DECISIONMAKER'S STORMWATER HANDBOOK

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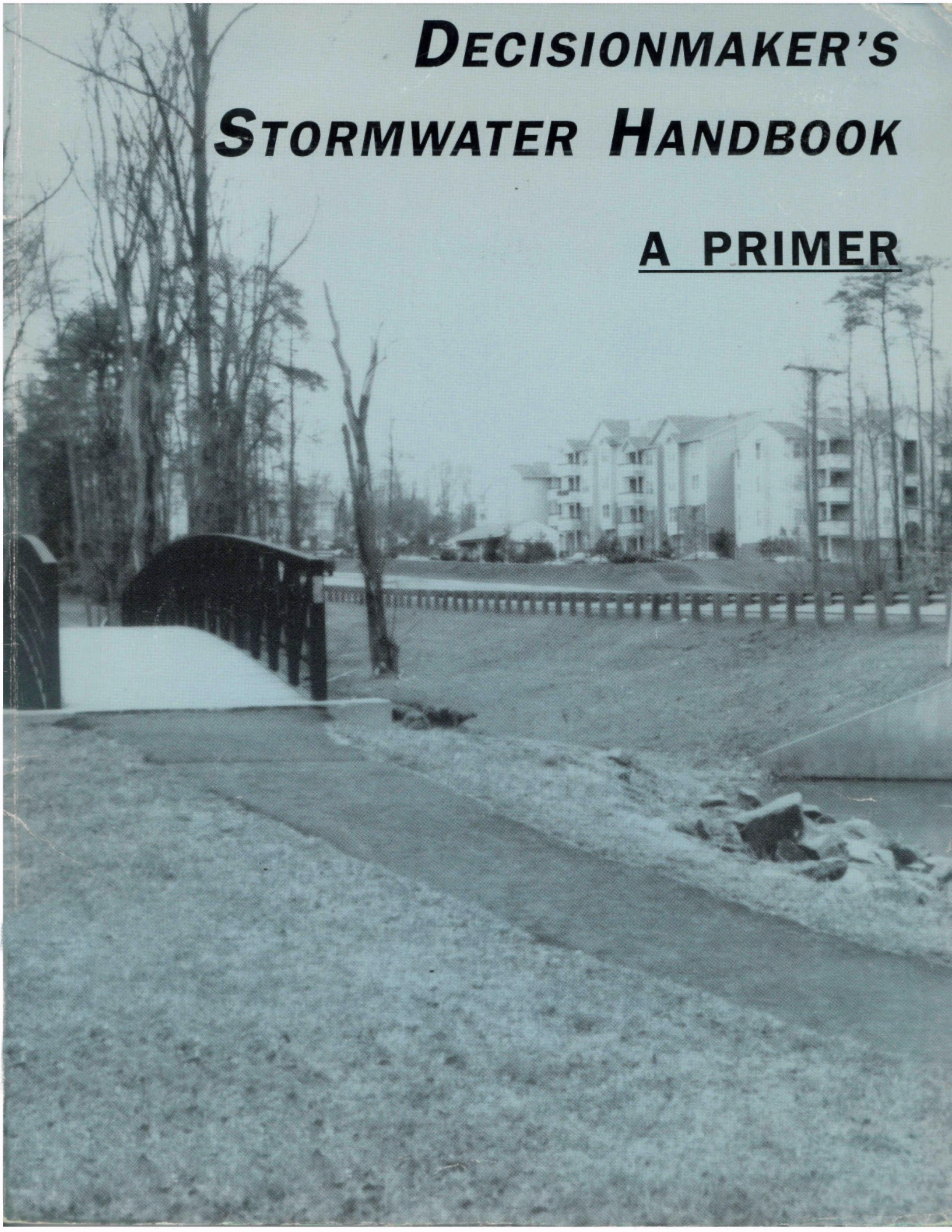

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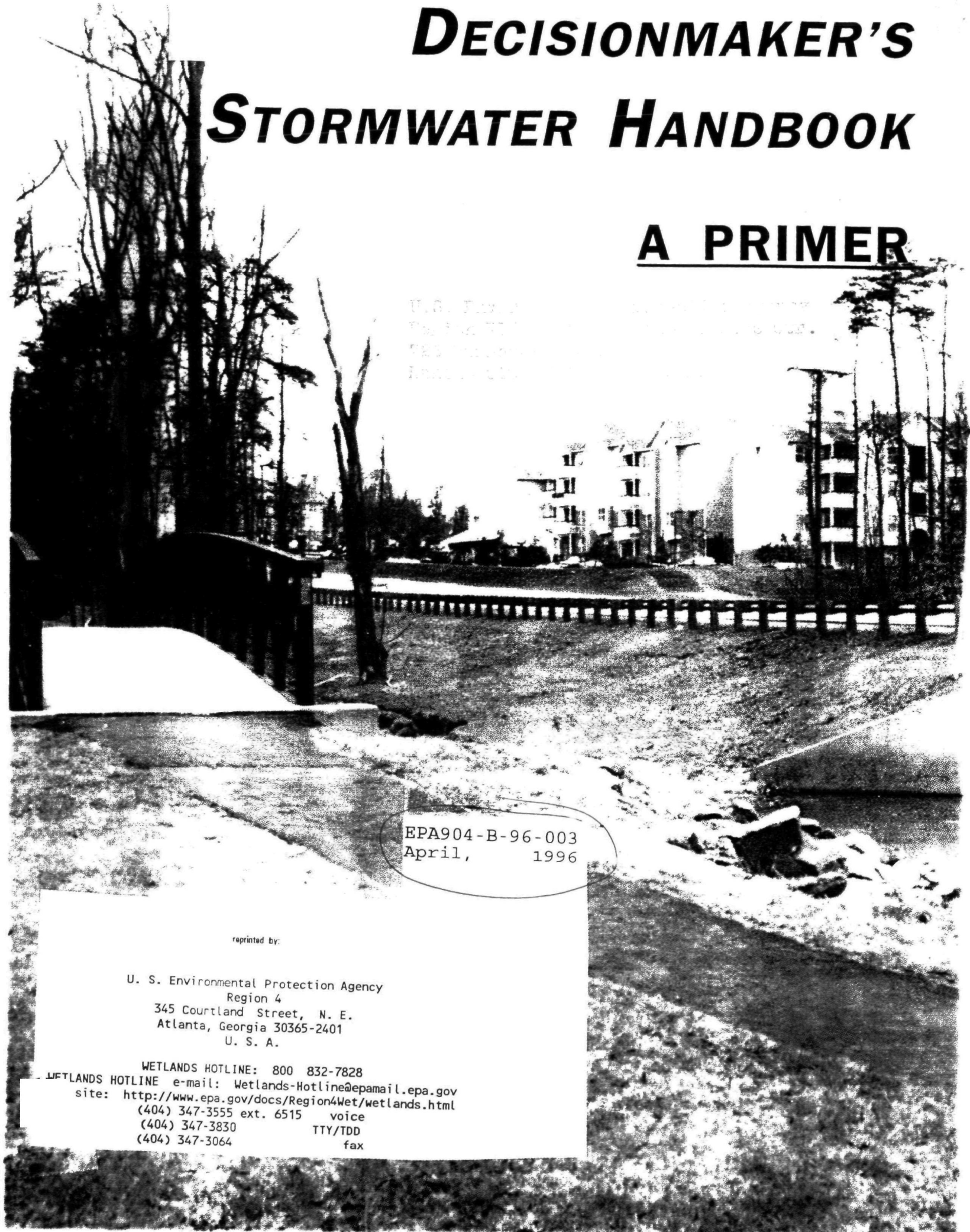

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CONTENTS

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PREFACE

With increased environmental awareness, more citizens have become involved in making decisions on local management of our natural resources. These motivated people are shaping environmental policies and programs in communities across the country

Urban stormwater runoff is a significant source of pollution to our nation's waters Essentially, when rain falls or snow melts, water runs off the land. Our own uses of water (irrigation, cleaning) may also create runoff As this runoff travels over the land and impervious surfaces into ground and surface waters, it carries various pollutants generated from our everyday activities The scope of this problem is massive. To effectively protect our environment, we must all work together to manage urban stormwater runoff

This handbook provides simple, straightforward information on urban stormwater runoff — why it is a concern, how to control it using best management practices (BMPs), and how to get help and information. However, because stormwater management is site- and project-specific, this handbook cannot prescribe BMPs for every situation. The goal of this handbook is to make you familiar with some simple concepts: ways to protect important natural resources and identify pollutants of concern and their sources, and management practices to prevent and control pollutants

It is our sincere hope that this information will enable you to more fully address the complex problem of stormwater management (urban runoff). Local commitment and educated actions are key to the development and implementation of successful management programs Working together, we can all benefit from improvements in the quality of our water resources

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COMPONENTS OF THE HANDBOOK

This handbook is organized into two parts: water quality plans and accompanying text with background information. Each part should be used in conjunction with the other However, the text and water quality plans can also be used independently This handbook has been developed as an interactive teaching tool that encourages the reader to "jump right in "

Water Quality Plans

In this handbook you will find four water quality site plans, each representing a different water resource area groundwater, fresh water, wetlands, and salt water Each of these traditional site plans portrays a setting that includes residential, commercial, and industrial developments

A basic assumption is that runoff from the developed area will affect the resource area(s) Therefore, stormwater best management practices (BMPs) are included on the site plan to give you possible approaches that could mitigate the effects of runoff for that site and prevent pollutants from entering the water resource.

A variety of BMPs to control stormwater pollution are used throughout the plans to encourage you to group them into a system. Taken together, these BMPs offer a feasible means to control urban stormwater runoff.

Each water quality site plan includes a legend that identifies the BMPs with a number (1, 2, 3) that correlates to the numbered fact sheet in the text Each fact sheet has a picture, brief description, and general guidelines for that particular BMP

Text

The text is organized into the following sections:

- **Introduction to Stormwater Pollution** — provides a general discussion of and technical information on stormwater runoff.

- **An Approach to Stormwater Pollution Control** — discusses impacts of development, changes in water quality, and typical urban pollutants.

- **Nonstructural and Structural Best Management Practices** — contains the fact sheets that describe the BMPs. These are keyed to the index of BMPs on the water quality plans and should be used for reference.

- **Funding Mechanisms** — outlines the various funding mechanisms that could support these activities.

■ **Water Quality Checklist** — guides local officials during the review process. The checklist should be given to those involved with the project (engineers, landowners, consultants) before site plan review so their questions and concepts in this handbook can be addressed.

■ **How to Use the Water Quality Site Plans** — provides a narrative description on how to use the water quality site plans as a teaching tool.

■ **For Further Reading** — contains additional material that readers are strongly encouraged to use. Contact names and telephone numbers make it easier to access these references.

■ **State Nonpoint Source Coordinators** — lists agencies by state, with addresses and telephone numbers.

■ **Survey Sheet** — asks questions of readers to get feedback on this handbook.

INTRODUCTION TO STORMWATER POLLUTION

With development, changes in water quantity and quality within a watershed can adversely affect water resource areas Reviews of water quantity generally address changes in the rate and timing of discharge from a site (water volume and velocity), water quality reviews address changes in the composition of the discharge from a site (pollutants of concern) General problems from both water quantity and quality perspectives as well as information on the pollutants of concern are provided on the following pages

Impacts of Urbanization on Stormwater Runoff

Changes in Water Quantity from a Site to the Resource Area(s)

Changes in water quantity result from alterations in the site's physical characteristics This is usually caused by an increase in the percentage of impervious cover on the site, a decrease in vegetative cover, and alterations of the slope. In addition, installation of "efficient" drainage devices, such as gutters and pipes, contributes to this problem. These changes can result in the following:

- Increased velocity of stormwater runoff, which can cause numerous problems, including an increase in the frequency and severity of flooding, accelerated channel erosion both locally and downstream, and alteration of the streambed composition
- Reduced infiltration into the ground that depresses the underlying water table (affecting groundwater recharge) and, in turn, lowers the level of surface waterbodies dependent on groundwater discharge, such as surrounding lakes, streams, and wetlands. (This is commonly referred to as a decrease in base flow)
- Increased volume of stormwater runoff, which, when combined with higher velocity, accelerates the rate of channel erosion and changes in streambed composition These changes could result in a loss of animal habitat and disruption of the natural ecology of the streams.

Changes in Water Quality from a Site to the Resource Area(s)

Changes in water quality result from changes in land use that contribute new or additional pollutants to the stormwater runoff. This can result in the following:

- Elevated nutrient inputs
- Greater contribution of solids, such as sediment

- Increased pathogens
- Introduction or increased loading of toxic substances, such as heavy metals, pesticides, oil, road salt, and synthetic organic chemicals
- Elevated inputs of organic matter
- More litter and rubbish along stream banks
- Lower levels of dissolved oxygen
- Alteration of the natural stream temperature

Typical Urban Pollutants

Nutrients

- **Contaminants:** Phosphorous and nitrogen.

