Working for Clean Water

An Information Program for Advisory Groups

Urban Stormwater Runoff

**What is urban stormwater runoff?
Why is it a problem?**

**What are urban stormwater pollutants?
Where do they come from?**

**What are the Best Management Practices (BMPs)
for the control of pollution from
urban nonpoint sources?**

**What can advisory groups do to improve
the management of urban stormwater?**

Citizen Handbook

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Urban Stormwater Runoff

What Is Urban Stormwater Runoff?

Urban stormwater runoff is the water which flows off lawns, streets, paved areas, and rooftops during and after a rainstorm. This rain removes chemicals and suspended particles from the air. As it flows across the ground it gathers dust, debris, litter, animal refuse, and toxic substances. Although the environment often seems cleaner after a rainfall, in reality stormwater runoff merely carries pollution from one place to another. Unfortunately, what is washed from the streets, parking lots, and rooftops in an area may turn up in the water supply somewhere else.

What Are Nonpoint Source Pollutants?

Most people think of urban pollution as belching smokestacks, auto exhaust, and industrial waste—all of which originate from an identifiable source. Technically, these pollutants are identified as coming from *point sources*, places that literally can be pointed out.

Stormwater runoff, because it collects pollutants from a wide area, is called a *nonpoint source of pollution*. Though much less obvious than point sources, it can be equally as hazardous.

Toxic substances in stormwater include acid, dust, and coal particles from atmospheric fallout. Pollutants associated with automobiles include lead, asbestos, grease, rubber, and de-icing chemicals such as salt. Urban construction sites contribute sediment, plant debris, and asphalt. Stormwater also contains public refuse such as street litter.

Origins of Urban Nonpoint Source Pollutants

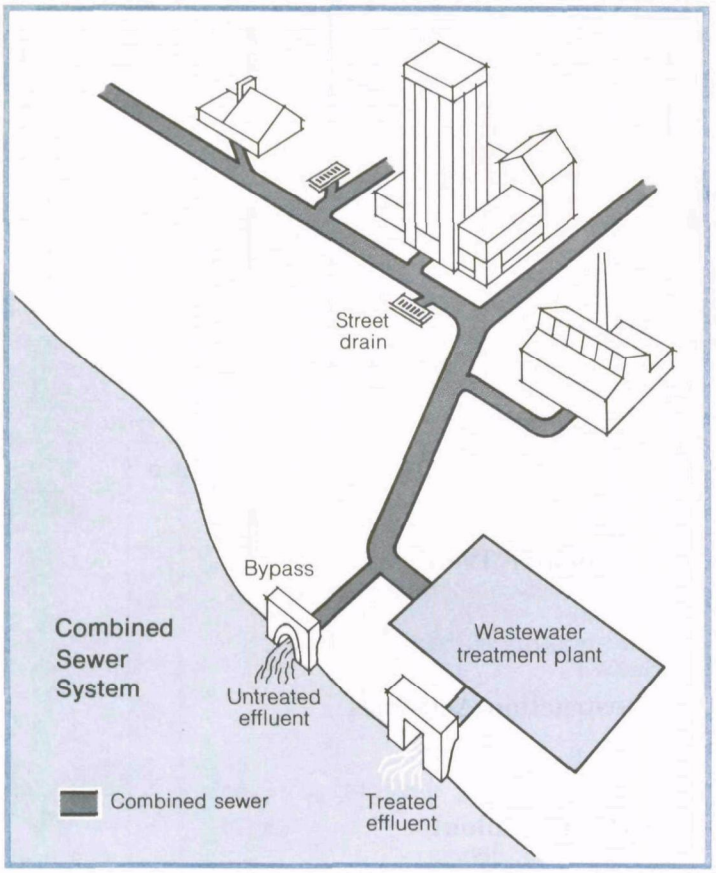
Automotive Traffic
Heavy metals such as lead
Asbestos
Acid-making substances
Salts

