Unit Cost:
Medium

Annual Maintenance:
Moderate to High



SW

Target Pollutants

Total Suspended Solids (TSS); 75%
Nutrients – Total Phosphorous/Total Nitrogen removal; 40/30%
Metals – Cadmium, Copper, Lead, and Zinc removal; 50%
Pathogens – Coliform, Streptococci, E.Coli removal; 70%

Description

Stormwater wetlands are constructed basins that have a pool of water throughout the year (or at a minimum, throughout the wet season). They differ from wet ponds primarily in being shallower and having greater vegetation coverage. They are considered among the most effective stormwater practices in terms of pollutant removal and offer aesthetic value. As stormwater runoff flows through the wetlands, pollutant removal is achieved through settling and biological uptake within the wetland. Flow through the root systems forces the vegetation to remove nutrients and dissolved pollutants from stormwater.

Suitable Applications

- Stormwater wetlands are recommended for the following locations:
  - Small outfalls with soil conditions that will support the establishment and growth of wetland vegetation.
  - Large industrial and commercial sites with enough space and soil conditions favorable towards the establishment and growth of wetland vegetation.
  - Adjacent to greenways, parks, and recreational areas or other locations amenable towards the promotion of wetland vegetation.
- Low and high visibility sites are conducive towards the establishment of stormwater wetlands, so long as the problem of stagnant or standing water is minimized.
- Stormwater wetlands provide a practice that:
  - Remove nutrients from stormwater runoff
  - Establish wildlife habitats
  - Lower maintenance costs

Approach

The design of a stormwater wetland should consider:

- The type of wetland and its characteristics
- The hydrologic characteristics of the wetland
- The vegetation planted within the wetland
- The type and volume of nutrients and pollutants entering the wetland prior to treatment
- Soil texture

Design Criteria

Several examples of stormwater wetland designs are shown in Exhibits 1 thru 4. These include shallow wetlands, extended detention (ED) shallow wetlands, pond/wetland systems, and pocket wetlands. Throughout this fact sheet the following plant community “zones” will be used to describe constructed wetlands. These zones are shown in Exhibit 5. These exhibits are found at the end of this fact sheet.

Location and Siting:

Stormwater wetlands should normally have a minimum contributing drainage area of 25 acres or more. For a pocket wetland, the minimum drainage area is 5 acres.

The wetlands’ vegetation will require a continuous base flow or high water table. A water balance should be calculated to demonstrate that a stormwater wetland can withstand a 30-day drought at summer evaporation rates completely drawing down the structure.

Stormwater wetlands cannot be located within navigable water of the United States, including wetlands, without obtaining a Section 404 permit under the Clean Water Act, and any other applicable State permit. In some isolated cases, a wetlands permit may be granted to convert an existing degraded wetland in the context of local watershed restoration efforts.

Minimum setback requirements for stormwater wetland facilities:

From a property line – 10 feet

From a private well – 100 feet; if the well is down gradient from a hotspot land use then the minimum setback is 250 feet

From a septic system tank/leach field – 50 feet

General Design:

A stormwater wetland should consist of:

- Shallow marsh areas of varying depths with wetland vegetation
- Permanent micropool at the outlet
- Overlying zone in which runoff control volumes are stored
- A sediment forebay at the inflow(s)
- Emergency spillway
- Maintenance access
- Safety bench
- Wetland buffer
- Indigenous wetland vegetation and landscaping

Physical Specification/Geometry:

In general, wetland designs are unique for each site and application. However, there are a number of geometric ratios and limiting depths for the design of a stormwater wetland that must be observed for adequate pollutant removal, ease of maintenance, the support of wetland vegetation, and improved safety. Table PTP-04-01 provides the recommended physical specifications and geometry for the various stormwater wetland design variants.

Design Criteria (cont.)

Table PTP-04-01 Recommended Design Criteria for Stormwater Wetlands

(*Modified from Massachusetts DEP, 1997; Schueler, 1992)*

Design Criteria	Shallow Marsh	ED Wetland	Pond/ Wetland	Pocket Wetland
Length:Width (min)	2:1	2:1	2:1	2:1
Extended Detention (ED)	No	Yes	Optional	Optional
Allocation of WQ_v Volume (pool/marsh/ED) in %	25/75/0	25/25/50	70/30/0	25/75/0
Allocation of Surface Area (deepwater/low marsh/high marsh/semi-wet)	20/35/40/5	10/35/45/10	45/25/25/5 (includes pond surface area)	10/45/40/5
Forebay	Required	Required	Required	Optional
Micropool	Required	Required	Required	Required
Outlet Configuration	Reverse-slope pipe or hooded broad-crested weir	Reverse-slope pipe or hooded broad-crested weir	Reverse-slope pipe or hooded broad-crested weir	Hooded broad-crested weir

Depth:
Deepwater: 1.5 to 6 feet below normal pool elevation
Low Marsh: 6 to 18 inches
High Marsh: 6 inches
Semi-wet zone: Above normal pool elevation

The stormwater wetland should be designed with the recommended proportion of "depth zones." Each of the four wetland design variants has depth zone allocation which are given as a percentage of the stormwater wetland surface area. Target allocations are found in the table above:

Deepwater zone

From 1.5 to 6 feet deep. Includes the outlet micorpool and deepwater channels through the wetland facility. This zone supports little emergent wetland vegetation, but may support submerged or floating vegetation.

Low marsh zone

From 6 to 18 inches below the normal permanent pool or water surface elevation. This zone is suitable for the growth of several emergent wetland plant species.

High marsh zone

From 6 inches below the pool to the normal pool elevation. This zone will support a greater density and diversity of wetland specie than the low marsh zone. The high marsh zone should have a higher surface area to volume ratio than the low marsh zone.

Semi-wet zone

Those areas above the permanent pool that are inundated during larger storm events. This zone supports a number of species that can survive flooding.

A minimum dry weather flow path of 2:1 (length to width) is required from inflow to outlet across the stormwater wetland and should ideally be greater than 3:1. This path may be achieved by constructing internal dikes or berms, using marsh plantings, and by using multiple cells. Finger dikes are commonly used in surface flow systems to create serpentine configurations and prevent short-circuiting. Microtopography (contours along the bottom of a wetland or marsh that provide a variety of conditions for different species needs and increases the surface area to volume ratio) is encouraged to enhance wetland diversity.

Design Criteria (cont.)

- A 4- to 6-foot deep micropool must be included in the design at the outlet to prevent the outlet from clogging and resuspension of sediments.
- Maximum depth of any permanent pool areas should generally not exceed 6 feet.
- The volume of the extended detention must not comprise more than 50% of the total WQ_v, and its maximum water surface elevation must not extend more than 3 feet above the normal pool. Storage for larger events can be provided above the maximum WQv elevation within the wetland.
- The perimeter of all deep pool areas (4 feet or greater in depth) should be surrounded by safety and aquatic benches similar to those for stormwater ponds.
- The contours of the wetland should be irregular to provide a more natural landscaping effect.

Pretreatment / Inlets

- Sediment regulation is critical to sustain stormwater wetlands. A wetland facility should have a sediment forebay or equivalent upstream pretreatment. A sediment forebay is designed to remove incoming sediment from the stormwater flow prior to dispersal into the wetland. The forebay should consist of a separate cell, formed by an acceptable barrier. A forebay is to be provided at each inlet, unless the inlet provides less than 10% of the total design storm inflow to the wetland facility.
- The forebay is sized to contain 0.1 inches per impervious acre of contributing drainage and should be 4 to 6 feet deep. The pretreatment storage volume is part of the total WQ_v requirement and may be subtracted from WQ_v for wetland storage sizing.
- A fixed vertical sediment depth marker should be installed in the forebay to measure sediment deposition over time. The bottom of the forebay may be hardened (e.g., using concrete, paver blocks, etc.) to make sediment removal easier.
- Inflow channels are to be stabilized with flared riprap aprons, or the equivalent. Inlet pipes to the pond can be partially submerged. Exit velocities from the forebay must be nonerosive.

Outlet Structures

- Flow control from a stormwater wetland is typically accomplished with the use of a concrete or corrugated metal riser and barrel. The riser is a vertical pipe or inlet structure that is attached to the base of the micropool with a watertight connection. The outlet barrel is a horizontal pipe attached to the riser that conveys flow under the embankment (see Figure PTP-04-01). The riser should be located within the embankment for maintenance access, safety and aesthetics.
- A number of outlets at varying depths in the riser provide internal flow control for routing of the water quality, channel protection, and overbank flood protection runoff volumes. The number of orifices can vary and is usually a function of the wetland design.

Design Criteria (cont.)