- **Sources:** Septic systems, agricultural runoff (fertilizers, animal waste), and urban landscape runoff (fertilizers, detergents, plant debris)

- **Effects** Phosphorus is typically the primary nutrient of concern in freshwater systems as is nitrogen in saltwater systems. These nutrients encourage algal growth that can contribute to greater turbidity and lower dissolved oxygen concentrations. Lower dissolved oxygen can cause the release of other substances (pollutants) into the water column Higher levels of nitrogen (nitrates) in groundwater are most commonly associated with agricultural practices and malfunctioning septic systems

- **Impacts:** Can limit recreational values (swimming, boating, fishing, and other uses), reduce animal habitat, and contaminate water supplies.

Solids (suspended and deposited)

- **Contaminants:** Sediment (clean and contaminated) and floatable wastes.

- **Sources:** Construction sites, agricultural lands, and other disturbed and/or non-vegetated lands, including eroding stream banks. Floatable wastes are contributed from street litter and careless disposal practices.

- **Effects:** Increased turbidity and deposition of sediment.

- **Impacts:** When deposited, clean sediment can decrease storage capacity in waterbodies, destroy benthic habitat (including animal nesting and spawning areas), and smother benthic organisms. Suspended solids can decrease transmission of light through water, and interfere with animal respiration and digestion. Contaminated sediment acts as a reservoir for particulate forms of pollutants, such as organic matter, phosphorus, or metals that could be released later. These pollutants can be toxic or can decrease dissolved oxygen levels through the process of sediment oxygen demand (SOD). Floatable wastes reduce the aesthetic value of the resource area and can cause clogging.

Pathogens

- Contaminants: Bacteria and viruses.

- Sources: Animal waste (including pets and birds), failing septic systems, illicit sewage connections.

- Effects: Presence of bacteria and viral strains, including fecal streptococcus and fecal coliform, in high numbers

- Impacts: Can pose health risks, and close or restrict use of shellfish beds and beach areas

Metals

- **Contaminants:** Heavy metals, including lead, copper, cadmium, zinc, mercury, and chromium.

- **Sources:** Industrial activities and waste, illicit sewage connections, automobile wear, exhaust and fluid leaks, and atmospheric deposition.

- **Effects:** Increased toxicity of runoff and availability of metals that can enter into the food chain.

- **Impacts:** Metals can accumulate in certain animal tissues that could be ingested by humans or other animals. They affect sensitive animal species, plants, and fisheries.

Hydrocarbons

- **Contaminants:** Oil and grease, other petroleum-based substances, and polycyclic aromatic hydrocarbons (PAHs).
- **Sources:** Parking lots and roadways, oil leaks, auto emissions, illicit sewage connections, and illegal dumping of waste oil.
- **Effects:** Degraded appearance of water surfaces; limiting water and air interactions (lowered dissolved oxygen).
- **Impacts:** Toxic to sensitive animal species; degrades fisheries habitats.

Toxic Organics

- **Contaminants:** Pesticides, polychlorinated biphenyls (PCBs)
- **Sources:** Indoor and outdoor use, industrial activities, illicit sewage connections
- **Effects:** Increased toxicity to sensitive animal species and fishery resources
- **Impacts:** Cause loss of sensitive animal species and fishery resources

Acids

- **Contaminants:** Nitrates (NO_3), sulfides (SO_2)
- **Sources:** Incomplete combustion process coupled with atmospheric reactions (acid rain)
- **Effects:** Increased toxicity to sensitive animal species and fishery resources.
- **Impacts:** Causes loss of sensitive animal species and fishery resources.

Humic Substances

- **Contaminants:** Plant materials, such as grass clippings, and leaves.
- **Sources:** Urban and suburban landscapes.
- **Effects:** Increased loading into waterbodies of organic materials that require oxygen to decompose; lowered dissolved oxygen levels can cause the release of other substances (pollutants) into the water column.
- **Impacts:** Degrades fishery resources, and reduces fish populations.

Salt

- **Contaminants.** Sodium and chloride
- **Sources:** Road salting procedures.
- **Effects:** Increased toxicity to organisms, reduction of fishery resources, and increased levels of sodium and chlorides in surface and ground waters Could stress plant species' respiration processes through their effect on soil structure and can cause loss of other compounds necessary for plant viability.
- **Impacts:** Causes loss of sensitive animal species, plant species, and fishery resources and contaminates surface and ground waters

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AN APPROACH TO STORMWATER POLLUTION CONTROL

When determining water quantity and quality issues for any site, you should take several simple steps that, when followed, will identify the major concerns within the project area.

STEP 1
Identify the Resource Area(s)

- Determine the drainage area of concern by using topographic maps and drainage system plans
- Identify flow patterns
- Identify resource area(s) that are affected by urban stormwater runoff. Consider these potential resource areas: groundwater, fresh water, salt water, and wetlands. Consider on-site and off-site resource areas.
- Identify other critical and sensitive areas, such as stream buffers, forest conservation areas, habitats, steep slopes, and open spaces that need protection.
- Identify critical geologic features, such as permeable soils, water table, and bedrock.

STEP 2
Identify Pollutants and Their Sources

- Identify the sources of pollutants and potential pollutants within the drainage area. Stormwater runoff can contain a variety of pollutants at different levels, depending on the nature of the proposed development and the surrounding area.

MAJOR SOURCES*

POLLUTANT	AGRICULTURE	RESIDENTIAL	INDUSTRIAL/ COMMERCIAL
Acids			X
Pathogens	X	X	
Humic substances	X	X	
Hydrocarbons		X	X
Metals		X	X
Nutrients	X	X	
Salt		X	X
Solids	X	X	X
Toxic organics	X	X	X

* The above matrix identifies major sources of pollutants commonly found in stormwater runoff. It is important to note that all of the pollutants could be found in a given area. You must identify those pollutants (and their sources) that are of greatest concern, based on the resource area to be protected and its use.

STEP 3
Consider Effects to Resource Area(s)

When considering the possible effects to the resource area, identify the pollutants of concern and prioritize them based upon the designated use of the resource area. Uses can include boating and similar water-related uses, swimming, wildlife habitat, fisheries, shellfishing, and water supply.

- **Freshwater Areas** *(including lakes, ponds and streams).* Areas sensitive to increased nutrient levels (phosphorus, primarily), sediment (scour and deposition), and bacterial discharges.

- **Salt Water Areas** *(including estuarine systems and salt water ponds).* Areas sensitive to increased nutrient levels (nitrogen, primarily), sediment deposition, bacterial discharge, and heavy metals.

- **Groundwater Areas** *(including aquifers and contribution zones to public and private wells).* Areas sensitive to increased nitrate, sodium, chloride, and pesticide levels.

- **Wetlands Areas** *(including freshwater and saltwater wetland systems).* Areas sensitive to sediment, hydrocarbons, and heavy metals.

STEP 4
Identify the Water Quality Design Storm

- Select the appropriate design storm to ensure adequate water quality control

- Compare the water quantity requirements with the water quality needs of the resource area.

Water quality design storms focus on the smaller and more frequent events (1-month to 3-year storms) as compared to the typical water quantity design storm of 25 years. These smaller storms can account for as much as 80 to 90 percent of the annual rainfall and as much as 75 percent of the total volume of rainfall in the area.

At a minimum, the BMP should be designed to effectively treat the "first flush" of stormwater runoff — generally defined as the first half-inch of runoff from a site. The first flush volume can carry a high percentage of the pollutant load for that storm event.

Selecting a design storm requires consideration of regional and/or local variables, including precipitation levels, inter-event dry periods, degree of imperviousness, and soil types.

STEP 5
Consider Pollutant Loads

- Avoid the common trap: "It's only a little bit, it won't hurt the resource area." A natural system will have a maximum assimilative capacity and only can accept a certain pollutant load.

- A careful review for stormwater management will consider pollutant loading to the system.

STEP 6
Identify Best Management Practices

- Identify which BMPs are appropriate for the pollutants of concern, the conditions of the site, and desired goals/objectives for resource protection Develop a BMP system

- BMPs can be pollutant-specific, therefore, a single BMP may not remove all pollutants found in stormwater runoff

- BMPs have different removal efficiencies. Depending on the degree of protection required, you may need to use multiple practices.

- BMPs have site-specific limitations; not all BMPs will work in any given situation. Factors such as soil type, depth to groundwater, and topography should be considered and may limit your choices.

- To address site-specific needs and limitations, design a system of BMPs that will effectively prevent or remove pollutants at the desired level. For

example, your review prescribes treatment for solids and dissolved metals in runoff from a development under construction to a surface water reservoir. An appropriate system could be a temporary sedimentation basin, followed by vegetated swales, then a wet pond, and finally discharge to the receiving water. Taken together, such a system might be the best available treatment for the stormwater runoff.

STEP 8
Review Existing and New Development

A review for stormwater management can include existing as well as new development. Implementing water quality BMPs in existing developed areas is commonly referred to as retrofitting; this can include modification of existing practices (such as detention basins) and construction of new BMPs — dry wells, filter strips, or infiltrative practices, for example. Retrofitting can be incorporated easily during redevelopment or when deemed appropriate by the landowner and/or local authority

STEP 7
Broaden Your Horizons

When reviewing a specific site, remember that adjoining land uses and, in most cases, all land uses within an entire watershed will affect the resource area. A proper water quantity and quality review considers the entire watershed, its uses, and the cumulative impact on the water resource.

- Review the site and determine volume and pollutant loading characteristics.
- Consider the effect of adjoining land uses within the project site's drainage area in a review of the sub-drainage area.

Selection of appropriate BMPs for the new site will depend on the designated use of the resource area. Also consider the cumulative impact of all land uses to the resource area.

STEP 9
Always Remember . . .

The amount of mitigation necessary and appropriate at each site will differ because of variations in site conditions and the economics involved in the particular project. All facets, including existing development, affected resource areas (including their present and potential use), and the nature and scope of the project should be considered All the stormwater management options shown or referred to on the water quality plans are not always essential for all proposed projects BMPs should be determined based on the particular water resource area that receives the stormwater discharge.

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NONSTRUCTURAL AND STRUCTURAL BEST MANAGEMENT PRACTICES

This section contains eight fact sheets that describe common best management practices (BMPs) to prevent or control contamination of runoff The practices include.

Each BMP identified on the water quality plans is keyed to a fact sheet for reference. Some of the fact sheets have a number of related BMPs. For example, the fact sheet on infiltration practices describes infiltration basins, trenches, islands, and various subsurface structures. All of the BMPs described are found on the water quality plans.

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FACT SHEET 1

NONSTRUCTURAL BMPs

Introduction

This fact sheet discusses best management practices that seek to prevent contamination of runoff. Through maintenance, education, or planning and design, these BMPs reduce the generation and accumulation of pollutants on impervious areas and the amount of such areas

Implementing these BMPs requires cooperation and participation from municipal personnel, project proponents, and the public. The use of nonstructural BMPs to prevent pollution has proven a very cost-effective way to manage stormwater runoff

These BMPs act to reduce the contribution of pollutants from sources and, in some cases, remove pollutants The following pollutants can be controlled by nonstructural BMPs·

- Nutrients
- Oil and grease
- Sediment
- Toxic chemicals
- Trace metals
- Bacteria
- Litter

Major nonstructural (also called source control) BMPs are described in this fact sheet and listed by those people who usually implement these practices: community governing bodies, public works departments, and private citizens.

Public education programs can be considered a nonstructural BMP that should be implemented for everyone. People can learn to properly dispose of litter, yard waste, oil, and other household wastes They can also learn how to use fertilizer correctly on their lawns and gardens Much pollution enters water resource areas as a result of carelessness or ignorance, which can be prevented through education

Community Governing Bodies: Boards of Health, Zoning, Conservation, and Planning

Protection Areas

- **Buffer Zones** Buffer zones around sensitive water resource areas can help reduce the impact of urban runoff. Forested and grassed areas around waterbodies can trap pollutants, encourage infiltration, and reduce erosion. Buffer zone regulations generally are part of community and state wetland protection laws, wellhead protection programs, and public surface drinking water programs.

- **Setback Requirements**. Setback requirements are discrete distances traditionally administered by boards of health

and zoning boards to protect human health needs. They also can be used to protect resource areas, ensure ecological integrity, and avoid concentration of flood flows.

- **Easement.** Easements are an alternate method to protect land areas around critical resources. Easements are an effective tool to use with designated buffer zones and setbacks. Traditionally, the easements are negotiated with individual landowners and included as part of the deed to the property.

- **Critical Areas.** Critical areas, including riparian zones, can be designated to maintain the quality of the resource area as well as sustain animal habitat. Once designated, these areas require long-term protection. Typically, planning boards, conservation commissions, and other local units of government are responsible for critical area management.