Construction Activities
Dirt
Asphalt and paint
Oil and cleaning solvents

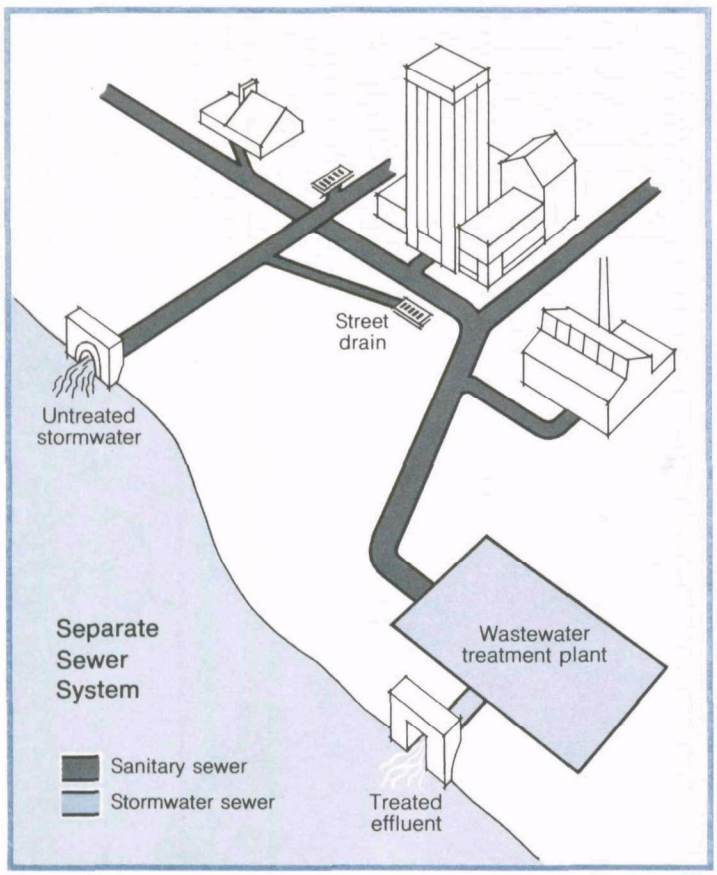
Airborne Fallout
Smokestack debris
Coal dust
Acid-making substances
Dirt

Public Refuse
Animal and plant refuse
Street debris
Trash

Street litter clogging a catch basin.



Transport of stormwater and wastewater together in combined sewers to treatment plant.



Transport of stormwater and wastewater in sewers separately to surface waters and treatment plant.

How Are Urban Nonpoint Source Pollutants Transported?

Stormwater runoff is a major problem in many urban areas. This is because much of a city's land surface is covered by buildings and pavement. The pavement collects and channels the pollutant-laden stormwater, and directs it into the city's sewer system.

Urban stormwater enters either a combined sewer system which carries both municipal sewage and stormwater runoff, or a separate sewer which takes the stormwater directly to the nearest lake or stream. Combined sewers transport the stormwater to the treatment plant, possibly overload the plant, or bypass it to flow directly to the surface waters. Thus, it is not just stormwater that enters the lakes and rivers when there is a treatment plant overflow, but stormwater mixed with raw sewage.

How Serious Is The Problem?

In the past water quality planning was directed towards controlling point source pollution. Now, nonpoint source pollution is receiving increasing attention. It is a vital concern in water quality decisions for both urban and rural areas.

The full impacts of nonpoint source pollutants in urban areas are only now being assessed:

- The water quality of over 75 percent of urban areas studied by the Council on Environmental Quality were found to be *controlled* by nonpoint source pollutants
- Construction sites may have a sediment runoff rate 100 times greater than sedimentation from farmland
- According to the State of Illinois, nearly half of the pollution in the Chicago waterways is due to combined sewer overflows.