- For shallow and pocket wetlands, the riser configuration is typically comprised of a channel protection outlet (usually an orifice) and overbank flood protection outlet (often a slot or weir). The channel protection orifice is sized to release the channel protection storage volume over a 24-hour period (12-hour extended detention may be warranted in some cold water streams). Since the water quality volume is fully contained in the permanent pool, no orifice sizing is necessary for this volume. As runoff from a water quality event enters the wet pond, it simply displaces that same volume through the channel protection orifice. Thus an off-line shallow or pocket wetland providing only water quality treatment can use a simple overflow weir as the outlet structure. In the case of a extended detention (ED) shallow wetland, there is generally a need for an additional outlet (usually an orifice) that is sized to pass the extended detention water quality volume that is surcharged on top of the permanent pool. Flow will first pass through this orifice, which is sized to release the water quality ED volume in 24 hours. The preferred design is a reverse slope pipe attached to the riser, with its inlet submerged 1 foot below the elevation of the permanent pool to prevent floatables from clogging the pipe and to avoid discharging warmer water at the surface of the pond. The next outlet is sized for the release of the channel protection storage volume. The outlet (often an orifice) invert is located at the maximum elevation associated with the extended detention water quality volume and is sized to release the channel protection storage volume over a 24-hour period (12-hour extended detention may be warranted in some cold water streams). Alternative hydraulic control methods to an orifice can be used and include the use of a broad-crested rectangular, V-notch, proportional weir, or an outlet pipe protected by a hood that extends at least 12 inches below the normal pool.
- The water quality outlet (if design is for an ED shallow wetland) and channel protection outlet should be fitted with adjustable gate valves or other mechanism that can be used to adjust detention time.
- Higher flows (overbank and extreme flood protection) pass through openings or slots protected by trash racks further up on the riser.
- After entering the riser, flow is conveyed through the barrel and is discharged downstream. Anti-seep collars should be installed on the outlet barrel to reduce the potential for pipe failure.
- Riprap, plunge pools or pads, or other energy dissipaters are to be placed at the outlet of the barrel to prevent scouring and erosion. If a wetland facility daylights to a channel with dry weather flow, care should be taken to minimize tree clearing along the downstream channel, and to reestablish a forested riparian zone in the shortest possible distance.
- The wetland facility must have a bottom drain pipe located in the micropool with an adjustable valve that can completely or partially dewater the wetland within 24 hours.
- The wetland drain should be sized one pipe size greater than the calculated design diameter. The drain valve is typically a hand wheel activated knife or gate valve. Valve controls shall be located inside of the riser at a point where they (a) will not normally be inundated and (b) can be operated in a safe manner.

Design Criteria (cont.)

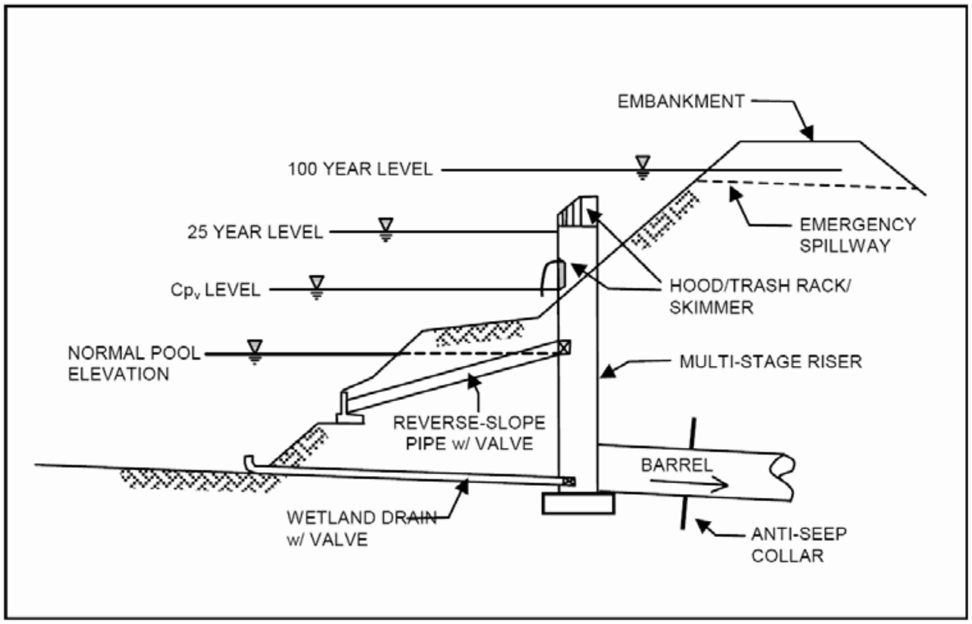


Figure PTP-04-01 – Typical Wetland Facility Outlet Structure

EMERGENCY SPILLWAY

- An emergency spillway is to be included in the stormwater wetland design to safely pass flows that exceed the design storm flows. The spillway prevents the wetland's water levels from overtopping the embankment and causing structural damage. The emergency spillway must be located so that downstream structures will not be impacted by spillway discharges.
- A minimum of 1 foot of freeboard must be provided, measured from the top of the water surface elevation for the extreme flood to the lowest point of the dam embankment, not counting the emergency spillway.

MAINTENANCE ACCESS

- A maintenance right of way or easement must be provided to the wetland facility from a public or private road. Maintenance access should be at least 12 feet wide, have a maximum slope of no more than 15%, and be appropriately stabilized to withstand maintenance equipment and vehicles.
- The maintenance access must extend to the forebay, safety bench, riser, and outlet and, to the extent feasible, be designed to allow vehicles to turn around.
- Access to the riser is to be provided by lockable manhole covers, and manhole steps within easy reach of valves and other controls.

SAFETY FEATURES

- Fencing of wetlands is not generally desirable, but may be required by the local review authority. A preferred method is to manage the contours of deep pool areas through the inclusion of a safety bench (see above) to eliminate drop-offs and reduce the potential for accidental drowning.
- The principal spillway opening should not permit access by small children, and endwalls above pipe outfalls greater than 48 inches in diameter should be fenced to prevent a hazard.

Design Criteria (cont.)

ADDITIONAL SITE-SPECIFIC DESIGN CRITERIA AND ISSUES

Physiographic Factors - Local terrain design constraints

- Low Relief – Providing wetland drain can be problematic
- High Relief – Embankment heights restricted per Kentucky Division of Water
- Karst – Requires poly or clay liner to sustain a permanent pool of water and protect aquifers; limits on ponding depth; geotechnical tests may be required

Soils

- Hydrologic group “A” soils and some group “B” soils may require liner (not relevant for pocket wetland)

Maintenance

Frequently (3-4 times a year)

- Clean and remove debris from inlet and outlet structures.
- Mow side slopes.

As Needed

- Repair undercut or eroded areas.

Semi-annual Inspection (first 3 years)

- Monitor wetland vegetation and perform replacement planting as needed.

Annual

- Inspect stability of the original growth zones and microtopographical features.
- Inspect for invasive vegetation and remove when and where possible.
- Inspect for damage to the embankment and inlet/outlet structures.
- Monitor and record for sediment accumulation in facility and forebay.
- Harvest wetland plants that are overgrown. Remove any harvested vegetation from the wetland.

5 to 7 years or after 50% of forebay capacity has been diminished

- Removal of sediment from forebay

10 to 20 years or after 25% of wetland volume has been lost

- Monitor sediment accumulations, and remove sediment when the pool volume has become reduced significantly, plants are “choked with sediment”, or the wetland becomes eutrophic.

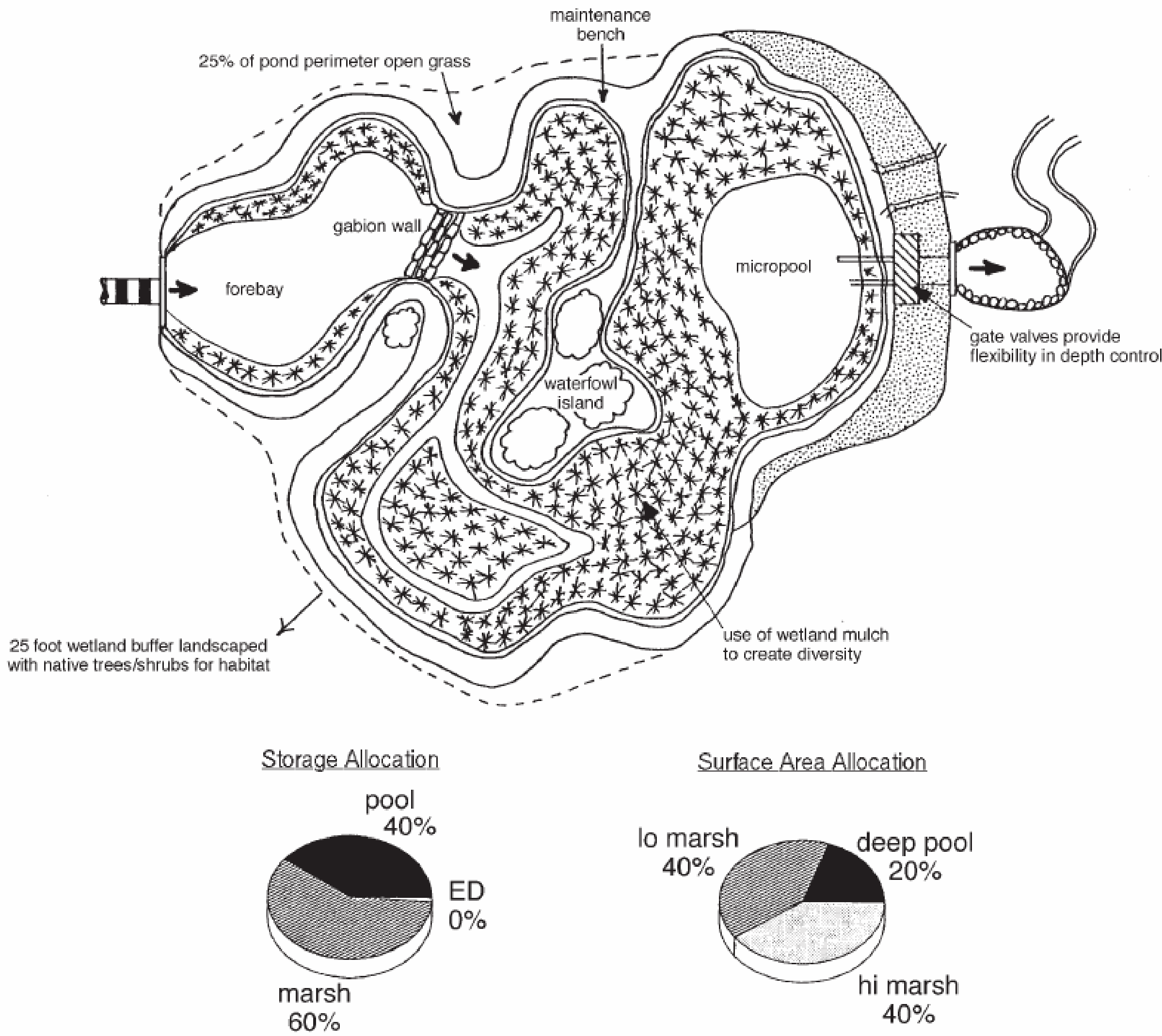
One time Activity

- Replace wetland vegetation to maintain at least 50% surface area coverage in wetland plants after the second growing season.