Land Use Planning/Zoning

Land use planning/zoning seeks to balance development needs with the needs of the resource area. Communities may restrict activities or set aside critical land near waterbodies that are important to protect. This can be accomplished by watershed protection plans and cluster development. Resource-based master planning can allow development while minimizing the effects of urbanization. However, it is critical that the community determine the level of protection needed to ensure long-term viability of its resource areas

The mechanisms to protect resource areas will usually involve boards and commissions that are responsible for wetlands management, planning, zoning, groundwater management, and boards of health.

Reduced Impervious Areas

Pollution from urban runoff increases when areas are covered with impervious materials that collect pollutants and then release them during rainstorms or when snow melts. Impervious areas can be reduced by incorporating open spaces into urban areas, protecting wetlands, and using alternatives to impervious surfaces, such as gravel or porous pavement. An important goal for everyone should be to minimize directly connected impervious areas, which will help reduce storm flow volumes and velocity and, if properly implemented, pollutant loadings. Zoning regulations can be used to ensure that new developments include vegetated open space.

Comprehensive Site Planning

Many problems related to site development can be minimized by careful site planning. This includes such concepts as fingerprinting (identifying total area to be developed within the subdivision, including septic systems, roadways, houses, and other appurtenances), minimum tree coverage requirements, maximum site disturbance requirements, steep slope protection, phased development, and seasonal development.

Sanitary Waste Management

Decisions related to the installation of community sanitary sewers and management of privately owned on-site disposal systems can be critical to maintaining the integrity of the resource area. Sewering critical areas and requiring proper septic system placement can reduce or eliminate the potential for pollutants to enter the resource area. Frequent inspections and cleaning can increase the longevity and efficiency of septic systems, thereby reducing pollution.

Department of Public Works

Catch Basin Cleaning

Most municipalities clean catch basins periodically. However, pollutants that collect in catch basins between cleanings can be resuspended during a rainfall. More frequent cleanings can help to mitigate this problem,especially in areas surrounding sensitive water resources.

Low Salt Application

Deicing salts used on roadways can adversely affect water resources. Stormwater management programs should specify low salt applications or salt substitutes in especially sensitive

areas. Many communities already restrict salt use near surface drinking water supplies.

Street Sweeping

Many communities sweep streets regularly, but generally for aesthetics rather than water quality control. Studies by the Nationwide Urban Runoff Program indicated that streets must be swept twice a week to noticeably reduce pollutant discharges in runoff; however, even this frequency by itself did not produce high removal rates. To be effective, street sweeping should be incorporated into runoff quality control programs.

Private Citizens

Animal Waste Collection

Animal wastes, usually from pets, are a source of bacteria in urban runoff. The level of bacteria can be lowered by reducing or eliminating waste left where it can be washed into the runoff. Regulations requiring collection and proper disposal of pet wastes from yards, parks, roadways, and other urban areas can help prevent this problem.

Reduced Use of Pesticides and Fertilizers

Pesticides can be toxic to certain animal species, and fertilizers can contribute nutrients to waterbodies Pesticides and fertilizers containing nitrogen have contaminated drinking water Agricultural practices are a source of these pollutants. Use of these products in urban areas is usually at a rate of application two to three times greater than that used for agriculture This increases the likelihood that pollutants may enter the water resource area.

Communities can lower the impact of these substances on receiving waters by reducing their use and switching to slow release fertilizers.

Neighborhood Recycling Programs

These programs are designed to remove pollutants from urban and rural households. This can include recycling cans, bottles, and plastics, which often end up as floatable material in stormwater, and composting yard wastes (grass clippings and leaves). Also, household hazardous waste collection and proper disposal of wastes, such as used oil and antifreeze, ensures that these pollutants do not enter the pollutant stream.

Industrial and Commercial Waste Management Program

Industrial and commercial sites can also be involved in good housekeeping practices. Removal of hazardous substances can prevent pollutants from entering stormwater runoff. Maintaining a clean area can reduce the amount of floatable materials found in stormwater.

Conclusion

Implementing the BMPs presented in this fact sheet require a strong commitment from local officials and extensive planning and community cooperation Some of these BMPs also require conferences with the project proponent. Community review boards must investigate development plans closely to determine if nonstructural BMPs are included. Residents living in areas close to water resource areas must also be aware of their responsibility to protect these resources.

Nonstructural BMPs should be used in conjunction with well-planned structural BMPs Comprehensive stormwater pollution control should include aspects of nonstructural BMPs to be successful

Additional Information

Metropolitan Washington Council of Governments, Department of Environmental Programs 1987. Controlling Urban Runoff A Practical Manual for Planning and Designing Urban BMPs $40. 777 N. Capitol Street, NE, Suite 300, Washington, DC 20002-4201, (202) 962-3256

Pitt, D.G, W G Gould, and L. LaSota. 1986. Landscape Design to Reduce Surface Water Pollution in Residential Areas Water Resources 32. Single copies free; bulk orders 20¢ per copy. University of Maryland, Agricultural Duplicating Services, 6300 Sheridan Street, Riverdale, MD 20737; (301) 403-4263.

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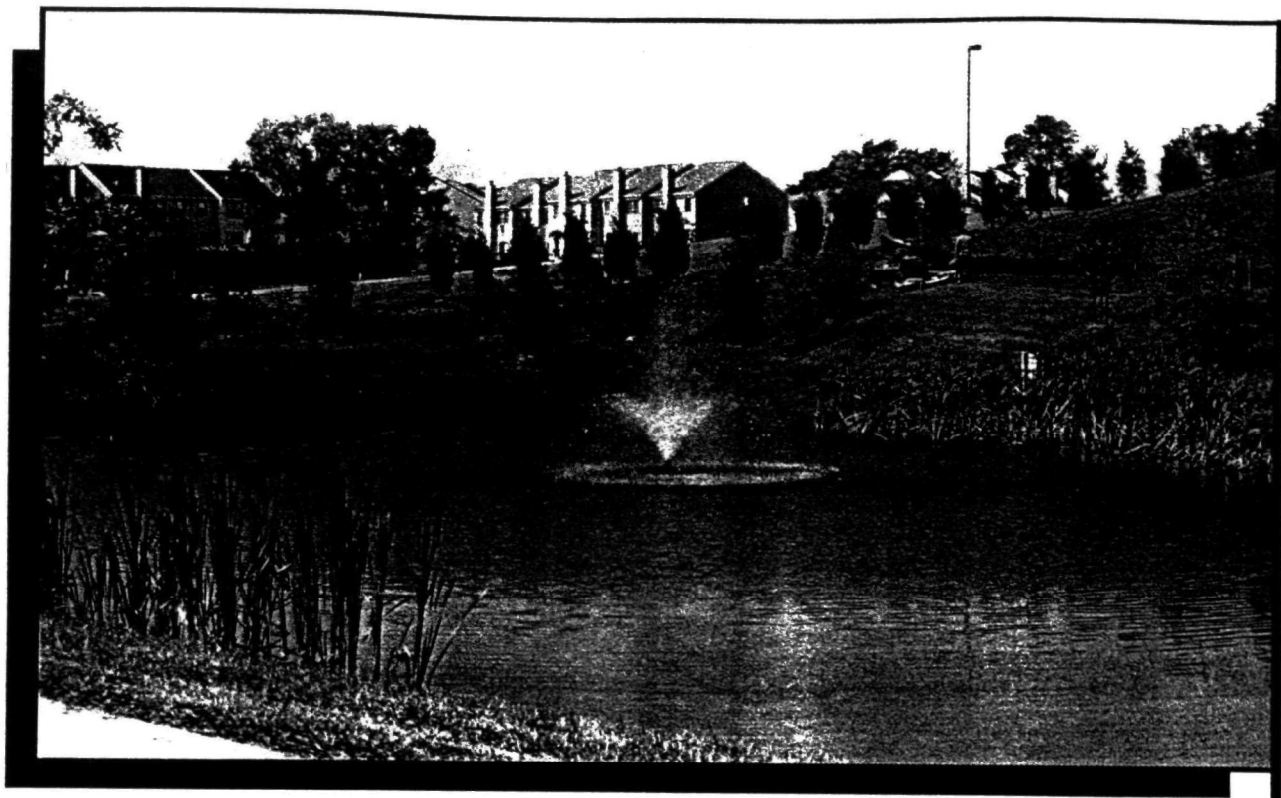

FACT SHEET 2

WET POND DETENTION BASINS

Introduction

This fact sheet discusses the characteristics, physical requirements, and design guidelines for wet pond detention basins (also known as wet ponds, retention ponds, wet detention basins, and detention ponds).

In a wet pond, stormwater runoff is directed into an artificially constructed or enhanced natural pond, where a permanent pool of water is maintained. During a storm event, the pool volume is increased until the capacity is exceeded. When this occurs, excess runoff is discharged through an outlet or emergency spillway.

Pollutant Removal

Wet ponds can remove the following pollutants:

- Suspended solids
- Total phosphorus
- Total nitrogen
- Trace metals, both particulate and dissolved

Wet pond pollutant removal mechanisms include:

- **Settling:** When the pond detains runoff, particulates and associated pollutants accumulate, or settle, within the pond. Additional stormwater entering the pond displaces the runoff, but the settled material remains.

- **Vegetative uptake:** Aquatic plants in wet ponds often remove nutrients and other pollutants from the runoff before it is discharged to the receiving water. The amount of vegetation in a wet pond can be

limited to that which is established naturally or enhanced by additional plantings.

Studies indicate that properly designed wet pond detention basins can be expected to remove pollutants effectively at the maximum removal rates as follows:

- Suspended solids: up to 98 percent
- Total phosphorus: up to 70 percent
- Total nitrogen: up to 48 percent
- Lead: up to 95 percent
- Biochemical oxygen demand (BOD), zinc, and copper: up to 45 percent

Physical Requirements

To be effective, wet ponds require:

- **Large amounts of land:** Wet ponds generally are better suited for new development projects with large amounts of open land.

- **Non-porous soils:** Since wet ponds must maintain a pool of water, they should not be built in areas with porous soils. Filtration can be prevented by constructing the pond bottom below the normal groundwater elevation or by using synthetic, impermeable materials or clay.

- **Level topography:** Wet ponds are not suited to areas with extreme slopes; therefore, sites should be relatively flat

- **Operation and maintenance:** To operate and maintain a wet pond properly

  - Remove accumulated sediments every five to six years or as necessary
  - Inspect, clean, and repair inlet and outlet structures
  - Inspect and repair pond bottom
  - Control erosion (regrade, revegetate, replace riprap)
  - Remove debris and litter
  - Control nuisance insects, weeds, odors, and algae
  - Harvest deciduous vegetation prior to onset of fall, as necessary

Design Guidelines

Principles of wet pond design include the following:

- **Multiple levels:** Wet ponds generally have a multi-level design.

  - ***First level:*** contains the permanent pool of water.
  - ***Second level:*** contains the flat, vegetated inundation area to be used during storms.
  - ***Third level:*** also should be vegetated but is inundated only during extremely heavy storms.

- **Sizing rules:** These rules specify the volume of runoff to be detained during a storm. Different government agencies specify different sizing rules, but none of these rules should be considered a design standard

- **Spillways:** Wet ponds should contain emergency spillways to prevent flooding from large storms

- **Sediment forebays:** Sediment forebays are areas or structures that trap larger sediment particles. They can be located upstream or incorporated into the wet pond. These BMPs can be easily cleaned to improve efficiency

- **Separated inlets and outlets:** Inlet and outlet structures should be constructed as far away from each other as possible — preferably at opposite ends of the pond — to prevent short circuiting and increase detention time

- **Other factors:** These factors, which are discussed in the references listed at the end of this section, include:

  - Vegetation
  - Side slopes
  - Depth
  - Shape
  - Buffers

Additional Information

For more information on characteristics or design of wet ponds, refer to the following publications:

Maryland Association of Soil Conservation Districts. 1987. Stormwater Management Pond Design and Construction Manual. $15. Howard Soil Conservation District, 9025 Chevrolet Drive, Ellicott City, MD 20142; (410) 465-3180.

Maryland Department of the Environment. 1986. Feasibility and Design of Wet Ponds to Achieve Water Quality Control. $3. Fiscal Services Division, Cash Receipt Unit, 2500 Broening Highway, Baltimore, MD 21224; (410) 631-3553.

Metropolitan Washington Council of Governments, Department of Environmental Programs. 1987. Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs. $40. 777 N. Capitol Street, NE, Suite 300, Washington, DC 20002-4201; (202) 962-3256.

U.S. Department of Agriculture, Soil Conservation Service. Field Office Technical Guide. Contact your state or county office listed in the phone book under U.S. Government, Department of Agriculture.