Urban stormwater runoff is of short duration, but it has far greater impacts than those of treated wastewaters. Over the same time period during a storm, urban runoff contributes much more heavy metals, suspended solids, and other substances to watercourses as compared to treated wastewaters.

Heavy storms which only last a short period of time (15 to 30 minutes) usually contribute the largest amounts of pollution. This is due to erosion and the dislodging of pollutant particles from surfaces.

Planning for Nonpoint Source Pollution

The concern about nonpoint pollution is growing. Section 208 of the Clean Water Act requires the control of nonpoint sources of pollution. State and local governments and areawide planning agencies are responsible for developing the control plans.

A six-step planning sequence is suggested for nonpoint source pollution prevention and abatement:

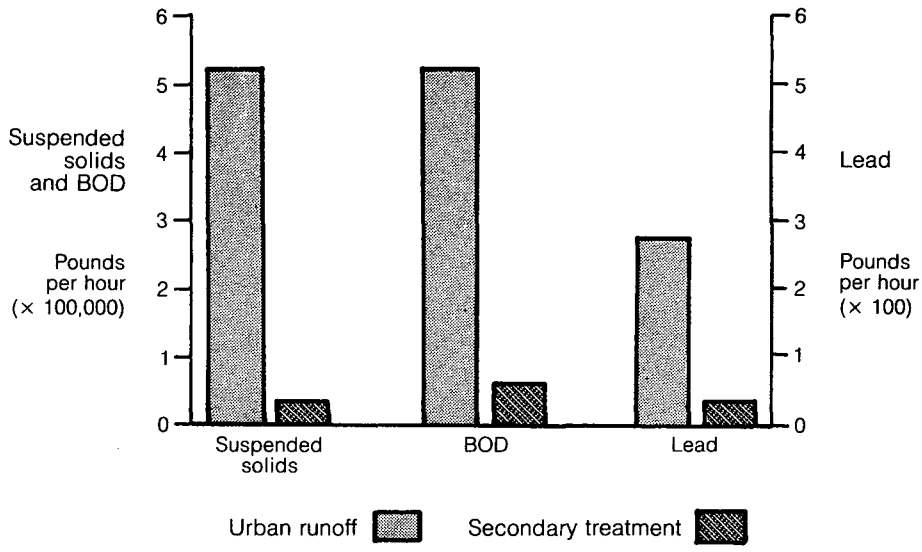
1. Set water quality goals and standards
2. Assess the local nonpoint source pollution situation
3. Determine allowable pollution loads for the various pollutant sources
4. Select Best Management Practices
5. Develop and implement a plan
6. Monitor the water quality and revise plans as necessary.

Step *one* establishes the basis for analysis and decision making.

States probably have already set water quality goals and standards, but advisory groups still have a role. Matters such as the scope of the studies and guidelines for considering possible tradeoffs have to be dealt with.

In step *two,* the sources, magnitude, and extent of nonpoint source pollution are assessed. The relationships between land use and the stormwater runoff are also determined. This step is difficult because it requires the collection of large amounts of data over an extended period of time.

Pollutant Loading during a Storm



Information on urban stormwater includes:

- Stormwater and surface water characteristics
- Environmental factors such as soils, slope, surface cover, and climate
- Pollutant types, amounts, and sources
- Demographic factors such as population and land use
- Existing and predicted urban stormwater problems, including those resulting from combined sewer overflow
- Ways to control stormwater pollution to meet the water quality standards
- Cost estimates for stormwater management plans.

Advisory groups can help identify the objectives of the studies, and give insights into local conditions. They also can assist in dialogue between the public and the technicians.

In step *three* allowable pollution loads are set. These requirements are based upon water quality standards, and characteristics of the pollutants and surface waters. This step is often bypassed in nonpoint source planning due to insufficient data.

Best Management Practices (BMPs), the techniques for preventing or controlling nonpoint source pollution, are identified in step *four*. Selection of the BMPs involves the consideration of regulations, reliability, fiscal aspects, technical matters, environmental impacts, and inter-agency coordination.