Regular inspections and maintenance are critical to the effective operation of constructed wetlands. Maintenance responsibility for a wetland facility and its buffer should be vested with a responsible authority by means of a legally binding and enforceable maintenance agreement that is executed as a condition of plan approval.

Exhibit 1

The Shallow Marsh System

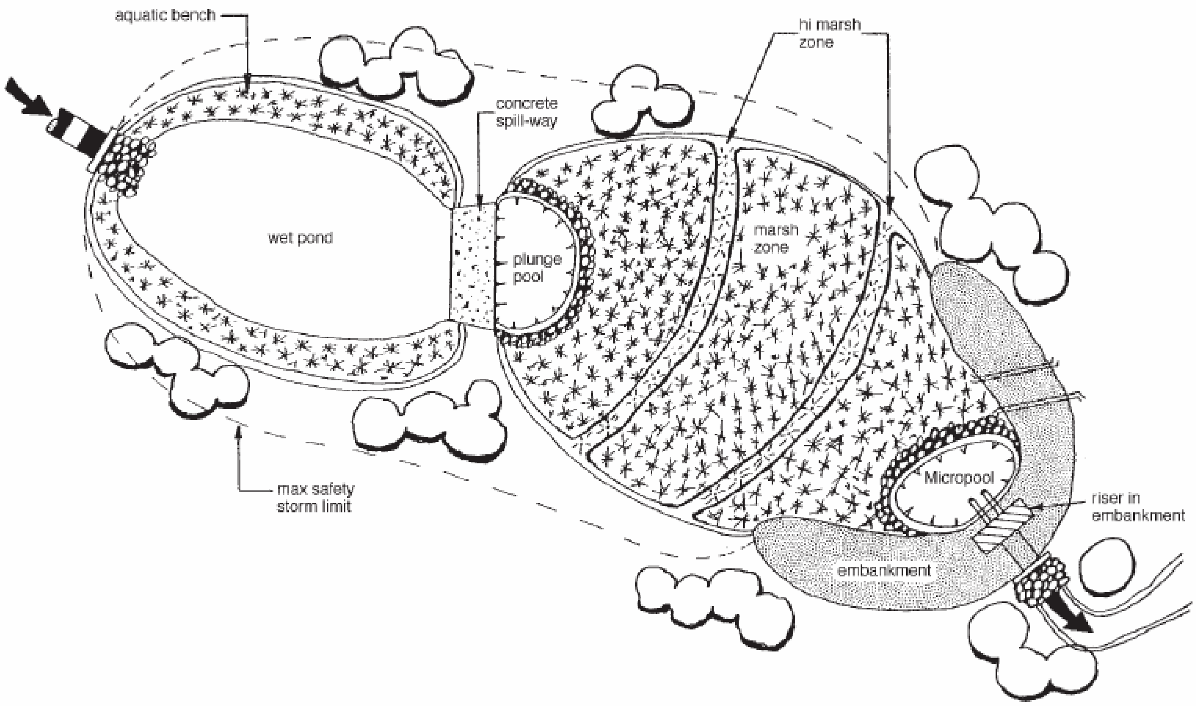


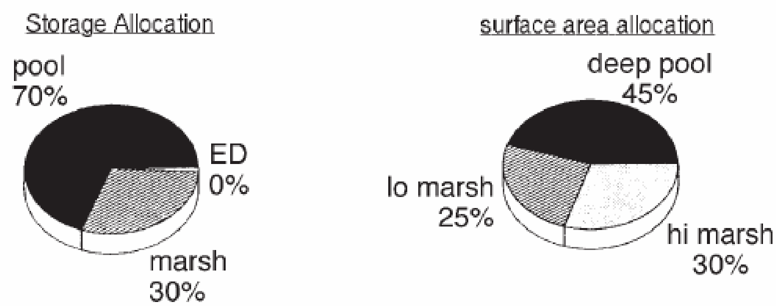
The majoriy of the shallow marsh system is zero to eighteen inches deep, which creates favorable conditions for the growth of emergent wetland plants. A deeper forebay is located at the major inlet, and a deep micropool is situated near the outlet.

Source: "Design of Stormwater Wetland Systems: Guidelines for Creating Diverse and Effective Stormwater Wetland systems in the Mid-Atlantic Region." Anacostia Restoration Team, Department of Environmental Programs, Metropolitan Council of Government.

Activity: Stormwater Wetlands / Pond/Wetland	PTP-04.2

Exhibit 2
The Pond/Wetland System



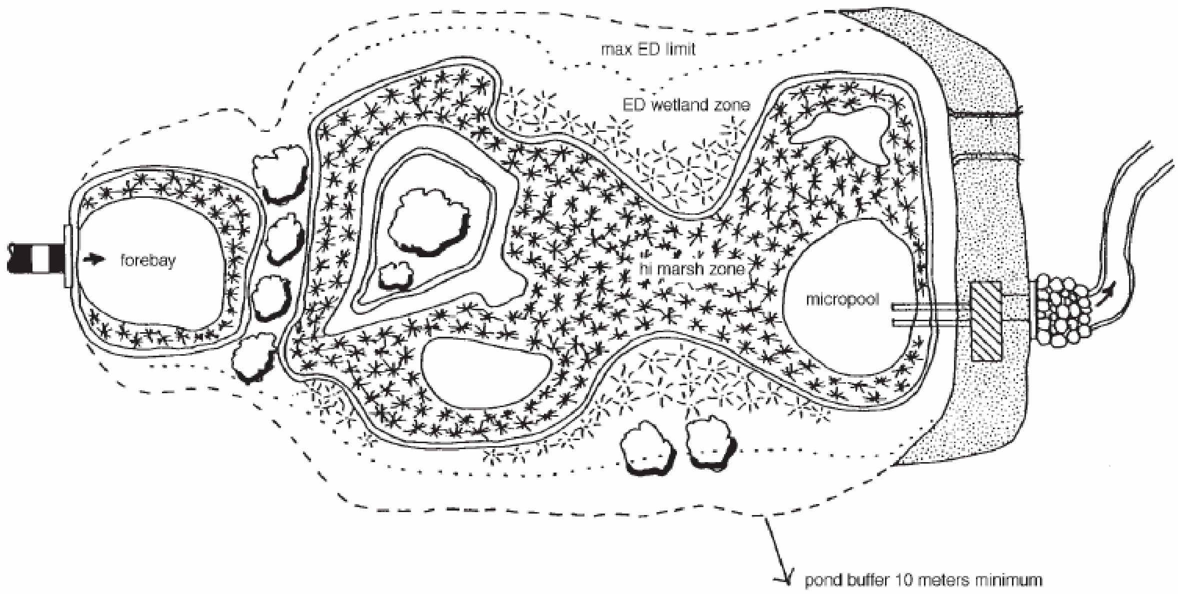


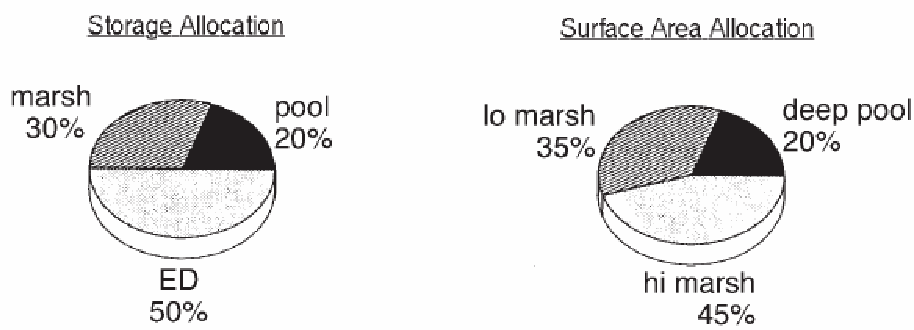
The pond/wetland system consists of two separate cells — a deep pond leading to a shallow wetland. The pond removes pollutants, and reduces the space required for the system.

Source: "Design of Stormwater Wetland Systems: Guidelines for Creating Diverse and Effective Stormwater Wetland systems in the Mid-Atlantic Region." Anacostia Restoration Team, Department of Environmental Programs, Metropolitan Council of Government.