———. Engineering Field Manual. Contact your state or county office listed in the phone book under U.S. Government, Department of Agriculture.

———. 1986. Revised Urban Hydrology for Small Watersheds. Technical Release No. 55. $29. Order #PB87101580. U.S. Department of Commerce, National Technical Information Service, Springfield, VA 22161; (703) 487-4650.

U.S. Environmental Protection Agency. 1986. Methodology for Analysis of Detention Basins for Control of Urban Runoff Quality. EPA 440/5-87-0001. Free. Urban Sources Section (WH-553), 401 M Street, SW, Washington, DC 20460; (202) 260-7085.

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FACT SHEET 3

DRY POND DETENTION BASINS

Introduction

This fact sheet discusses how dry pond detention basins (also known as dry ponds, dry detention basins, and dry retention ponds) remove pollutants; their design, physical, and maintenance requirements; and how to retrofit flood control dry ponds.

Pollutant Removal

Dry ponds can remove the following pollutants:

- Total phosphorus
- Total nitrogen
- Suspended solids
- Trace metals
- Hydrocarbons
- Bacteria

Removal mechanisms for pollutants include:

- **Settling:** Dry ponds are designed to store runoff before discharging it. During this time, heavier particles settle out, thus removing suspended solids and pollutants, such as metals that are attached to the particles.

- **Infiltration:** In some dry ponds, stored runoff is discharged through perforated pipes under the pond bottom or porous media, thereby providing some minor filtration.

- **Vegetative uptake:** Some dry ponds are designed with vegetated areas that filter and absorb pollutants. These vegetated areas can be established naturally or enhanced through plantings.

Field studies indicate that dry pond detention basins can be expected to remove pollutants within the following ranges:

- Suspended solids: 50 to 70 percent
- Total phosphorus: 10 to 20 percent
- Total nitrogen: 10 to 20 percent
- Lead: 75 to 90 percent
- Zinc: 30 to 60 percent
- BOD: 20 to 40 percent
- Hydrocarbons: 50 to 70 percent
- Bacteria: 50 to 90 percent

Physical Requirements

To be effective, dry ponds require:

- **Large amounts of land:** Since dry ponds require a large expanse of land, it is easier to locate them in new developments.

- **Gentle slopes:** Side slopes should be no greater than 3:1 to prevent erosion during larger storms and allow for easier mowing. Steeper banks should be riprapped to prevent washouts.

- **Porous soils:** Dry ponds need permeable soils (or alternatives such as underdrains) to avoid problems with standing water. If the bedrock layer is too close to the surface of the soil, excavating a dry pond may be both expensive, difficult, and ultimately ineffective. Soil borings can determine the depth of bedrock

- **Operation and Maintenance:** To operate and maintain a dry pond properly:

  - Mow the slopes periodically and check for erosion
  - Inspect the pond regularly for sediment buildup and vegetative overgrowth, and clear them away
  - Remove debris and litter, which can clog control devices
  - Periodically unclog extended detention control devices

Design Guidelines

Principles of dry pond design include the following:

- **Proper sizing:** Desired detention time and volume of runoff are the most important criteria when determining the size of dry ponds. One example of a sizing rule comes from the Maryland Department of the Environment, which specifies that water quality dry ponds must allow the runoff volume generated from the one-year, 24-hour storm to be released over a minimum of 24 hours.

- **Aboveground outlet structures:** These are less susceptible to clogging and easier to maintain. Otherwise, separated inlet and outlet structures should be used.

- **Sediment forebay:** Sediment forebays are areas or structures that trap larger sediment particles. They can be located upstream or incorporated into the wet pond. These BMPs can be easily cleaned to improve efficiency.

- **On-site disposal areas for sediment:** These disposal areas should be capable of holding sediment from at least two cleanout cycles. The manual prepared by the Metropolitan Washington Council of Governments (1987) describes a simple way to calculate sediment disposal requirements.

- **Maintenance right-of-way:** The Metropolitan Washington Council of Governments suggests a public or private right-of-way for maintenance access that has a minimum width of 10 feet and maximum slope of 15 percent. Lack of proper access can lead to expensive disputes over damage to residential property.

- **Retrofitting:** Dry ponds originally designed for water quality control generally provide little treatment for small storms

because the outlets are designed to allow these storms to flow directly through the pond. Retrofitting these systems with new outlet structures can sometimes be an efficient way of converting the flood control structure to one that will control runoff pollution. However, communities must ensure that the overflow capacity of the pond is maintained. If the existing structure was designed to handle flows from the 25-year storm before overflowing into an emergency spillway, these conditions should be maintained after the retrofit of the dry pond; otherwise, it may no longer serve its original flood control function. Study of the hydraulic characteristics of the dry pond will probably be necessary to ensure this condition.

Other than retrofitting the outlet structure, some form of temporary storage can be provided for smaller storms by building a small stone berm around the existing outlet structure. In this way, smaller storms can be detained before being released rather than flowing directly through the pond, as in many current systems

Additional Information

For more information about the processes, design, and maintenance of water quality dry ponds, refer to the following publications:

Maryland Department of the Environment. 1991. Standards and Specifications for Soil Erosion and Sediment Control. $11.25. Steve Kay, Maryland Sediment and Stormwater Administration, 2500 Broening Highway, Baltimore, MD 21224; (410) 631-3553.

Metropolitan Washington Council of Governments, Department of Environmental Programs. 1987. Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs. $40. 777 N. Capitol Street, NE, Suite 300, Washington, DC 20002-4201; (202) 962-3256.

U.S. Department of Agriculture, Soil Conservation Service. Field Office Technical Guide. Contact your state or county office listed in the phone book under U.S. Government, Department of Agriculture.

———. Engineering Field Manual. Contact your state or county office listed in the phone book under U.S Government, Department of Agriculture.

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FACT SHEET 4

ARTIFICIAL WETLANDS

Introduction

Artificial wetlands (also known as created or constructed wetlands, artificial marshes, and artificial wetland systems) can treat stormwater runoff effectively because they combine the pollutant removal capabilities of structural stormwater controls with the flood attenuation provided by natural wetlands. Careful design, including configuration, the choice of vegetation, and potential pretreatment requirements, is crucial to these systems' effectiveness.

Pollutant Removal

Artificial wetlands remove the following pollutants:

- Suspended solids
- Nutrients
- Oil and grease
- Bacteria
- Trace metals

These wetland systems remove pollutants through:

- **Settling:** Wetlands reduce runoff velocity, thereby promoting settling of suspended solids.

- **Vegetative uptake:** Plants, which both remove and filter pollutants, often function as part of the denitrification process that removes nitrogen. The level of efficiency and types of pollutants filtered vary with the kinds of plants growing within the system. Cattails, bulrushes, and canary grass are among the most commonly used wetland plants.

Artificial wetland systems can be highly efficient when constructed and maintained properly. These systems can be expected to achieve or exceed the pollutant removal rates as estimated for wet pond detention basins.

- Suspended solids: up to 98 percent
- Total phosphorus: up to 70 percent
- Total nitrogen: up to 48 percent
- Oil and grease: up to 90 percent
- BOD: up to 45 percent
- Trace metals: up to 95 percent

Physical Requirements

To function effectively, artificial wetlands require:

- **Large amounts of undeveloped land:** A large area is needed to provide sufficient water storage; therefore, it is easier to incorporate wetland systems into new developments rather than retrofit them into existing developed areas.

- **Dry weather source of baseflow:** A minimum baseflow should be provided for the wetland system to survive during periods of dry weather.

- **Operation and maintenance:** Artificial wetlands require regular maintenance to operate effectively, including:

  - Periodic sediment removal and
  - Harvesting of dead vegetation. If these plants are allowed to decay, pollutants that were taken up will be recycled back into the water.

Design Guidelines

Because using wetland systems to control stormwater runoff is relatively new and wetland function is not yet fully understood, universally accepted design criteria do not exist. However, some general guidelines are important to wetland design, including the following:

- **Maximize detention time:** The Rhode Island Department of Environmental Management has recommended that wetland systems be designed for 24-hour detention during the one-year storm. This allows more sediments to settle, while plants can absorb greater amounts of nutrients and other pollutants. Runoff travel time can be increased by reducing the gradient over which water flows or lengthening the distance it flows before discharge.

- **Separate inlets and outlets adequately:** If the distance separating the inlet and outlet is not sufficient, flow entering the wetland may not be fully mixed during large rainstorms. This phenomenon, known as "short circuiting," can greatly reduce the level of treatment.

- **Provide pretreatment for sediment removal:** Sediment accumulation in wetlands can shorten their effective life; therefore, some suspended solids should be removed from the runoff before it enters the system. An area near the inflow channel can be excavated to provide a shallow pond for sediment deposition Also, a separate sediment forebay may be added to the BMP system. In addition, sloped sides will allow easy removal of both sediment and decaying plants.

- **Use live plants:** Live plants from nursery stock will take hold faster and often grow better than transplants from other wetlands. The Metropolitan Washington Council of Governments notes that stands of at least two hardy, primary plants should be put in approximately 30 percent of the total shallow area Up to three other, less aggressive species can be planted in clumps around the perimeter. New plants should be added as needed in years 1 and 3 to ensure viability of the system.

- **Variable bottom topography:** The depth of the artificial wetland should vary from -12 to +12 inches of the normal water elevation.

Additional Information

More information about artificial wetlands can be found in the following publications:

Maryland Department of the Environment, Sediment and Stormwater Administration. 1987. Guidelines for Constructing Wetland Stormwater Basins. $2. Fiscal Services Division, Cash Receipt Unit, 2500 Broening Highway, Baltimore, MD 21224; (410) 631-3553.

———. 1987. Wetland Basins for Stormwater Treatment: Discussion and Background. $6.25. Baltimore.

Metropolitan Washington Council of Governments, Department of Environmental Programs. 1987. Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs. $40. 777 N. Capitol Street, NE, Suite 300, Washington, DC 20002-4201; (202) 962-3256.

Rhode Island Department of Environmental Management, Rhode Island Nonpoint Source Management Program. 1989. Artificial Wetlands for Stormwater Treatment: Processes and Designs. Free. 83 Park Street, Providence, RI 02903; (401) 277-2776.

Strecker, E., J. Kersnar, and E. Driscoll. In press. The Use of Wetlands for Controlling Stormwater Pollution. Prep. for U.S. Environmental Protection Agency, Region V Water Division and Office of Water Regulations and Standards, Water Enforcement and Permits, and Wetlands Protection by Woodward-Clyde, Suite 990, 111 SW Columbia, Portland, OR 97201; (503) 222-7200.

U.S. Department of Agriculture, Soil Conservation Service. Field Office Technical Guide. Contact your state or county office listed in the phone book under U.S. Government, Department of Agriculture.

———. Engineering Field Manual. Contact your state or county office listed in the phone book under U.S. Government, Department of Agriculture.

Wengrzynek, R.J. and C.R. Terrell. 1990. Using Constructed Wetlands to Control Agricultural Nonpoint Source Pollution. $20. Order #PB 92102359. U.S. Department of Commerce, National Technical Information Service, Springfield, VA 22161; (703) 487-4650.