A *fifth* step in the process is the implementation of the plan. Although the plan is the responsibility of the agency, various private and public organizations participate.

The *sixth* and final step involves a constant monitoring of the plan. Changes should be made to meet future needs.

Input from advisory groups will be needed in the continuing planning process.

Advisory groups around the country are in various stages of planning. Most areawide 208 advisory groups are in the latter stages (Steps four to six). In contrast, many 201 advisory groups are just beginning the planning process. Central to all advisory group activities are the best management practices and plan implementation.

Best Management Practices

The options for dealing with problems of urban stormwater runoff range from doing nothing, to strategies for catching the stormwater runoff, storing it, and channeling it through treatment facilities. Doing nothing only neglects the problem until the waterways become open sewers. On the other hand, it would cost billions of dollars to separate the combined sewers, or build treatment plants large enough to handle all the stormwater that runs off city streets.

Best Management Practices

Structural Controls	Nonstructural Controls
Porous pavement	Open storage regulations
Parking lot ponding	Anti-litter laws
Infiltration systems	Air pollution abatement
Diversion structures	Catch basin cleaning
Vegetation seeding and mulching	Improved de-icing methods
Rooftop ponding	Public education
Detention basins	Street cleaning
Grade stabilization	Land use ordinances

Other management alternatives are available. They can be classified as structural or nonstructural measures. The structural ones involve the construction of physical works such as catch basins and dams. These Best Management Practices (BMPs) are relatively expensive.

Nonstructural alternatives often are more effective and less costly than structural measures. In addition to erosion and flood control benefits, they result in cleaner neighborhoods and environmental amenities. These approaches range from improved urban maintenance programs, to land use controls such as zoning to keep pollution-prone firms away from watercourses. Some of these nonstructural BMPs include:

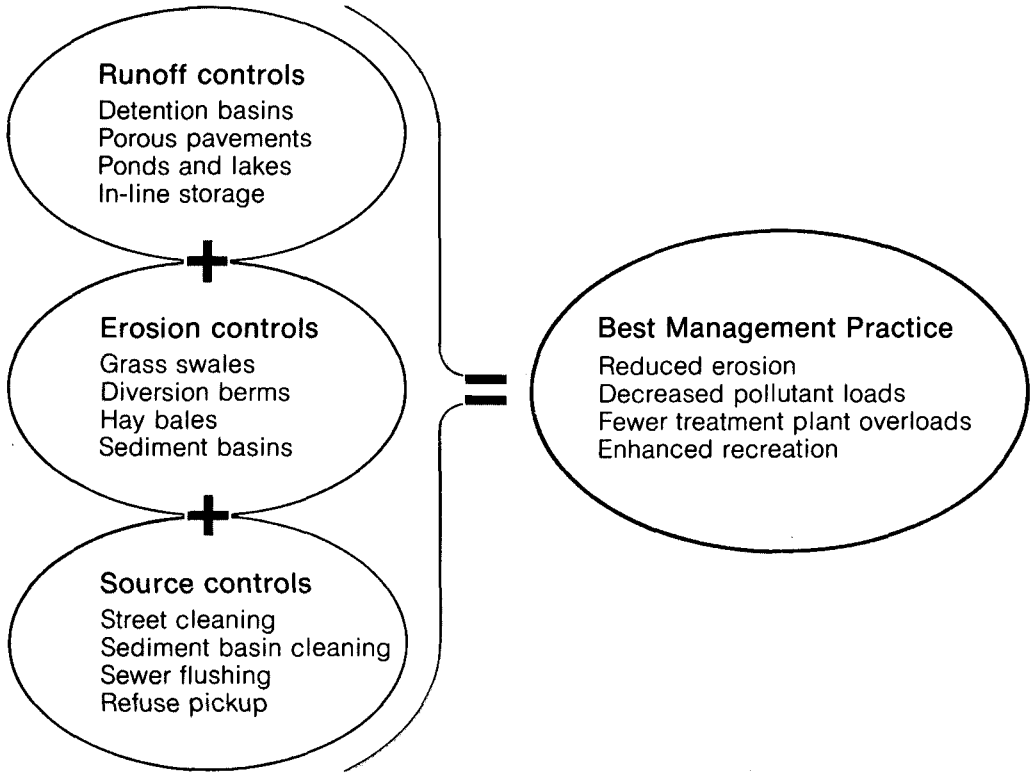
- Anti-litter ordinances and educational programs
- Erosion controls in building codes and subdivision regulations
- Frequent trash removal and street cleaning
- Cleaning of catch basins and sewer pipes
- Controls on herbicide and pesticide usage.