Exhibit 3

The Extended Detention Wetland



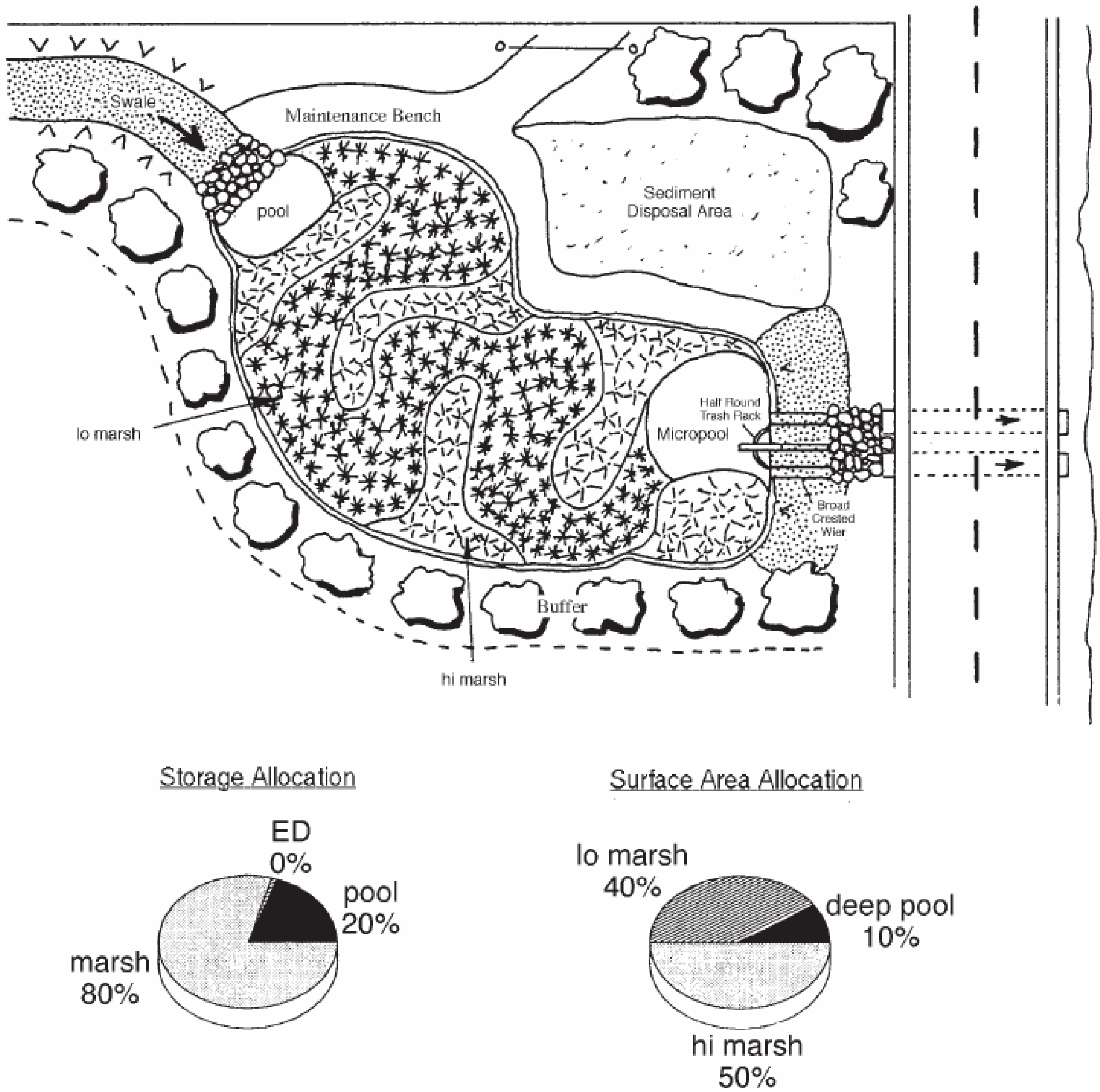


The water level within an ED wetland can increase by as much as three feet after a storm event, and then returns to normal levels within 24 hours. As much as 50% of the total treatment volume can be provided as ED storage, which helps to protect downstream channels from erosion, and reduce the wetland's space requirement.

Source: "Design of Stormwater Wetland Systems: Guidelines for Creating Diverse and Effective Stormwater Wetland systems in the Mid-Atlantic Region." Anacostia Restoration Team, Department of Environmental Programs, Metropolitan Council of Government.

Exhibit 4

The Pocket Stormwater Wetland

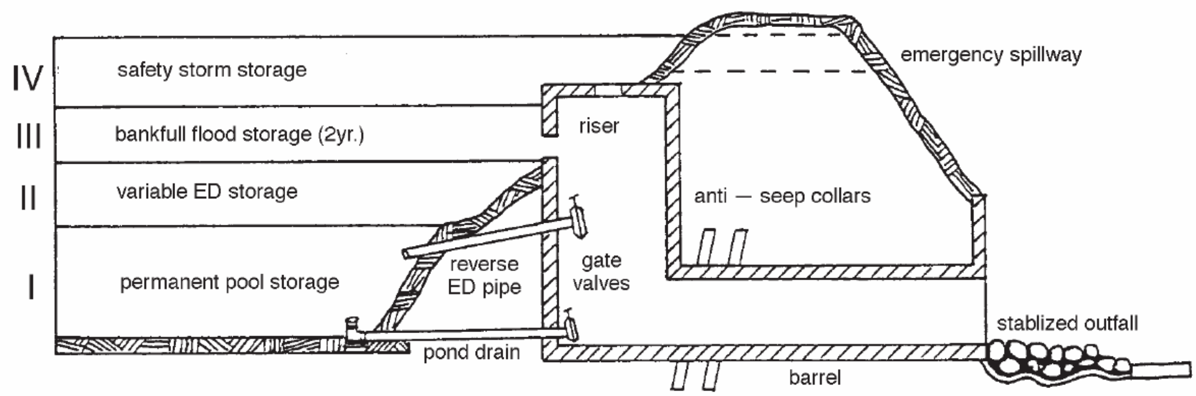


Pocket wetlands seldom are more than a tenth of an acre in size, and serve development sites of ten acres or less. Due to their size and unreliable water supply, pocket wetlands do not possess all of the benefits of other wetland designs. Most pocket wetlands have no sediment forebay. Despite many drawbacks, pocket wetlands may be an attractive BMP alternative for smaller development situations.

Source: “Design of Stormwater Wetland Systems: Guidelines for Creating Diverse and Effective Stormwater Wetland systems in the Mid-Atlantic Region.” Anacostia Restoration Team, Department of Environmental Programs, Metropolitan Council of Government.

Exhibit 5

Extended Detention Wetland Outlet Structure



Source: "Design of Stormwater Wetland Systems: Guidelines for Creating Diverse and Effective Stormwater Wetland systems in the Mid-Atlantic Region." Anacostia Restoration Team, Department of Environmental Programs, Metropolitan Council of Government.

Activity: Stormwater Wetlands	PTP-04

Stormwater Wetland Design Procedures

Step 1. Compute runoff control volumes.

Calculate the Water Quality Volume (WQ_v), Channel Protection Volume (Cp_v), Overbank Flood Protection Volume (Q_p), and the Extreme Flood Volume (Q_f).

Step 2. Determine if the development site and conditions are appropriate for the use of a stormwater wetland.

Consider the Application and Design Criteria.

Step 3. Confirm local design criteria and applicability.

Consider any special site-specific design conditions in Design Criteria. Check with local officials and other agencies to determine if there are any additional restrictions and/or surface water or watershed requirements that may apply.

Step 4. Determine pretreatment volume.

A sediment forebay is provided at each inlet, unless the inlet provides less than 10% of the total design storm inflow to the pond. The forebay should be sized to contain 0.1 inches per impervious acre of contributing drainage and should be 4 to 6 feet deep. The forebay storage volume counts toward the total WQ_v requirement and may be subtracted from the WQ_v for subsequent calculations.

Step 5. Allocate the WQ_v volume among marsh, micropool, and ED volumes.

Use recommended criteria from Table PTP-04-01.

Step 6. Determine wetland location and preliminary geometry, including distribution of wetland depth zones.

This step involves initially laying out the wetland design and determining the distribution of wetland surface area among the various depth zones (high marsh, low marsh, and deepwater). Set WQ_v permanent pool elevation (and WQ_v-ED elevation for ED shallow wetland) based on volumes calculated earlier.

Step 7. Compute extended detention orifice release rate(s) and size(s), and establish Cp_v elevation.

Shallow Wetland and Pocket Wetland: The Cp_v elevation is determined from the stage/ storage relationship and the orifice is then sized to release the channel protection storage volume over a 24-hour period (12-hour extended detention may be warranted in some cold water streams). The channel protection orifice should have a minimum diameter of 3 inches and should be adequately protected from clogging by an acceptable external trash rack. A reverse slope pipe attached to the riser, with its inlet submerged 1 foot below the elevation of the permanent pool is a recommended design. The orifice diameter may be reduced to 1 inch if internal orifice protection is used (i.e., an over-perforated vertical stand pipe with ½-inch orifices or slots that are protected by wirecloth and a stone filtering jacket). Adjustable gate valves can also be used to achieve this equivalent diameter.

Stormwater Wetland Design Procedures (cont.)

ED Shallow Wetland: Based on the elevations established in Step 6 for the extended detention portion of the water quality volume, the water quality orifice is sized to release this extended detention volume in 24 hours. The water quality orifice should have a minimum diameter of 3 inches, and should be adequately protected from clogging by an acceptable external trash rack. A reverse slope pipe attached to the riser, with its inlet submerged one foot below the elevation of the permanent pool, is a recommended design. Adjustable gate valves can also be used to achieve this equivalent diameter. The Cpv elevation is then determined from the stage-storage relationship. The invert of the channel protection orifice is located at the water quality extended detention elevation, and the orifice is sized to release the channel protection storage volume over a 24-hour period (12-hour extended detention may be warranted in some cold water streams).

Step 8. Calculate Q_{p25} (25-year storm) release rate and water surface elevation.

Set up a stage-storage-discharge relationship for the control structure for the extended detention orifice(s) and the 25-year storm.

Step 9. Design embankment(s) and spillway(s).

Size emergency spillway, calculate 100-year water surface elevation, set top of embankment elevation, and analyze safe passage of the Extreme Flood Volume (Qf). At final design, provide safe passage for the 100-year event. Attenuation may not be required.

Step 10. Investigate potential pond/wetland hazard classification.

The design and construction of stormwater management ponds and wetlands are required to follow the latest version of the State of Kentucky dam safety rules (www.water.ky.gov/damsafety).