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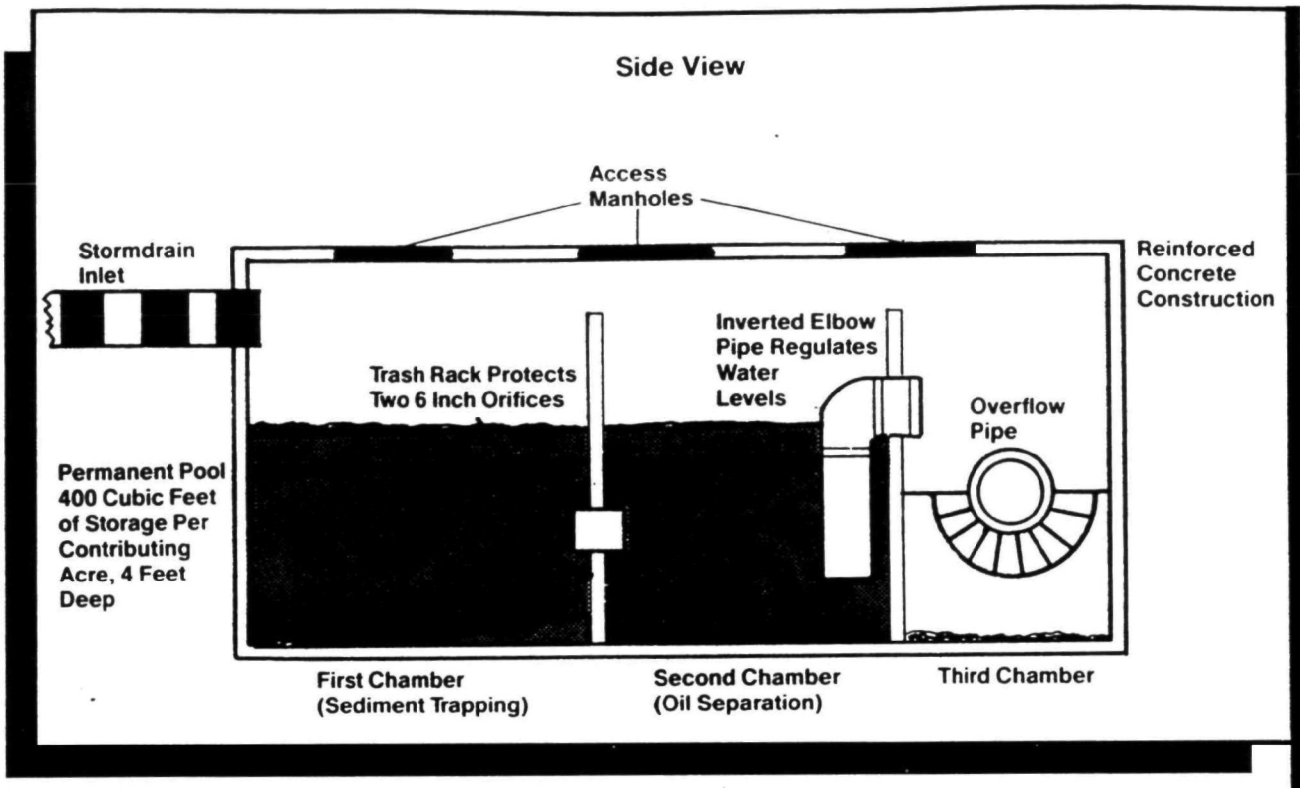


FACT SHEET 5

WATER QUALITY INLETS AND OIL AND GREASE TRAP CATCH BASINS

Introduction

Water quality inlets (also known as oil and grit separators) and oil and grease trap catch basins are underground structures that remove floatable and suspended solids.

Water quality inlets are usually found where there is vehicular traffic or gas and oil storage, such as parking lots, service stations, and loading areas.

Oil and grease trap catch basins are generally incorporated into the traditional storm sewer system. Oil and grease trap catch basins are functionally similar to water quality inlets that are described in this fact sheet.

Pollutant Removal

Water quality inlets remove the following pollutants:

- Suspended solids
- Litter
- Oil and gasoline
- Grease
- Trace metals

The primary removal mechanisms are

- **Settling:** In these inlets, runoff flows through three chambers, which slow its movement and allow matter to settle.

- **Separation:** The baffles and elbows within the inlets skim pollutants off the surface of the runoff.

Limited information exists on the efficiency of these structures. Results generally depend on the volume of water detained permanently, the velocity of flow, and the depth of baffles and elbows in the tank.

Well-maintained water quality inlets should be capable of removing:

- Suspended solids: up to 25 percent
- Oil and grease: up to 75 percent
- Trace metals: up to 25 percent

Physical Requirements

Water quality inlets are limited by only a few restrictions:

- Use must be limited to small watersheds no larger than two acres
- If dry weather flows occur within the drainage system, then it must be designed to accommodate them as well as rainfalls

- **Operation and maintenance:**
eration and maintenance of water quality inlets requires

- Cleaning of the system at least twice a year to remove accumulations of pollutants Municipalities use a vacuum truck or carefully siphon out each chamber and then manually remove the remaining matter. Wastes must be tested to determine proper disposal methods. Currently, no universally acceptable disposal methods exist for these wastes.

Design Guidelines

Among the minimal design criteria for water quality inlets are:

- Watershed size
- Detention time required
- Velocity of entering runoff (which should be restricted by size of inlet pipe)
- Access to the inlet (separate manhole and metal steps) to help in cleaning
- The volume of the permanent pool per each impervious acre that contributes runoff and in each chamber of the system

Other factors include:

- Clogging
- Preventing resuspension
- Hydraulic design
- Design for the inverted elbow that connects the second and third chambers

Conclusion

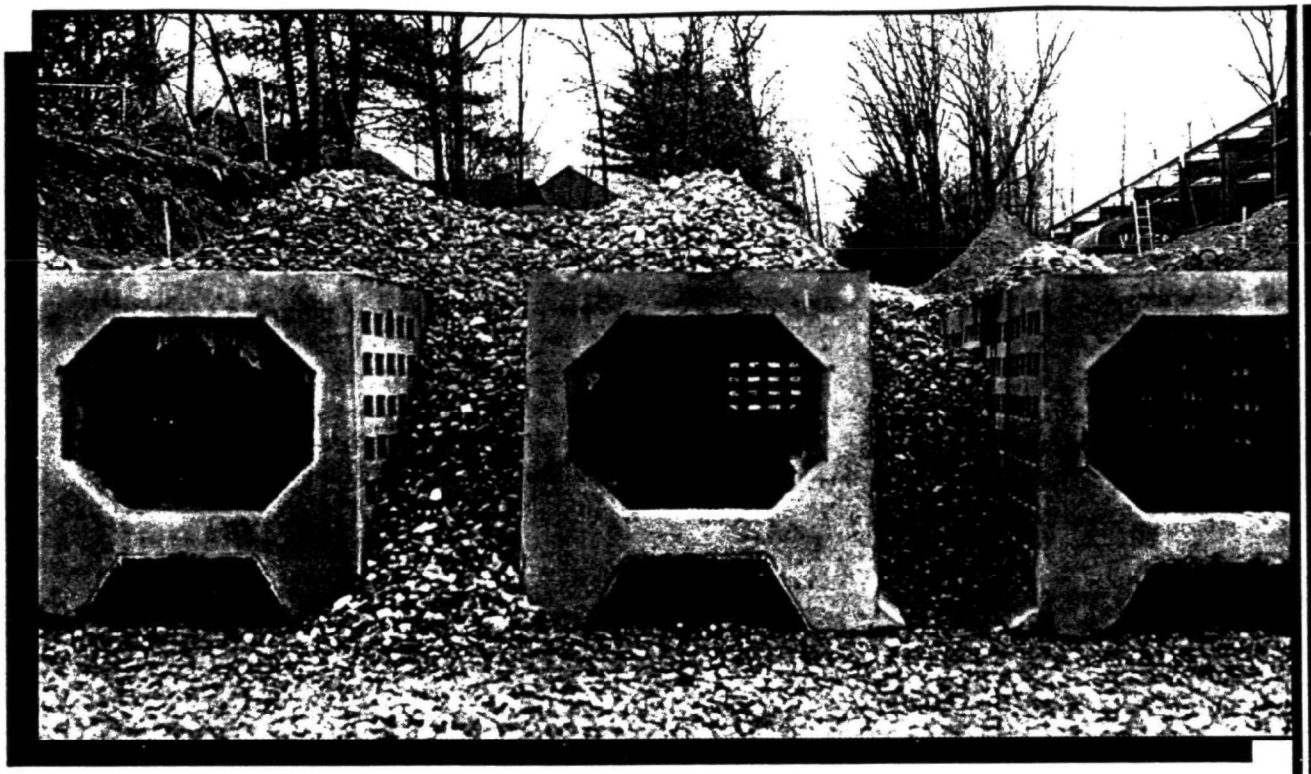
Detention times for water quality inlets are usually measured in minutes or hours; therefore, these BMPs do not remove pollutants as effectively as facilities that retain runoff for days. However, since these inlets are relatively small, they can be placed throughout a drainage system, rather than just downstream, to capture coarse sediments, floating wastes, and accidental or illegal spills of hazardous wastes and thus reduce maintenance of infiltration systems or detention basins.

Additional Information

For additional information concerning the processes, design, and maintenance of water quality inlets, consult the following document:

American Petroleum Institute, Refining Department February 1990 Design and Operation of Oil-Water Separators First Edition API Publication 421 $48 plus shipping and handling and applicable state tax 1220 L Street, NW, Washington, DC 20005, (202) 682-8375

Metropolitan Washington Council of Governments, Department of Environmental Programs 1987. Controlling Urban Runoff A Practical Manual for Planning and Designing Urban BMPs $40. 777 N. Capitol Street, NE, Suite 300, Washington, DC 20002-4201; (202) 962-3256.



FACT SHEET 6

INFILTRATION PRACTICES

Introduction

Infiltration is one way in which pollutants are removed from stormwater runoff. This fact sheet addresses various infiltration best management practices that force runoff into the soil to remove pollutants and recharge groundwater.

Examples of infiltration BMPs include infiltration basins, trenches, leaching facilities, dry wells, leaching catch basins, and infiltration islands.

It is important to note that the concept of infiltration practices, although somewhat accepted, has variable efficiency and longevity. Careful planning and consideration need to precede implementation. Practices that have been poorly planned and installed have been known to fail completely.

Pollutant Removal

Infiltration BMPs remove the following pollutants:

- Suspended sediments
- Trace metals
- Total nitrogen
- Total phosphorus
- BOD
- Bacteria

The primary pollutant removal mechanism is infiltration. A secondary mechanism for some practices, such as infiltration basins, is settling.

- **Infiltration:** Stormwater is directed into the infiltration structure, where the runoff

fills the system and infiltrates into the ground. Pollutants adsorb onto soil particles as infiltration occurs.

- **Settling:** Stands of grass on the basin floor can trap sediments.

Infiltration BMPs can remove pollutants efficiently. The Metropolitan Washington Council of Governments estimates the following removal rates for infiltration basins with the capacity to store and exfiltrate 0 to 5 inches of runoff per impervious acre in the contributing watershed:

- Suspended solids: 75 percent
- Total phosphorus: 50 percent
- Total nitrogen: 45 to 65 percent
- Trace metals: 75 to 80 percent
- BOD: 70 percent
- Bacteria: 75 percent

Subsurface infiltration BMPs have similar pollutant removal rates.

In both surface and subsurface BMPs, the greater the runoff capture efficiency of the system, the greater the pollutant removal potential.

Physical Requirements

To be effective, these BMPs require.

- **Variable amounts of land:** Since these BMPs can be located below ground, they can be built in areas such as parking lots and access roads. If they are constructed at the downstream end of a drainage system or are aboveground basins, infiltration BMPs can require large amounts of land These BMPs can be made smaller by locating some upstream, thus reducing land requirements for downstream BMPs.

- **Porous soil:** Permeability tests should be performed at the proposed structure site to determine the soil infiltration rate. Areas with clay, silt, and other dense soils will probably be unsuitable.

- **Two to four feet clearance above groundwater:** To provide proper treatment and reduce the possibility of contaminating groundwater, this minimum distance should be maintained between the bottom of the BMP and the mean high groundwater elevation.

- **Operation and maintenance:** Infiltration BMPs require

  - For aboveground infiltration areas, frequent inspections for clogging, erosion, tree growth on the embankment, and density of grass growth in the bottom: several times the first few months, annually thereafter, and following large storms.
  - Periodic cleaning out of pre-treatment inlets either manually or with a vacuum pump; removal of accumulated sediment.
  - Mowing, tilling, reseeding, fertilizing, and watering of grass buffer strips and bottom vegetation.
  - As deemed necessary, inspection of structures with observation wells to ensure continued performance.

Design Guidelines

Principles of design for these BMPs include the following:

- **Soil infiltration rate:** As previously noted, many soils are inappropriate. Soils underlying the infiltration structure must be tested for porosity and seasonal high groundwater elevation. The Metropolitan Washington Council of Governments specifies soils with infiltration rates of 0.5 inches per hour for structures and basins

- **Sizing rules:** Structures must be sized to handle the desired design storms and allow larger storms to bypass them. Infiltration basins should be designed to capture and release the first half-inch of rainfall from the drainage area. Another factor is the amount of time it takes the basin bottom to dry out between rainstorms — usually specified for at least three days.

- **Rainfall characteristics:** Structures must empty within a reasonable length of time. To effectively remove pollutants

from runoff, underlying soils must dry out between rainstorms. Many sources specify that infiltration structures should contain runoff for no more than three days. Therefore, the size of the infiltration structure will depend upon the permeability of the soil.

■ **Off-line design (subsurface structures):** Since these structures do not have outlets, they must be designed off-line of the regular drainage system so runoff will enter the structure until it is full and additional runoff will be directed away from the BMP. This prevents damage to the structure and eliminates backups during large storms.

■ **Shape, vegetation, and access (infiltration basins):** Basins should be designed with gently sloping sides and a flat bottom to allow easy access for mowing and tilling bottom vegetation and removing sediments. Access should be provided through a public or private right-of-way at least 12 feet wide that can withstand light equipment. Immediately after construction, the basin floor should be planted densely with reed canary grass or tall fescue.

■ **Emergency spillway (infiltration basins):** An emergency spillway should be incorporated into the basin to release runoff from storms larger than those for which the area is designed.