Strict enforcement of regulations is crucial. For example, effective street sweeping is seriously impeded by parked cars, because most of the street dirt lies within six inches of the curb. The public often does not realize the importance of such measures.

Because of the variability in pollution sources and physical factors such as climate, soils, and topography, *no one best management practice will fit all situations.* BMPs must be tailored to fit the needs of particular sources, and circumstances. In urban areas, BMPs are often directed towards three aspects of urban nonpoint source pollution: erosion, pollutant sources, and stormwater runoff.

At the 208 areawide planning level the advisory group is concerned with assessing which alternatives can be implemented.

For example, where there is strong county or regional government, land use ordinances may be very effective in controlling nonpoint sources of pollution.



Best Management Practice is a sum of management techniques.

Advisory groups involved with 201 local facilities planning should be concerned with the implementation of nonpoint source pollution BMPs for two major reasons:
- **Assurance that local government actions are compatible with the areawide plans**
- **Influence upon the design requirements for wastewater treatment facilities and/or programs.**

Much information is known about urban stormwater, but a better understanding of pollution sources and control techniques is needed. The United States Environmental Protection Agency (EPA) has initiated the Nationwide Urban Runoff Program (NURP) to provide some of the answers. The main objective of this program is to develop improved solutions to runoff problems in various climates. Thirty extensive studies are being conducted under this program.

A Durham, New Hampshire study measures the loading of urban runoff constituents during individual storm events, and evaluates maintenance practices such as litter control, chemical-use control, street sweeping, and detention basins.

A project of the Council of Governments in Lane, Oregon, focuses on special concerns such as toxic materials and air quality-runoff interactions, management practices, and promotion of public awareness and actions.

Preliminary results of all the studies will be available when the NURP compiles its findings in a report to Congress in 1983.

Construction Activities

Construction is a major source of urban stormwater pollution. About a million acres of land are disturbed by construction each year in the United States. Sediment is the most common pollutant, but other substances are washed from the construction sites. These pollutants include asphalt, paint, cleaning solvents, and concrete compounds.

BMPs for construction activities fall into two groups: controls for erosion, and controls for chemicals and other substances. Some principles for managing soil erosion are:

- Keeping barren soils exposed for a minimum time period
- Preserving as much natural cover, topography, and drainage as possible
- Protecting fragile and erosion-prone areas from construction activities

- Prohibiting ground-disturbing activities during heavy rainfall
- Requiring stringent erosion prevention and control practices.

Despite the most effective BMPs, some erosion will always occur. Sedimentation can be controlled effectively by basins which trap runoff and allow sediment to settle out before the water leaves the site. For many construction projects these basins should be permanent.

Certain chemicals, pesticides, and fertilizers are also construction pollutants. They should be prevented from entering the water through proper storage and use.