Step 11. Design inlets, sediment forebay(s), outlet structures, maintenance access, and safety features. See Design Criteria.

Step 12. Prepare Vegetation and Landscaping Plan.

A landscaping plan for the wetland facility and its buffer should be prepared to indicate how aquatic and terrestrial areas will be stabilized and established with vegetation.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Stormwater Pollution Treatment Practices (Structural)

PTP-05

Activity: Infiltration Systems

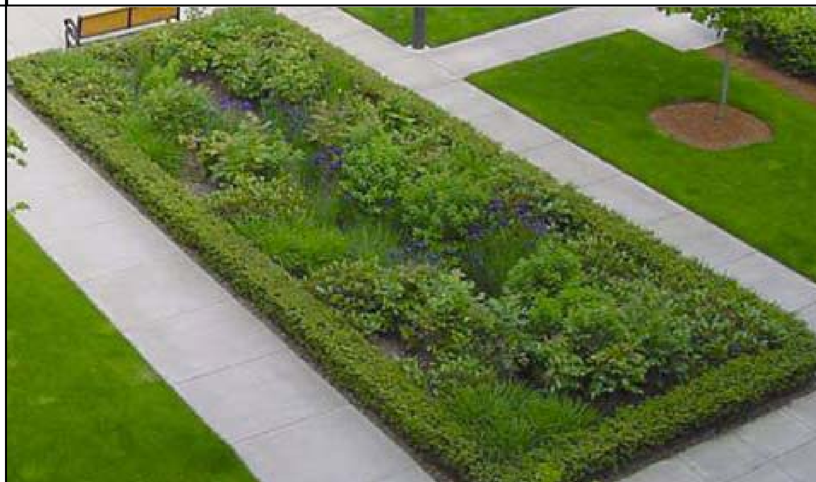
PLANNING CONSIDERATIONS:

Design Life:
Short

Acreage Needed:
Low to High

Estimated Unit Cost:
Moderate to High

Annual Maintenance:
Moderate



IS

IS

Target Pollutants

Total Suspended Solids (TSS); 90%
Nutrients – Total Phosphorous/Total Nitrogen removal; 60/60%
Metals – Cadmium, Copper, Lead, and Zinc removal; 90%
Pathogens – Coliform, Streptococci, E.Coli removal; 90%

Description

Infiltration systems are depressions with no outlet used to detain stormwater for a short period of time until it percolates into the groundwater table. Runoff flows into the system, is stored in the voids between stones and is slowly infiltrated through soil layers. Pollutants are filtered out of the stormwater runoff as it infiltrates the soil. Infiltration systems also provide groundwater recharge and preserve baseflow in nearby streams. Two types of infiltration systems that will be addressed here include: infiltration trenches (Figures PTP-05-01 and PTP-05-02) and infiltration basins (Figures PTP-05-03 and PTP-05-04).

Suitable Applications

Infiltration systems can be used to manage stormwater runoff from urban areas, where they can be used to treat sheet flow from impervious areas. Sheet flow should enter the infiltration system perpendicular to its main axis, and channel flow should enter parallel to the main axis of the direction of flow. Infiltration systems are typically suitable for the following applications:

- Offline systems
- Impervious area runoff
- Areas where removal of suspended solids, pathogens, metals, and nutrients is needed
- Small drainage areas of generally less than 5 acres

Infiltration systems should only be applied to stabilized drainage areas, as heavy sediment loads from construction areas will clog and disable the infiltration media. Likewise, they should not be used in areas where stormwater has the potential for high silt or clay content.

Infiltration systems are *not* recommended to treat sites where runoff could contribute to groundwater contamination. Sites with high pesticide or pathogen levels, manufacturing or industrial sites, and combined sewer overflows are not suitable applications for this BMP.

Suitable Applications (cont.)

Infiltration systems should typically be designed for off-line use to capture the first flush of runoff. A diversion structure such as a flow splitter or weir may be necessary to separate and route the first flush to the infiltration system for water quality control, and route the remaining stormwater to a water quantity device downstream. Infiltration systems are most effective when turbulent flow is minimized and the flow is spread uniformly across the filter media.

Feasibility Criteria

The following feasibility criteria should also be considered:

- To be suitable for infiltration, underlying soils shall have an infiltration rate (f) of 0.52 inches per hour or greater, as initially determined from NRCS soil textural classification and subsequently confirmed by field geotechnical tests. The recommended geotechnical testing is one test hole per 5000 square feet, with a minimum of two borings per facility (taken within the proposed limits of the facility).
- Soils should have a clay content of less than 20% and a silt/clay content of less than 40%.
- Infiltration cannot be located on slopes greater than 15% or within fill soils.
- To protect groundwater from possible contamination, runoff from designated hotspot land uses or activities should not be infiltrated without proper pretreatment to remove hydrocarbons, trace metals, or toxicants.
- Infiltration systems should be constructed with a minimum of 4 feet distance between its base and the water table or bedrock to allow for infiltration to occur. Care must especially be taken in karst areas where the potential for groundwater contamination should be considered. If a site overlies karst geology, the local approval authority should be consulted for specific design requirements.
- Infiltration facilities should be located at a minimum of 100 feet horizontally from any water supply well.
- The maximum contributing area to an individual infiltration practice should generally be less than 5 acres.
- Infiltration practices should not be placed in locations that cause water problems to downgrade properties. Infiltration facilities should be set back 25 feet (10 feet for dry wells) down gradient from structures.

Design Criteria

Infiltration Conveyance Criteria

- A conveyance system shall be included in the design of all infiltration practices in order to ensure that excess flow is discharged at non-erosive velocities.
- The overland flow path of surface runoff exceeding the capacity of the infiltration system shall be evaluated to preclude concentrated flow that causes erosion. If computed flow velocities do not exceed the non-erosive threshold, overflow may be accommodated by natural topography.
- Infiltration systems should be designed to fully de-water the entire WQ_v within 48 hours after the storm event.

Design Criteria (cont.)

Infiltration Pretreatment Criteria

To ensure the long term effectiveness of infiltration systems, preventative measures should be taken to minimize clogging. Pretreatment is generally most effective when multiple BMPs are placed in series. These may include vegetated filter strips, swales, sedimentation basins, or sediment traps.

Pretreatment Volume

- A minimum of 25% of the WQ_v must be pretreated prior to entry to an infiltration facility. If the infiltration rate for the underlying soils is greater than 2.00 inches per hour, 50% of the WQ_v shall be pretreated prior to entry into an infiltration facility. This can be provided by a sedimentation basin, stilling basin, sump pit or other acceptable measures. Exit velocities from pretreatment shall be non-erosive during the two-year design storm. The Camp-Hazen equation may be used as an acceptable alternative for determining infiltration pretreatment requirements. The Camp-Hazen equation accounts for the effects of turbulent flow to compute the required minimum surface area for pretreatment, A:

$$A_s = \frac{Q_o}{W} \times E'$$

Where:
A_s = sedimentation basin surface area (ft^2)
Q_o = discharge rate from basin = (WQv) / (24 hr)
W = particle settling velocity (ft/s); for percent impervious, I <= 75%, use W = 0.0004 ft/s, for I > 75%, use W = 0.0033 ft/s
E' = sediment trapping efficiency constant; for sediment trapping efficiency, E, of 90%, E' = 2.30 [2]

Pretreatment Techniques to Prevent Clogging

Each system shall have redundant methods to protect the long term integrity of the infiltration rate. The following techniques, at least three per trench and two per basin, should be installed in infiltration systems:

- Grass channel
- Grass filter strip (minimum 20 feet and only if sheet flow is established and maintained)
- Bottom sand layer
- Upper sand layer (6" minimum) with filter fabric at the sand/gravel interface.
- Use of washed bank run gravel as aggregate

The sides of infiltration trenches should be lined with an acceptable filter fabric that prevents soil piping but has greater permeability than the parent soil.

Infiltration Treatment Criteria

- Infiltration practices should be designed to exfiltrate the difference between the WQ_v minus the exfiltration volume. Infiltration practices are best used in conjunction with other BMPs and often downstream detention is still needed to meet the Cp_v and Q_p sizing criteria. Experience has shown that the longevity of infiltration practices is strongly influenced by the care taken during construction.

Activity: Infiltration Systems	PTP-05

Design Criteria (cont.)

Infiltration Landscaping Criteria

- A porosity value "n" ($n=V_v/V_t$) of 0.40 should be used in the design of stone reservoirs for infiltration systems.
- Establish a dense and vigorous vegetative cover over the contributing pervious drainage areas before runoff can be accepted into the facility. Infiltration trenches should not be constructed until the contributing drainage area has been finally stabilized.
- An infiltration trench should have a 2 to 10 foot excavation lined with a sand base beneath filter fabric and filled with coarse stone aggregate. The surface layers should consist of filter fabric and a layer of 2 inch pea gravel (See Figures PTP-05-01 and PTP-05-02). The empty spaces between the stones provide temporary storage for runoff as it filters through the soil at the bottom of the trench.
- An infiltration basin is typically 3 to 12 feet in depth with a maximum depth dependant on soil type. Basins should be designed to hold runoff from the design storm. Typical drainage areas range from 5 to 50 acres, with slopes less than 20%. The basin itself should be located at least 50 feet away from slopes greater than 20%. An emergency spillway should be provided to direct overflows from storms exceeding the design strom capacity.

Infiltration Maintenance Criteria

- Infiltration practices should not be used for a sediment control device during the site construction phase.
- A perforated pipe should be installed in the infiltration trench to monitor water levels and drawdown time. The pipe should be flush with the bottom of the trench. An anchored six-inch diameter perforated PVC pipe with a lockable cap is recommended for the observation well.
- It is recommended that infiltration designs include dewatering methods in the event of failure. This can be done with underdrain pipe systems that accommodate drawdown.
- Direct access should be provided to all infiltration practices for maintenance and rehabilitation.
- Infiltration practices should not be covered by an impermeable surface.