■ **Sediment forebay:** Sediment forebays are areas or structures that trap larger sediment particles They can be located upstream or incorporated into the wet pond These BMPs can be easily cleaned to improve efficiency.

■ **Redundancy of practices:** Several infiltration practices in series will increase the efficiency of the system. Redundancy is highly recommended to ensure pollutant removal.

■ **Limited applications:** All parties should carefully consider the application of infiltration practices. Not all infiltration devices will work in all situations every time. Also, infiltration practices may not be recommended, given the land use in the immediate area. Improperly placed practices can have a net negative impact on groundwater quality.

Additional Information

For additional information concerning the processes, designs, and maintenance of infiltration BMPs, consult the following publications:

Maryland Department of the Environment, Sediment and Stormwater Administration 1984. Standards and Specifications for Infiltration Practices. $9. Fiscal Services Division, Cash Receipt Unit, 2500 Broening Highway, Baltimore, MD 21224, (410) 631-3553

———. 1985 Inspector's Guidelines Manual for Stormwater Management Infiltration Practices $4. Baltimore

———. 1986 Inspectors' Guideline Manual for Stormwater Management Infiltration Practices $4. Baltimore.

———. 1986 Minimum Water Quality Objectives and Planning Guidelines for Infiltration Practices $2. Baltimore

Metropolitan Washington Council of Governments, Department of Environmental Programs 1987. Controlling Urban Runoff A Practical Manual for Planning and Designing Urban BMPs $40 777 N. Capitol Street, NE, Suite 300, Washington, DC 20002-4201, (202) 962-3256

U S Department of Agriculture, Soil Conservation Service. 1987. Water Quality Field Guide TP 160 Free USDA SCS, Publications Division, PO Box 2890, Washington, DC 20013, (202) 720-5157

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FACT SHEET 7

VEGETATIVE PRACTICES

Introduction

Vegetative best management practices are used primarily to reduce the velocity of stormwater runoff in an attempt to promote infiltration and settling of suspended solids and prevent erosion.

Used alone, these vegetative BMPs usually cannot treat stormwater sufficiently; therefore, they are generally part of a system containing other BMPs, where they act to remove suspended solids from runoff before more intensive treatment.

Examples of vegetative BMPs include filter strips, grassed swales, riparian areas, and basin landscaping.

Pollutant Removal

Vegetative BMPs remove the following pollutants:

- Suspended solids
- Organic material
- Nutrients
- Trace metals

Vegetative BMPs remove pollutants by:

- **Infiltration:** Runoff is directed to travel over vegetation, rather than impervious areas, so that it infiltrates into the ground.

- **Settling:** Vegetation reduces runoff velocity. Heavier suspended particles settle out of the flow and are filtered by the vegetation.

- **Plant uptake:** Under certain circumstances, vegetation can absorb some pollutants from the runoff. Plant uptake is more effective if small berms are used to produce ponding.

While each practice alone generally cannot entirely control runoff velocity and pollutants, it can enhance a total system. The efficiency of the following practices is affected by a variety of factors, as described by the Metropolitan Washington Council of Governments:

- **Filter strips:** Efficiency has been ranked from good to mediocre, depending on the strip's length and slope, the soil's porosity, size of the runoff area, type of vegetation, and the runoff's usual velocity. Vegetated strips supplemented with shrubs and small trees may remove more pollutants than grassed strips because shrubs and trees can absorb and retain more nutrients.

- **Swales:** Swales' ability to remove pollutants has been assessed as moderate to negligible, depending upon slope grading, type of grass cover, underlying soils, and the distance from the swale's bottom to groundwater. Grassed swales that include check dams can increase the pollutant removal efficiency and slow stormwater runoff velocity.

- **Riparian reforestation:** This BMP's efficiency is limited; in fact, if trees grow over an impervious area, nutrients from fallen leaves and pollen can pollute. However, trees near streambanks can stabilize soil, reducing erosion and resulting sediment, and can cool water temperature, benefitting many aquatic species.

- **Basin landscaping:** The efficiency of stormwater basins in removing pollutants depends upon the landscaping plan.

The pollutant removal rates of vegetative practices vary widely. Vegetative practices often remove some of the suspended solids during small storms (up to 50 percent). Removal rates for nutrients, trace metals, and BOD are often low, but can be important when combined with other BMPs into a system.

Physical Suitability

To be effective, vegetative BMPs require that:

- Vegetated areas be fairly large in relation to the area being drained
- The vegetated area is relatively flat
- The groundwater level is relatively low

- **Operation and maintenance:** The following procedures must be followed to operate vegetative BMPs properly:

  - Mowing and repairing the outer edges of the vegetated area to prevent channeling and concentrated flows
  - Periodic inspection to determine the condition of the outer edges
  - Reseeding bare spots and removing weeds
  - Watering and staking trees and protecting them against rodents
  - Fertilizing, to establish vegetation and regular maintenance

Design Guidelines

Principles behind the design of vegetated BMPs vary with each type. The slope of the land, type of soil, size of the contributing watershed, and land use in the area all affect the design.

Construction

- For maximum pollutant removal efficiency, a minimum length of 200 feet is recommended for grass swales.
- Proper ground cover must be developed quickly and then maintained. Fast growing grasses and other plants should be used initially to vegetate the area. Storm flows should not be diverted to the area until vegetative cover is well established.

- Vegetative areas should be planned for land with a slope no greater than 5 to 10 percent.
- Expected flow velocities must be calculated to ensure that runoff will not wash away vegetation or cause erosion.

Some vegetative BMPs may require a structure, such as a small impoundment, that collects the concentrated flow and distributes it evenly across the area. These structures help prevent channeling in the vegetation that can increase erosion of soil into the waterbody.

Additional Information

More information about vegetative BMPs can be found in the following publications:

Maryland Department of the Environment. 1984. Standards and Specifications for Infiltration Practices. $9 Fiscal Services Division, Cash Receipt Unit, 2500 Broening Highway, Baltimore, MD 21224; (410) 631-3553.

———. 1986. Wetland Basins for Stormwater Treatment: Discussion and Background. $6.25. Baltimore.

Metropolitan Washington Council of Governments, Department of Environmental Programs. 1987. Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs. $40. 777 N. Capitol Street, NE, Suite 300, Washington, DC 20002-4201; (202) 962-3256.

U.S. Department of Agriculture, Soil Conservation Service. 1983. Standards and Specifications for Soil Erosion and Sediment Control. Contact your local county or state office listed in the phone book under U.S. Government, Department of Agriculture.

———. 1986. Technical Guide for Wetland Management.

Virginia Department of Soil and Water Conservation. 1972. Best Management Practices Handbook: Agriculture. Plann. Bull. 316. Free. 203 Governor Street, Suite 206, Richmond, VA 23219-2094, (804) 786-2064.

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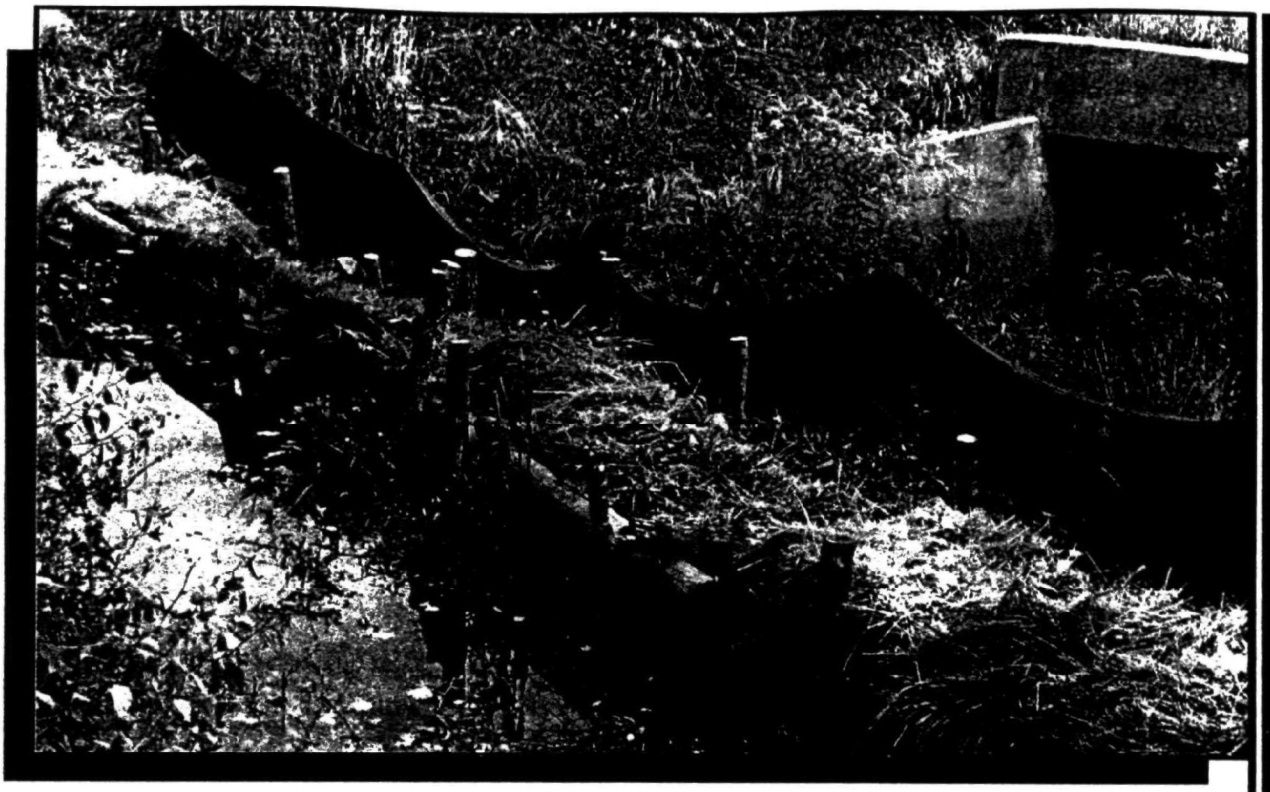

FACT SHEET 8

EROSION AND SEDIMENT CONTROL PRACTICES DURING CONSTRUCTION

Introduction

During construction, vegetation is removed from the site, exposing the topsoil. Rainfall can erode this bare soil, carrying it to nearby waterbodies where it may settle to the bottom. This sediment may deposit pollutants attached to it and could smother benthic organisms and their habitat.

Both temporary and permanent best management practices can be used on construction sites. Temporary BMPs, which usually do not require engineering analysis, are designed to control pollutants for days to months and are usually removed when no longer needed. Permanent BMPs, on the other hand, are designed to remain in place for years and generally require engineering analysis.

Nonstructural construction BMPs, which can prevent erosion, are more effective than structural controls, which capture eroded soil. However, since the latter require more advance planning, local officials must carefully review construction plans. Generally, communities pass ordinances that require specific BMPs for certain situations and stipulate how these practices should be installed.

Descriptions of various types of erosion and sediment control practices follow.

Diversions

Temporary diversions are channels with a supporting ridge built across the downslope to divert runoff around a construction site to a receiving area, such as a detention basin. Design criteria include

- Timing of construction
- Channel capacity
- Cross-sectional width and height of berm
- Channel grade and runoff velocity
- Adequate outlets to receiving areas that will not be affected by the flow

Temporary diversions must be inspected within 24 hours after rainfall and daily during prolonged storms; any repairs must be made immediately.

Permanent diversions although of similar design to temporary, should be designed by a registered professional engineer as part of the initial site development. Design specifications require advance assessment of potential hazards if the BMP fails to hold. Criteria also resemble those for temporary diversions, with the exception of more stringent specifications for the channel cross section. Maintenance standards are identical for both

Management of Overland Flows

Overland flow is runoff that sheets over the land rather than running in channels BMPs to contain overland flows can be put on all slopes These BMPs can also be used to contain pollutants from storage piles.

Temporary BMPs for managing overland flows include sedimentation control practices, such as:

- Filter fabric fences
- Straw bale fences
- Mulching

Permanent erosion control practices include:

- Seeding with mulching
- Sodding

Both types of BMPs should be built according to predefined criteria and have distinct maintenance standards.

Channelized Flow Sediment Traps

Channelized flow is runoff through depressions, swales, or channels. Channelized flow BMPs, which are usually temporary, vary by drainage area:

- Less than 2 acres: filter fabric barriers and straw bales (also temporary diversions) and check dams
- Less than 5 acres: sediment traps
- Less than 150 acres: sediment basins

Each of these BMPs is constructed to predetermined criteria and has definite maintenance standards.

Permanent Drainageway Stabilization

Concentrated runoff can erode soil and carry it to receiving waters Permanent BMPs to stabilize areas of concentrated flow include:

- Seeding with mulching
- Sodding
- Grassed waterways
- Geotextile reinforced grassed waterways
- Rock- and concrete-lined waterways

Each of these permanent BMPs should be constructed to predetermined criteria and have definite maintenance standards.

Inlet Protection

BMPs to minimize pollutant movement can never be totally effective; therefore, practices to prevent pollutants from entering waterbodies are necessary. These temporary BMPs to protect storm drain inlets include straw bales and barriers made of filter fabric or similar material.

All of these BMPs should be constructed to predetermined criteria and maintained though a pre-set schedule.

Dewatering Settling Basins

During pumping of suspended sediment, pollutants can flow out of a construction site and into receiving waters. Temporary dewatering settling basins can detain this sediment-laden discharge long enough to allow most of it to settle.

Design criteria and maintenance schedules for settling basins should be stipulated in design plans.

- **Maintenance:** All erosion control and sedimentation structures should be inspected and repaired as needed. A recommended inspection schedule is twice monthly and after each rainfall event.

Recommended Ordinances

Sediment runoff on streets flows into drains and then pollutes receiving waters. Communities should write ordinances that contain both BMPs to minimize sediment runoff and methods to clean up sediment when it reaches the street, with design criteria and maintenance schedules.

Additional Information

Kamber Engineering (A Division of Chester Environmental Group). 1989. Wetland Regulations: How They Affect Development and Construction Projects. $2. 818 West Diamond Avenue, Gaithersburg, MD 20878; (301) 840-1030.

Metropolitan Washington Council of Governments, Department of Environmental Programs. 1990. Performance of Current Sediment Control Measures at Maryland Construction Sites. $15. 777 N. Capitol Street, NE, Suite 300, Washington, DC 20002-4201; (202) 962-3256.

U.S. Department of Agriculture, Soil Conservation Service. Water Management and Sediment Control for Urbanizing Areas. Contact your local county or state office listed in the phone book under U.S. Government, Department of Agriculture.

Wisconsin Department of Natural Resources. 1989. Wisconsin Construction Site Best Management Practice Handbook. $5.45. Document Sales, P.O. Box 7840, Madison, WI 53707; (608) 266-3358.

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FUNDING MECHANISMS

Adequate funding sources and mechanisms must be established to ensure that operation and maintenance (O&M) continues as planned. Several options may be considered by the community.

Lump Sum Payment by Project Proponent

This one-time payment by the project proponent covers the O&M costs for that site. These payments are also called impact fees. The funds should be put into an interest-bearing capital fund that is controlled by the servicing department (Department of Public Works) and boards and commissions (planning, conservation) responsible for oversight of the O&M operations

Special Assessment District–Stormwater Districts

Initially, the community has to identify area(s) where it would be beneficial to establish and maintain stormwater facilities. These would then become stormwater districts, subject to a special assessment or provisions for stormwater management.

Special Property Tax

A special tax levied as part of the local property tax can be proposed and brought to voters for approval. The public should be thoroughly educated on the issues to encourage passage of such a tax and ensure consistent servicing of the stormwater facilities.

Storm Sewer Tie-in Fee

The town could assess a storm sewer tie-in fee (similar to a sanitary sewer fee) for every development proposed in the community. The assessment could be based upon the amount of impervious coverage of the site.

Stormwater Utility

A utility is established that would provide services to the user community(s), such as flood control, drainage, and stormwater management. The utility is responsible for all levels of service: plan development, implementation, and operation and maintenance. A fee is charged to users based upon the amount of impervious coverage.

General Funds

Funding is provided through county or state taxes The monies may support front-end construction costs to be later reimbursed or may be used for regular operation and maintenance expenses.

Long-term Borrowing

Usually in the form of general obligation bonds or revenue bonds, these funds can support any aspect of stormwater management. Generally, they are used to establish regional stormwater management facilities and are later paid off. This process requires voter approval.

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WATER QUALITY CHECKLIST

This checklist, which is intended for use during the review process, should be made part of every review file. All questions should be addressed by the project proponent before project approval.

Is the resource area(s) identified on the plan? Please address groundwater, surface water (fresh and salt), and wetlands.	❑ Yes	❑ No
Have the pollutants of concern resulting from the proposed development been identified?	❑ Yes	❑ No
Have the potential impacts of pollutants of concern on the resource areas(s) been discussed?	❑ Yes	❑ No
Has the pollutant loading been addressed?	❑ Yes	❑ No
Have appropriate BMPs for treating pollutants and mitigating impacts to the resource area(s) been proposed?	❑ Yes	❑ No
Has a description been provided of how the BMP selected will function to provide water quality control for smaller, more frequent storms?	❑ Yes	❑ No
Have the pollutant removal efficiencies of the BMPs been discussed?	❑ Yes	❑ No
Are they adequate to maintain the existing quality of the resource area?	❑ Yes	❑ No
Are they adequate to meet the pollutant load requirements?	❑ Yes	❑ No
Has the pollutant removal mechanism employed by the BMPs been identified?	❑ Yes	❑ No
Has the proponent adequately considered the variables of precipitation patterns, inter-event dry periods, soil types, and impervious cover?	❑ Yes	❑ No

Has the engineer used appropriate technical references to develop the performance standards, design specifications, or selection of a design storm?	❑ Yes	❑ No
Has the engineer used appropriate methods to calculate pollutant loads?	❑ Yes	❑ No
Has the project proponent considered the constraints that the site may impose on the use of BMPs and does the proposal address constraints (depth to groundwater, soils, slopes, available area, etc.)?	❑ Yes	❑ No
Is the proposed operation and maintenance schedule adequate for the project?	❑ Yes	❑ No
Is it addressed by design or long-term maintenance agreements?	❑ Yes	❑ No
Have responsible parties been identified for operation and maintenance?	❑ Yes	❑ No
Has an adequate funding mechanism been proposed to support the operation and maintenance schedule?	❑ Yes	❑ No
Has the project proponent addressed the use of nonstructural and structural BMPs for the area and presented acceptable reasons why one, the other, or both have been chosen?	❑ Yes	❑ No
Has there been a discussion of the economic feasibility and need for the stormwater management plan, including existing site conditions, existing and proposed uses, benefits to resource areas, regional impacts or management plans, and economics of the project?	❑ Yes	❑ No
Have aesthetics and safety been adequately addressed by the project proponent?	❑ Yes	❑ No
Have steps been taken to minimize site clearing, grading, and/or creation of impervious cover in the basic design of the development site?	❑ Yes	❑ No
Have landscaping and/or habitat creation been considered?	❑ Yes	❑ No
Have all applicable permits been applied for or obtained by the applicant?	❑ Yes	❑ No

How to Use the Water Quality Site Plans

The four individual site plans contained in the pockets at the end of this handbook depict development within the drainage area to a particular water resource. Four resource areas — groundwater, fresh and salt surface waters, and wetlands — have been selected.

To help you become familiar with the site plans, how to use them, and the appropriate stormwater management practices, we will lead you through the freshwater site plan.

The main elements of this plan include:

- **Legend:** Identifies the BMPs
- **Resource Area:** Freshwater bodies
- **Pollutants of Concern:** A list of pollutants that can affect the resource area
- **Important Notes:** Special guidelines
- **Existing Light Residential**
- **Existing Residential**
- **New Industrial/Commercial**
- **New Dense Residential**
- **Recreational**

Step 1

Locate the resource area, which is identified in two places on the plan.

1. The title: PROTOTYPE STORMWATER QUALITY CONTROL. FRESHWATER RESOURCES SITE PLAN *(lower right-hand corner).*
2. The area under development: POND/LAKE *(upper left-hand corner).*
3. Notation: RESOURCE AREA FRESHWATER BODIES *(lower left side).*

Step 2

Think about the proposed land use and how it may affect the resource area. Note the pollutants of concern listed on the plan that could be generated by the development. This list is prioritized to indicate pollutants that are likely to pose the greatest threat to the specific resource area. In this example the freshwater pollutants include nutrients (phosphorus), pesticides, pathogens, suspended solids, oil and grease,. and heavy metals. The pollutant of concern is determined by its potential to negatively impact the resource area.

Step 3

Determine if the use proposed will generate any of these pollutants What pollution can be expected from a new residential or industrial development? If the development is a retrofit, what are the existing uses? If the proposed development will change the existing land use, how will it affect the resource area? In some cases, a single pollutant will be generated; however, usually there will be a variety of pollutants.

- **Identify the pollutants of concern** — the pollutants that require treatment by stormwater best management practices. Then select the BMPs best-suited for the site. BMPs are graphically depicted throughout the plan and identified in the legend.

1. LEGEND *(lower left-hand corner)*.

Step 4

For example, look closer at the range of options to protect fresh water when considering a new dense residential development (located on the lower right-hand side of the plan). Note the following information:

- The development (roadways, housing units)
- The BMPs within the development
  - Reduced pesticide/fertilizer use
  - Reduced salt use
  - Land use planning/zoning
  - Neighborhood recycling program
  - Designated riparian area
- The BMPs outside of the development
  - Wet pond detention basin with artificial wetlands
  - Designated riparian area
- Additional resource area (existing wetlands)

The BMPs shown within the residential area are identified on the legend with a number that relates to a fact sheet describing them in more detail, with basic technical information.

Step 5

Look again at the new dense residential development. Note how the planned unit (clustered) layout differs from the existing light residential development next door. Stormwater from the roadway is discharged into a wet pond detention basin before it flows to the additional resource area, an existing wetland. This is an example of using BMPs in a series, otherwise known as a system. All of the stormwater runoff from the site will receive some type of treatment through a mix of structural and nonstructural BMPs. Note the suggestion to reduce pesticide and fertilizer applications and that no pavement (impervious cover) has been proposed within the designated riparian area.

BMPs are used throughout the drainage areas in the new residential, recreational, and industrial/commercial developments to protect the freshwater resource. Retrofitting has been employed in existing residential and redevelopment areas to reduce pollutant loads.

A special BMP system has been included on the Freshwater Resource Plan. It is located by the snow pile. Note that the plan shows the snow storage location, followed by an oil and grease trap catch basin that then goes to a point where the system splits, with a portion of the flow going to the vegetated swale and the other portion going to the water quality inlet. The inlet is followed by a leaching facility that has an overflow that discharges to the vegetated swale when the capacity of the leaching facility is exceeded. This is an example of an off-line treatment system. This system allows for a certain portion of the stormwater runoff (usually the first flush) to be directed to the water quality BMPs for extended treatment. Off-line treatment can be especially useful as an approach to retrofitting.

Step 6

Imagine that you are responsible for community stormwater management as an urban planner or county engineer. A comprehensive approach, as depicted by the water quality plan, could adequately manage the stormwater discharges and pollutant loading to the resource area. You have gone from management of a single site to an entire drainage area!

Taking an even broader approach, an entire watershed could be reviewed and managed in a similar manner. You can select a series of BMPs in a system to manage stormwater flows and pollutants to protect all the resource areas. The use of more regional practices, rather than site-specific practices, can be implemented to protect resources in a watershed.

FOR FURTHER READING

The following booklets contain information for the public, teachers, and business and industry professionals on water systems and environmental issues that affect water quality. Prices listed include shipping and handling unless otherwise noted.

TITLE: ***A Primer on Water***

Intended Audience: Schools, Business and Professional, Industry

Description: A 50-page booklet that describes basic hydrology, the hydrologic cycle, groundwater, and groundwater movement. Defines terms such as "aquifier" Also talks about streamflow and how floodplains are formed Basic and complete primer on water $2 75.

Order From: Books and Open-File Services, U S Geological Survey, Box 25425, Federal Center, Denver, CO 80225 (303) 236-7476

TITLE: ***Handle with Care: Your Guide to Preventing Water Pollution***

Intended Audience: General Public

Description: A practical 30-page guide to pollution prevention at home. Includes a national source list for help. $9.95 ($2 S&H). Bulk discounts.

Order From: The Terrene Institute, 1700 K Street, N.W., Suite 1005, Washington, D.C. 20006; (202) 833-8317.

TITLE: ***Urban Runoff and Stormwater Management Handbook***

Intended Audience: General Public, Local Governments

Description: A 15-page publication that explains stormwater management problems and describes practical methods for educating communities $4.50 ($2 S&H). Bulk discounts.

Order From: The Terrene Institute

TITLE: ***Fact Sheets***

Intended Audience: General Public, Local Governments

Description: A series of briefing sheets for decisionmakers that overview specific water quality management practices Set of 11–$15, any 6–$10; separate sheets: $2.50 each ($2 S&H).

- Regional Stormwater Management Planning
- Institutional Support for Stormwater Management Programs
- Urban Runoff Impacts to Receiving Waters
- Facts about Stormwater Management Programs in the State of Florida
- Stormwater Management Ordinances for Local Governments
- Stormwater Control Benefits of Managed Floodplains and Wetlands
- Financing Mechanisms for BMPs
- Uses of Wetlands in Stormwater Management
- Impacts of Changes in Hydrology Due to Urbanization

- Integrated Stream Management Programs Reduce Impacts to Aquatic Habitats
- Retrofitting Stormwater Management Basins for Phosphorus Control

Order From: The Terrene Institute.