Maintenance

When not properly maintained, infiltration systems have a high failure rate. Maintenance and inspections should be conducted regularly to ensure the long term functionality of the system.

An observation well should be installed in trenches to determine how quickly it drains after a storm event and to observe sediment buildup.

Semi-Annual Maintenance

- Check observation wells following 3 days of dry weather (failure to infiltrate within this time indicates clogging).
- Inspect pretreatment devices and diversion structures for sediment buildup and structural damage.

Standard Maintenance

- Remove sediment and oil/grease from pretreatment devices and outflow structures.

Maintenance (cont.)

5-Year Maintenance

- Utilize bypass capability to provide an extended dry period, if available. This may allow the system to regain the infiltration rate in the short term.

Upon Failure

- Total rehabilitation of the system to maintain storage capacity.
- Excavate trench walls to expose clean soil.

Infiltration Trench

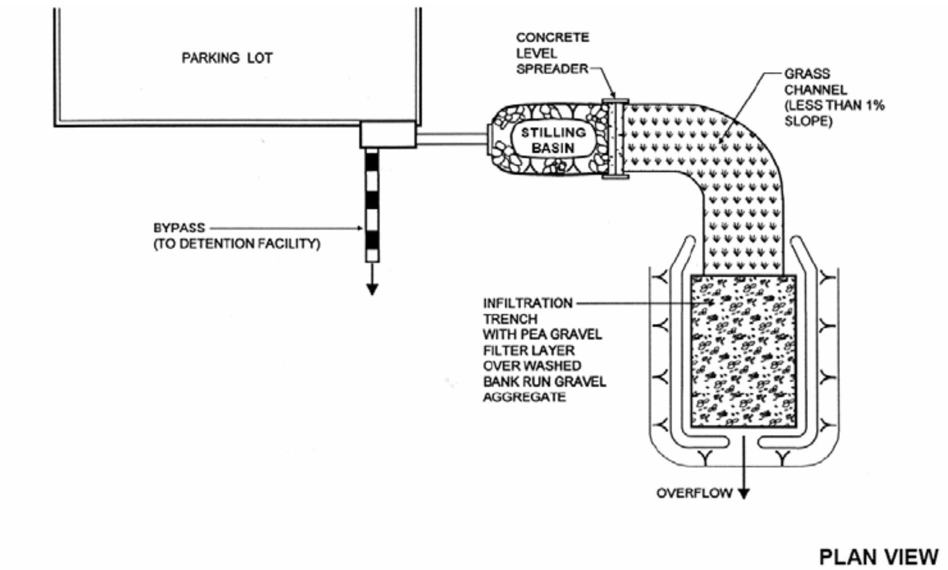


Figure PTP-05-01 Infiltration Trench Schematic
Source: Maryland Stormwater Design Manual

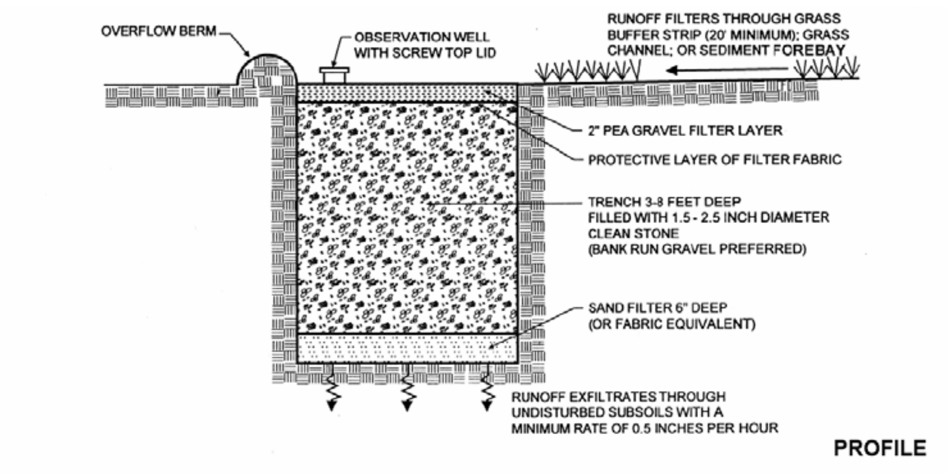


Figure PTP-05-02 Infiltration Trench Schematic
Source: Maryland Stormwater Design Manual

Infiltration Basin

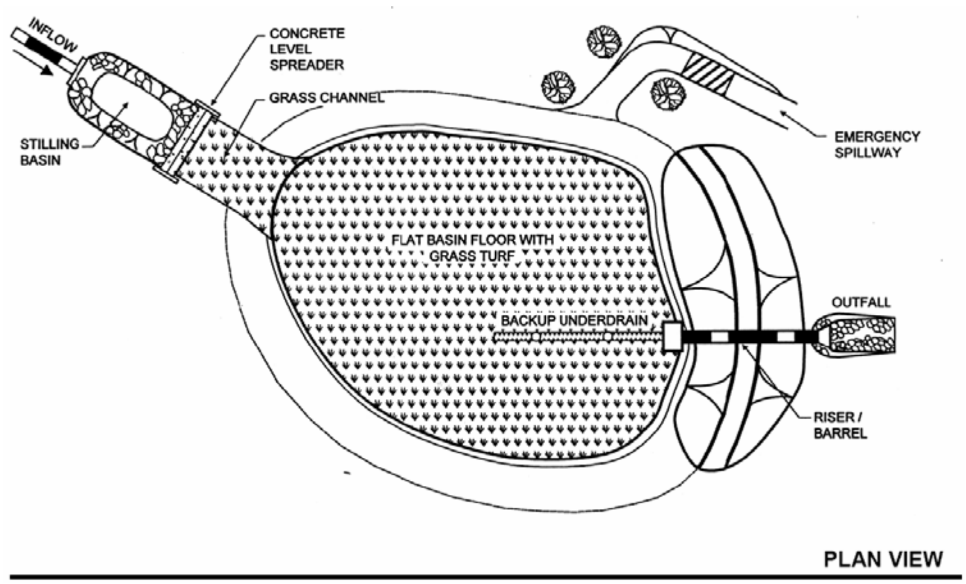


Figure PTP-05-03 Infiltration Basin Schematic
Source: Maryland Stormwater Design Manual

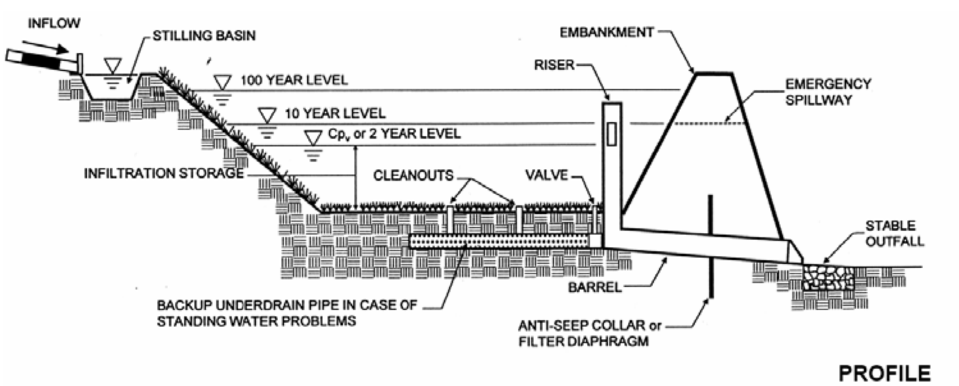


Figure PTP-05-04 Infiltration Basin Schematic
Source: Maryland Stormwater Design Manual

Infiltration Trench Design Procedures

Infiltration Trench Design Procedures

Step 1. Compute runoff control volumes.

Calculate the Water Quality Volume (WQ_v), Channel Protection Volume (Cp_v), Overbank Flood Protection Volume (Q_p), and the Extreme Flood Volume (Q_f).

Step 2. Determine if the development site conditions are appropriate for the use of an infiltration trench.

- Type of development?
- Permeable subsoils?
- Low water table?
- Low sediment load?
- Karst area?

Step 3. Confirm local design criteria and applicability

Consider any special site-specific design conditions/criteria (Additional Site-Specific Design Criteria and Issues). Check with local officials and other agencies to determine if there are any additional restrictions and/or surface water or watershed requirements that may apply.

Step 4. Compute WQv peak discharge (Q_{wq}).

The peak rate of discharge for water quality design storm is needed for sizing of off-line diversion.

- Using WQ_v (or total volume to be infiltrated), compute CN.
- Compute time of concentration using TR-55 method.
- Determine appropriate unit peak discharge from time of concentration.
- Compute Q_{wq} from unit peak discharge, drainage area, and WQ_v.

Step 5. Size flow diversion structure, if needed

A flow regulator (or flow splitter diversion structure) should be supplied to divert the WQ_v to the infiltration trench.

Size low flow orifice, weir, or other device to pass Q_{wq}.

Infiltration Trench Design Procedures (cont.)

Step 6. Size infiltration trench

The area of the trench can be determined from the following equation:

$$A = (WQ_v) / (nd + kT/12)$$

Where:

- A = Surface Area
- WQ_v = Water Quality Volume (or total volume to be infiltrated)
- n = porosity
- d = trench depth (feet)
- k = percolation (inches/hour)
- T= Fill Time (time for the practice to fill with water), in hours

A porosity value n = 0.32 should be used. All infiltration systems should be designed to fully dewater the entire WQv within 24 to 48 hours after the rainfall event. A fill time T=2 hours can be used for most designs.