TITLE: ***Controlling Nonpoint Source Water Pollution: A Citizen's Handbook***

Intended Audience: General Public, Local Governments, Business and Professional

Description: A 170-page book that outlines the state planning process to control nonpoint source pollution and suggests how citizens can encourage, monitor, and support state efforts. $7.50. Bulk discounts: 5 to 9, 20 percent; 10 to 99; 25 percent; 100-plus, 40 percent.

Order From: The World Wildlife Fund (incorporated with The Conservation Foundation), P.O. Box 4866, Hampden Post Office, Baltimore, MD 21211; (410) 516-6951.

TITLE: ***Groundwater Information Flyers***

Intended Audience: General Public, Business and Professional, Local Government

Description: Nine 3-hole-punched booklets published by the Massachusetts Audubon Society's Community Groundwater Protection Project to help Massachusetts citizens and local officials protect groundwater sources in their communities. Set $15; $2 each. Bulk discounts

- An Introduction to Groundwater and Aquifiers
- Groundwater and Contamination: From the Watershed to the Well
- Mapping Aquifiers and Recharge Areas
- Local Authority for Groundwater Protection
- Protecting and Maintaining Private Wells
- Underground Storage Tanks and Groundwater Protection
- Pesticides and Groundwater Protection
- Landfills and Groundwater Protection
- Road Salt and Groundwater Protection

Order From: Educational Resources Office, Massachusetts Audubon Society, South Great Road, Lincoln, MA 01773; (617) 259-9500, ext. 7252.

TITLE: ***Groundwater: Why You Should Care***

Intended Audience: General Public

Description: Brochure gives practical information on how to prevent groundwater contamination. First copy free w/self-addressed, stamped envelope. To order quantities, call 1-800-666-0206.

Order From: Water Environment Federation, 601 Wythe Street, Alexandria, VA 22314-1994.

TITLE: ***Wetlands***

Intended Audience: General Public

Description: Brochure describing the importance of wetlands and how individuals can help save this valuable resource. First copy free w/self-addressed, stamped envelope. To order quantities, call 1-800-666-0206.

Order From: Water Environment Federation.

TITLE: ***National Wetlands Newsletter***

Intended Audience: General Public, Business and Professional, Legal, Scientific, Public Policy, and Environmental Organizations

Description: A non-technical journal for people involved in wetlands issues and reporting on legal, scientific, and public policy developments concerning wetlands. Includes comprehensive wetlands literature guide. $48 per year. Student discounts.

Order From: Environmental Law Institute, 1616 P Street, NW, Suite 200, Washington, DC 20036, (202) 939-3844

TITLE(s) ***Phosphorus Control in Lake Watersheds: A Technical Guide to Evaluating New Development***

Implementation Strategies for Lake Water Quality Protection: A Handbook of Model Ordinances and Nonregulatory Techniques for Controlling Phosphorus Impacts from Development

Comprehensive Planning for Lake Watersheds

Intended Audience: Local Governments

Description: Three publications of a series that focuses on effects of development on watersheds and community planning to control them. Free.

Order From: Maine Department of Environmental Protection, State House Station #17, Augusta, ME 04333 (207) 289-3901.

TITLE: ***The NPDES Best Management Practice Guidance Document***

Intended Audience: Local Governments

Description: This publication provides a basis for developing BMP plans under the NPDES program. Free.

Order From: SAIC, EPA Stormwater Hotline, 7600-A Leesburg Pike, Falls Church, VA 22043; (703) 821-4823.

TITLE: ***Baybook: A Guide to Reducing Water Pollution at Home***

Intended Audience: General Public

Description: A 32-page guide to reducing water pollution. Topics include erosion control, drainage, septic systems, paving, landscaping, gardening, pesticides, household chemicals, water conservation, and boats $1.

Order From: Alliance for the Chesapeake Bay, Inc., 6600 York Road, Baltimore, MD 21212; (410) 377-6270.

TITLE: ***A Homeowner's Guide to Domestic Wells***

Intended Audience: General Public

Description: A 32-page booklet about locating, constructing, and maintaining a domestic well. $6 (free to Virginia residents).

Order From: Publications Services, Virginia Water Resources Research Center, 617 N. Main Street, Blacksburg, VA 24060

TITLE: ***A Homeowner's Guide to Septic Systems***

Intended Audience: General Public

Description: A booklet to help homeowners construct and maintain their sewage systems. $6 (free to Virginia residents).

Order From: Publications Services, Virginia Water Resources Research Center.

TITLE: ***Hazardous Chemicals In Your Home: Proper Use and Disposal***

Intended Audience: General Public

Description: Fact sheet defines and describes hazardous household products and their disposal. 1 to 10 free; 10¢ thereafter.

Order From: Rutgers Cooperative Extension, Publications Distribution Center, Cook College, Dudley Road, Box 231, New Brunswick, NJ 08903; (908) 932-9762.

TITLE: ***Water Quality Fact Sheet Series (1–10)***

Intended Audience: General Public, Schools (Grade 7 to 12)

Description: These 10 double-sided fact sheets cover TVA's Water Quality Role, Multiple-use Management, Thermal Stratification and Dissolved Oxygen Interaction in Reservoirs, Nonpoint Source Pollution, Wastewater Assimilation, Federal and State Agency Roles in Water Quality Management, The Role of the Private Citizen, Bacterial Contamination of Water and Effects on Recreation, Water Conservation, and Toxic Contamination of Streams and Reservoirs. Free.

Order From: Tennessee Valley Authority, Water Quality Branch, Attn: Department Library, Haney Building 2C, 1101 Market Street, Chattanooga, TN 37402-2801; (615) 751-7338.

TITLE: ***Community Action Guides for Waste, Household Waste, Groundwater, Drinking Water, Pesticides, and Farmland***

Intended Audience: General Public, Schools (Grades 9 to 12), Business and Professional, Industry, Environmental Organizations, Public Interest Groups, Governmental Agencies

Description: Six separate booklets. $4 each. $1.50 S&H for first booklet; 50¢ for additional booklets. Bulk discounts.

- The Waste Guide concentrates on general issues;
- The Household Waste Guide on reducing waste;
- The Groundwater and Drinking Water Guides cover everything from supplies to quality, treatment, and monitoring.

- The Pesticides Guide discusses pesticides' relationship to health, agriculture, forests, and communities.
- The Farmlands Guide discusses how farming practices affect food, water, air, and lifestyles.

Order From: Concern, Inc., 1794 Columbia Road NW, Suite 6, Washington, DC 20009; (202) 328-8160.

TITLE: ***Groundwater: Out of Sight — Not Out of Danger***

Intended Audience: General Public, Schools (Grades 6 to 12), Business and Professional, Municipal Officials

Description: Pamphlet describes groundwater, aquifiers, recharge areas, and costs for managing groundwater. Free.

Order From: New England Interstate Environmental Training Center, 2 Fort Road, South Portland, ME 04106; (207) 767-2539.

TITLE: ***Here Lies the Problem . . . Leaking Underground Storage Systems***

Intended Audience: General Public, Schools (Grades 10 to 12), Business and Professional, Industry

Description: Pamphlet describes the use of underground storage tanks and problems associated with leaks from them, including leak prevention Free.

Order From: New England Interstate Environmental Training Center

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TITLE: ***Slope Stability on Forest Land***

Intended Audience: General Public, Schools, Business and Professional, Industry

Description: Describes slope failures, their causes and control, particularly sedimentation of streams resulting from landslides. $1 25 Bulk discounts.

Order From: Publications Orders, Agricultural Communications, Oregon State University, Administrative Services, Room A-422, Corvallis, OR 97331-2119; (503) 737-2513.

TITLE: ***Impact of Timber Harvest on Soil and Water Resources (EB 827)***

Intended Audience: General Public, Schools, Business and Professional, Industry

Description: A 17-page overview of key watershed concerns and research findings related to logging and soil and water resources in the Pacific Northwest. $1. Bulk discounts.

Order From: Publications Orders, Agricultural Communications, Oregon State University.

TITLE: ***Maintaining Woodland Roads***

Intended Audience: General Public, Schools, Business and Professional, Industry

Description: An 11-page booklet that describes the most common and important road maintenance activities for avoiding erosion and related soil and water problems. $1.50. Bulk discounts.

Order From: Publications Orders, Agricultural Communications, Oregon State University.

TITLE: ***Impact of Forest Practices on Surface Erosion***

Intended Audience: General Public, Schools, Business and Professional, Industry

Description: Describes surface erosion on forest lands and techniques to minimize these problems $1 25 Bulk discounts

Order From: Publications Orders, Agricultural Communications, Oregon State University

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TITLE: ***Soil and Water Conservation: An Introduction for Woodland Owners***

Intended Audience: General Public

Description: A 4-page fact sheet that describes how common woodland management activities can influence soil and water resources 75¢.

Order From: Publications Orders, Agricultural Communications, Oregon State University.

TITLE: ***Pesticides and Groundwater: A Health Concern for the Midwest***

Intended Audience: General Public

Description: Describes symptoms and potential health effects of pesticides in groundwater, including ways to protect groundwater. $6.

Order From: Freshwater Foundation, 725 County Road 6, Wayzata, MN 55391; (612) 449-0092.

TITLE: ***Land and Water 201***

Intended Audience: General Public

Description: Brochure describes the state/USDA/TVA Regional Resource Conservation Program to reduce soil erosion and improve water quality in the Tennessee Valley region. Free.

Order From: Tennessee Valley Authority, Water Quality Branch, Attn: Department Library, Haney Building 2C, 1101 Market Street, Chattanooga, TN 37402-2801; (615) 751-7388.

TITLE: ***River Fact Sheets***

Intended Audience: General Public, Schools (Grades 9 to 12)

Description: Nineteen fact sheets on major rivers within the Chesapeake Bay watershed: Susquehanna, Conestoga, Elizabeth, Gunpowder, Chester, Potomac, Rappahannock, and Anacostia Free

Order From: Alliance for the Chesapeake Bay, Inc., 6600 York Road, Baltimore, MD 21212, (410) 377-6270.

TITLE: ***Nonpoint Source NEWS-NOTES***

Intended Audience: General Public, Schools (Grades 9 to 12), Business and Professional, Industry, Environmental Organizations, Public Interest Groups, Governmental Agencies

Description: *Nonpoint Source NEWS-NOTES is an occasional bulletin (ranging from 28 to 32 pages) dealing with the condition of the environment and the control of nonpoint sources of water pollution. NEWS-NOTES* is published under the authority of section 319(l) of the Clean Water Act by the Nonpoint Source Information Exchange, Office of Water, U.S Environmental Protection Agency. Free

Order From: NPS News-Notes (WH-553), Assessment and Watershed Protection Division, U.S. EPA, 401 M Street, SW, Washington, DC 20460; Fax (202) 260-1517

TITLE: ***The Nashua River Greenway***

Intended Audience: General Public, Business and Professional

Description: Brochure includes a map of the extensive greenway areas protected along the Nashua River and its major tributaries and describes the importance of preserving river corridors. First copy free: cost for quantity.

Order From: Nashua River Watershed Association, 348 Lunenburg Street, Fitchburg, MA 01420-4566; (508) 342-3506.

TITLE: ***Watershed Newsletter***

Intended Audience: General Public, Business and Professional

Description: Quarterly newsletter deals with watershed management, water quality, land conservation, and related environmental issues affecting a 540-square-mile region of central Massachusetts and southern New Hampshire First copy free; cost for quantity.

Order From: Nashua River Watershed Association

TITLE: ***The Power to Protect: Three Stories about Groundwater***

Intended Audience: State, Regional and Local Governments, Water Utilities, Developers, Schools, and General Public

Description: 30-minute video on groundwater protection issues. Topics include nonpoint source pollution, aquifer delineation, mapping, overlay districts, and community coordination. $25.

Order From: Massachusetts Audubon Society, Educational Resources Department, South Great Road, Lincoln, MA 01773; (800) 677-9453.
To Rent: Send $10 to New England Interstate Environmental Training Center, 2 Fort Road, South Portland, ME 04106; (207) 767-2539.

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2100 Martin Luther King, Jr Drive
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Forbes Field, Building 740
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Frankfort Office Park
18 Reilly Road
Frankfort, KY 40601
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P.O. Box 82215
Baton Rouge, LA 70884-2215
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MAINE
Nonpoint Source Coordinator
Bureau of Water Quality Control
State House #17
Augusta, ME 04333
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Director, Sediment and Stormwater Administration
Maryland Department of the Environment
2500 Broening Hwy., Building 30
Baltimore, MD 21224
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