Step 7. Determine pretreatment volume and design pretreatment measures.

Pretreatment facility should be sized to treat 25% of the water quality volume (WQ_v) for off-line configurations.

Step 8. Design spillway(s).

Adequate stormwater outfalls should be provided for the overflow exceeding the capacity of the trench, ensuring nonerosive velocities on the down-slope.

Somerset, Kentucky
Stormwater Best Management Practices (BMPs)
Stormwater Pollution Treatment Practices (Structural)

PTP-06

Activity: Water Quality Units

WQ

WQ

PLANNING CONSIDERATIONS:

Design Life:
35 years

Acreage Needed:
Low

Estimated Unit Cost:
Moderate

Annual Maintenance:
Moderate to High

Target Pollutants

Litter and Debris
Total Suspended Solids (TSS); 20%
Nutrients – Total Phosphorous removal; 17%
Metals – Lead/Zinc/Copper removal; 24/17/0%

Description

Water quality units target urban areas and provide water quality benefits at stormwater inlets. Units are generally designed as compact below grade systems constructed of precast concrete. Units often employ a swirling motion that causes sediments and particulates to settle out and a chamber to capture floatable material. Water quality units included here are hydrodynamic separators, filtration units, and continuous deflection separators.

Hydrodynamic separators are flow-through systems with a separation cylinder unit to promote the settlement of sediments and other pollutants. No outside power source is required as the system is designed to utilize the energy of flowing water. Means of separation vary between hydrodynamic separator units, which may employ a swirl action or indirect filtration.

Filtration units are devices inserted into storm drains to filter or absorb sediment, pollutants and oil and grease. Filter media cartridges are commonly used to collect and dispose of pollutants.

Continuous deflection separators treat runoff by screening sediment and debris via a vortex of water that deflects sediment and debris into a sump while water flows through a screen.

Suitable Applications

Water quality units are most suitable for highly impervious sites. Because of their limited removal ability of soluble pollutants and fine particles, these devices should be used as a pretreatment device, and should not act as a stand-alone practice for new development. However, when space is limited, water quality units are ideal for retrofit applications. Site types may include automotive lots, parking lots, roadways, road salt storage facilities, hazardous substance facilities and rooftop runoff.

Suitable Applications (cont.)

Water quality units are typically suitable for the following applications:

- Impervious area runoff
- Retrofit applications
- In conjunction with other stormwater BMPs

Target Pollutants

Target pollutants and removal effectiveness may vary widely between the unit type and manufacturer. If available, independent data should be used to consider a water quality unit brand or manufacturer. Independent studies suggest that water quality units primarily target litter and debris with limited pollutant removal capacity, particularly for fine particles and soluble pollutants. Target pollutant information for this fact sheet was based on data from the Environmental Protection Agency's fact sheet, *Manufactured Products for Stormwater Inlets*, referencing S.S. Greb and R. Waschbusch's study, "Evaluation of Stormceptor® and multi-chamber treatment train as urban retrofit strategies", 1998. This study investigated 45 precipitation events over a 9-month period and calculated percent removal rates to reflect overall efficiency, accounting for pollutants in bypassed flows.

Design Criteria

The sizing and design for water quality units should be based on the manufacturer's product specifications. Units are generally designed according to the peak flow rate for a given design storm event at the inlet. Units may have features designed to reduce the velocity of the stormwater flow entering the unit, which increases the capacity of sediment removal of the system. See Figure PTP-06-01 for a sample schematic for general features of a water quality unit.

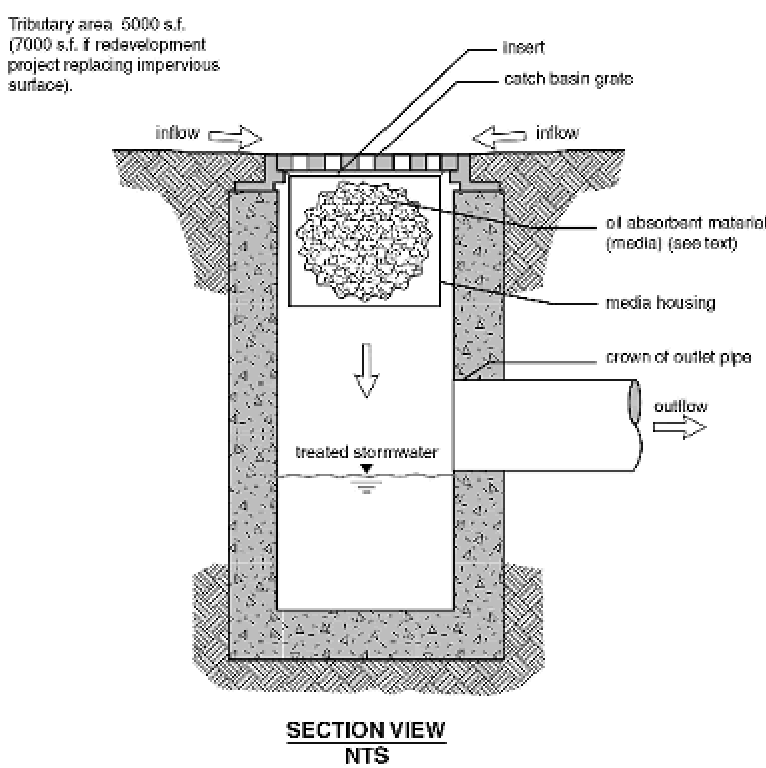


Figure PTP-06-01 Water Quality Unit Schematic
Source: Environmental Protection Agency

Cost

Costs for water quality units vary by type and manufacturer. In general, costs for water quality units increase for sites requiring treatment for high peak flows or where pre-manufactured units are not available. If pre-manufactured units cannot accommodate the site or design conditions, cost may increase for a customized unit.

Product Examples

The City of Somerset does not endorse the manufacturers or brand product names listed below. The following examples are meant to facilitate the evaluation of specifications for water quality units in general and to provide the user with a cross-section of water quality unit products available on the market.

Hydrodynamic Separator: *Vortechs® System, a product by Vortechnics®, Inc.*

This hydrodynamic separator (Figure PTP-06-02) is designed to promote gravitational separation of particles using a swirl action in a cylindrical tank. The tank has compartments separated by baffle walls to control floatables at low, medium and high flows. The unit size is based on site area, runoff coefficient and time of concentration, regional precipitation intensity distribution, and anticipated pollutant characteristics. This data is applied to the Rational Method to estimate pollutant removal efficiency. The Rational Method works well for designing this system for most sites due to small site area and impervious surface characteristics. Flow rates calculated for each rainfall intensity are used to generate an operating rate for the Vortechs® System unit. Pollutant removal efficiencies can then be paired with operating rates based on laboratory tests and pollutant types and loads expected for the site.

The design incorporates the following features:

- Cylindrical grit chamber
- Baffle wall
- Flow control wall

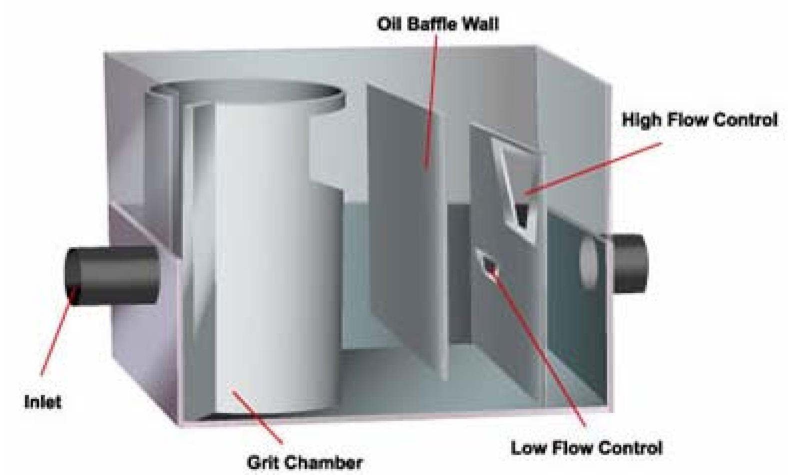


Figure PTP-06-02 Hydrodynamic Separator, Vortechs® System Schematic
Source: University of Massachusetts Amherst Stormwater Technologies Clearinghouse, www.mastep.net.

Product Examples (cont.)

Removal efficiency performance is compared in Table PTP-06-01.

Table PTP-06-01 Performance Comparison

Source: University of Massachusetts Amherst Stormwater Technologies Clearinghouse, www.mastep.net.

Pollutants Addressed	Manufacturer's Removal Efficiency Claim (%)	Minimum Particle Size	Tested Removal Efficiency (%)
Suspended sediment concentration	35-85%	63	61 %
Total suspended solids	35-85%	63	35 %
Total dissolved solids	-	-	-110 %
Total volatile solids	-	-	-
Total solids	35-85%	0	-
Oil and grease	35-85%	-	-
Debris - floatables	35-85%	-	-
Debris- sinking	35-85%	-	-
Zinc	0-80%	-	24 %
Copper	0-80%	-	33 %
Lead	0-80%	-	-
Iron	0-80%	-	-
Chromium	0-80%	-	-
Mercury	0-80%	-	-
Cadmium	0-80%	-	-
Hydrocarbons	35-85%	-	-
Organic contaminants	0-80%	-	-
Salt	0-80%	-	-
Fecal coliform	0-80%	-	-
E. coli	0-80%	-	-
Enterococcus	0-80%	-	-
Total nitrogen	0-80%	-	-
Total Phosphorus	0-80%	-	21 %
Suspended sediment concentration	35-85%	63	61 %
Total suspended solids	35-85%	63	35 %
Total dissolved solids	-	-	-110 %
Total volatile solids	-	-	-
Total solids	35-85%	0	-
Oil and grease	35-85%	-	-
Debris - floatables	35-85%	-	-
Debris- sinking	35-85%	-	-
Zinc	0-80%	-	24 %
Copper	0-80%	-	33 %
Lead	0-80%	-	-
Iron	0-80%	-	-
Chromium	0-80%	-	-

Product Examples (cont.)

Table PTP-06-01 Performance Comparison (continued)

Pollutants Addressed	Manufacturer's Removal Efficiency Claim (%)	Minimum Particle Size	Tested Removal Efficiency (%)
Mercury	0-80%	-	-
Cadmium	0-80%	-	-
Hydrocarbons	35-85%	-	-
Organic contaminants	0-80%	-	-
Salt	0-80%	-	-
Fecal coliform	0-80%	-	-
E. coli	0-80%	-	-
Enterococcus	0-80%	-	-
Total nitrogen	0-80%	-	-
Total Phosphorus	0-80%	-	21 %

Filtration Unit: *StormFilter®, a product by Stormwater Management®, Inc.*

This filtration unit (Figure PTP-06-03) utilizes rechargeable media filter cartridges to remove pollutants from stormwater as it flows into the vault and passes through the filter. Inflow to the filter media is controlled by an orifice disk that can be adjusted from 5 to 15 gallons per minute. After traveling through the filter media, stormwater is released to discharge into a pipe. The unit is sized according to peak flow designed for treatment. The peak flow is based on hydrologic characteristics of the contributing watershed and the design storm. The unit size is indirectly related to the peak flow; size increases for additional filter cartridges required to treat larger peak flows.

The design incorporates the following features:

- Rechargeable media-filter cartridges
- Flow control orifice disk at base of cartridge
- 5 basic design configurations

Product Examples (cont.)

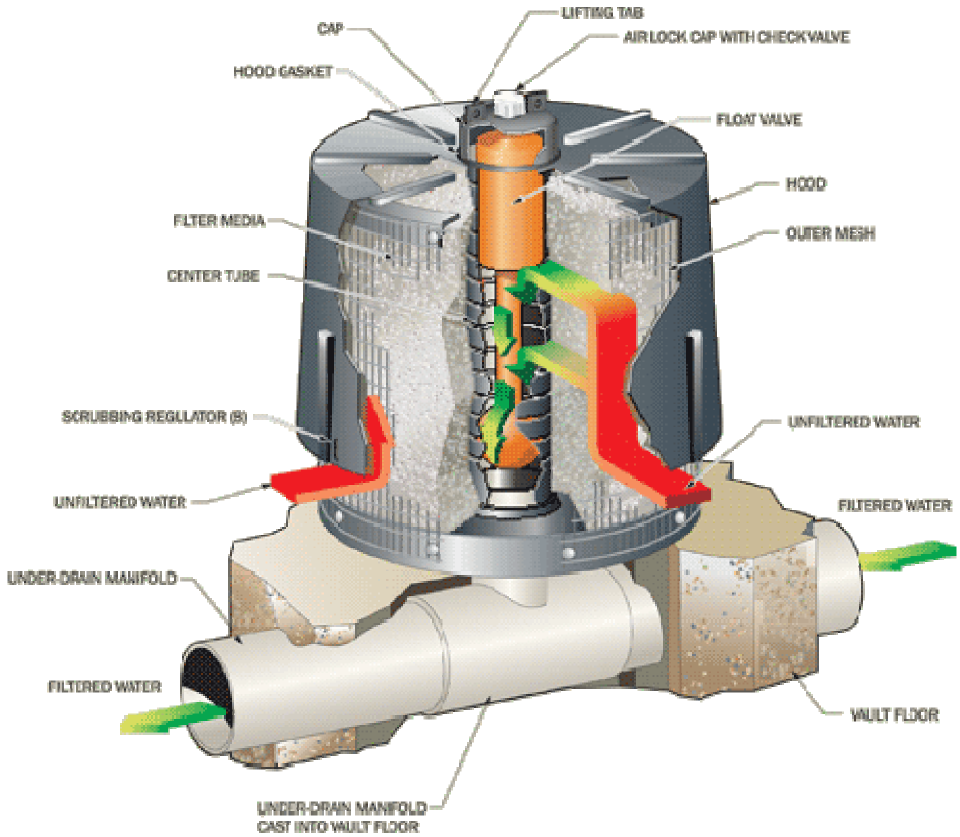


Figure PTP-06-03 Filtration Unit, StormFilter® Schematic
Source: University of Massachusetts Amherst Stormwater Technologies Clearinghouse, www.mastep.net.

Removal efficiency performance is compared in Table PTP-06-02.

Table PTP-06-02 Performance Comparison
Source: University of Massachusetts Amherst Stormwater Technologies Clearinghouse, www.mastep.net.

Pollutants Addressed	Manufacturer's Removal Efficiency Claim (%)	Minimum Particle Size	Tested Removal Efficiency (%)
Total suspended solids	50-85%	-	79 %
Zinc	20-60%	-	64 %
Copper	20-60%	-	59 %
Hydrocarbons	74%	-	-

Product Examples (cont.)

Continuous Deflection Separator: *CDS® Inline Unit, a product by CDS Technologies®, Inc.*

This continuous deflection separator unit (Figure PTP-06-04) is installed beneath one manhole access point. The unit promotes gravitational separation of particles using a swirl action in its cylindrical tank and through a screen. Sediments settle into the separation chamber at the base of the unit. For flows greater than the treatment capacity, a bypass through the system is available.

The design incorporates the following features:

- Cylindrical grit chamber
- Flow bypass
- Separation chamber
- Small footprint area required

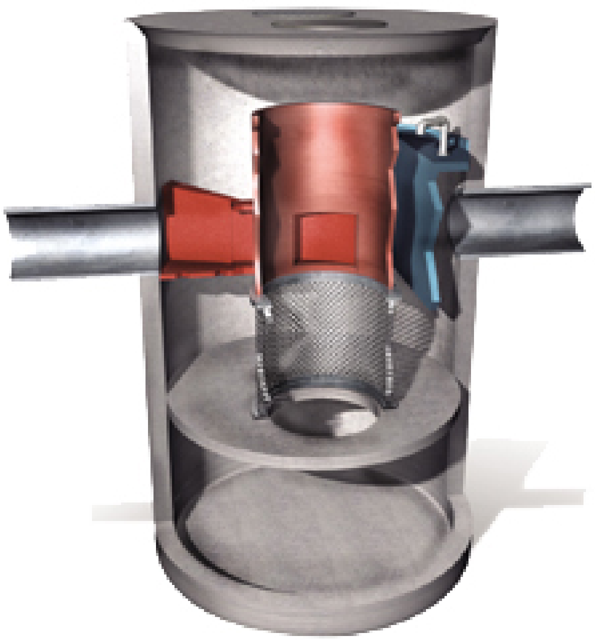


Figure PTP-06-04 Continuous Filtration Separator Unit, CDS® Inline Unit Schematic
Source: University of Massachusetts Amherst Stormwater Technologies Clearinghouse, www.mastep.net.

Product Examples (cont.)

Removal efficiency performance is compared in Table PTP-06-02.

Table PTP-06-03 Performance Comparison

Source: University of Massachusetts Amherst Stormwater Technologies Clearinghouse, www.mastep.net.

Pollutants Addressed	Manufacturer's Removal Efficiency Claim (%)	Minimum Particle Size	Tested Removal Efficiency (%)
Total suspended solids	80%	-	73.7 %
Oil and grease	83-86%	-	-
Debris - floatables	100%	-	-

Installation

A representative from the company who manufactured the water quality unit should be present during installation activities. Installation of the water quality unit should be conducted by a qualified individual under the supervision of the representative from the unit's manufacturer.

Maintenance

Water quality units are reliable and relatively low maintenance systems due to their design with no moving parts. Maintenance is primarily needed to clean the system of debris and pollutants to keep it working properly. When not properly maintained, water quality units have a high failure rate.

Maintenance and inspections should be conducted regularly after storm events to ensure the long term functionality of the system. By inspecting the unit before and after a significant rain event, the amount and the types of materials being captured can be monitored. This practice can aid in scheduling maintenance based on physical observation and attention to rainfall frequency. Consideration should also be placed on droughts or dry periods, where accumulation of pollutants can build up and create large amounts of floatables, debris, sediment, oils, hydrocarbons, and other pollutants during first-flush events.

Access to manholes should be clear and unobstructed to allow vacuum trucks to perform maintenance to the unit.

Semi-Annual Maintenance

- Inspect unit for sediment buildup and structural damage

Standard Maintenance

- Remove sediment and debris from unit via vacuum truck, sump vac or other means
- Increase maintenance schedule to remove debris during heavy leaf fall or other seasonal accumulation of trash or debris

Appendix A

LIST OF RELATED WEBSITES / TECHNICAL RESOURCES

National Menu of Best Management Practices for Stormwater Phase II,

http://cfpub.epa.gov/npdes/stormwater/menuofbmps/menu.cfm

United States Environmental Protection Agency, NPDES Site, http://cfpub.epa.gov/npdes/index.cfm

United States Environmental Protection Agency, www.epa.gov

The City of Somerset, www.cityofsomerset.com

Kentucky Division of Water, www.water.ky.gov

Occupational Safety and Health Administration, www.osha.gov

United States Coast Guard, www.uscg.mil

National Clean Boating Campaign, www.cleanboating.com

Tennessee Valley Authority Clean Marina Guidebook, www.tva.com/environment/water/boating.htm

United States Army Corp of Engineers, www.usace.army.mil

United States Geological Survey, www.usgs.gov

Center for Watershed Protection, http://www.cwp.org/

Fuller, Mossbarger, Scott and May Engineers, Inc., www.fmsm.com