Selection of Best Management Practices

Advisory groups have an important role in helping identify BMPs that are most suitable for the community. A few approaches that may be pursued include:

- **Contacting experienced municipal employees and labor unions (who may have to implement BMPs) for their insights**
- **Checking the compatibility of local actions and regulations with those of neighboring communities**
- **Reviewing existing ordinances to construction and other sources of nonpoint source pollution**
- **Explaining and publicizing the relationships between water quality and ordinances to the public.**

Regulatory vs. Voluntary Control Programs

The effectiveness of *voluntary* versus *regulatory* approaches to nonpoint source controls is a continuing controversy. Many programs, such as erosion and sedimentation abatement, initially have been voluntary. However, in an increasingly urban society the regulatory programs may work better than voluntary ones. Of course, voluntary programs could be more effective if incentives were present and residents had pride in their cities.

Voluntary Programs

Voluntary programs for the control of nonpoint sources of pollution should have the following dimensions:

- Leadership by organizations such as the soil conservation agency at the state level, and the council of governments at the local level
- Strong education and information program through the state extension service, agencies, and private groups
- Technical and cost-sharing assistance necessary to meet target abatement dates
- Programs to check progress and to evaluate periodically the work effectiveness.

Regulatory Programs

If a regulatory program is required to meet water quality objectives, a joint effort by state agencies, local jurisdictions, and other agencies may be needed. Effective regulatory programs often have these elements:

- Enactment of state laws which provide water quality standards and appropriate management agencies
- State soil conservation or municipal assistance agency for preparing model ordinances and regulations, and assisting counties and municipalities in local program development
- Local authorities for designating BMPs, approving construction site plans, requiring building permits, and enforcing building codes
- Arrangements for funding administrative and technical assistance costs, and monetary incentives
- Vigorous information and education programs.

Advisory groups, of course, cannot execute such actions. However, they can influence decision-making organizations, and act as an ombudsman between the organizations and the public.

Management Agencies

Several agencies have important roles in the control of stormwater pollution. The police department should enforce an anti-litter ordinance as well as parking regulations to keep curbs clear and allow street sweeping equipment to work more effectively. The highway maintenance department should clean the sewers. The town council should adopt a comprehensive plan with zoning regulations to protect fragile environments and unstable soils. The conservation district should supervise erosion and sedimentation control programs. The Soil Conservation Service should provide technical advice.

If the program is to be effective, all agencies must understand their own responsibilities and work together. Cooperation is more likely to occur if a formal, written agreement is made among the agencies which will be working together.

Questions to Keep in Mind

Advisory groups should keep the following questions in mind when advising agencies on alternative solutions to urban stormwater runoff pollution:

- **How much will it cost and how can it be paid for? What are the public and private costs (including capital, operation, and maintenance)?**
- **How effective is it in controlling water pollution? To what extent are pollutant loads reduced?**
- **How easy will it be to implement? What legal authority, financial resources, and administrative abilities are needed to carry out each option?**
- **What water resources, land resources, and cultural resources are affected?**
- **Is public health affected?**
- **What other important impacts will it have?**

Brief Recap

Urban stormwater runoff is a problem not only because of its scope and the large number and amounts of pollutants involved, but also because of the associated economic, social, institutional, and political issues which are difficult to resolve. Some of the more important issues are the cost and effectiveness of nonpoint source controls; the apparent need for more regulatory, as opposed to voluntary, control programs; and complications in water law.

Nonpoint source problems are variable, widespread, and serious. Planning for the control of such pollutants has lagged behind point source efforts, but substantial commitments are being made.

Controls and methods exist which reduce the nutrient, pesticide, sediment, and bacteria levels in urban stormwater runoff. The EPA, however, currently lacks detailed information on the BMPs used in a specific situation with the resultant improvement in water quality. More studies of these relationships are needed. Projects in the National Urban Runoff Program are compiling such information.

Developer Fees Pay for Stormwater Facilities

Weber and Davis Counties, Utah

The areawide water quality planning program for the tri-county area of Weber River Water Quality Planning Council started in June, 1975. A major effort of the Council was directed toward documenting stormwater facilities, identifying water quality related problems, and developing a master plan to correct these problems. This urban stormwater runoff study focused on the rapidly growing Utah counties of Weber and Davis.

Best Management Practices

Several alternative control methods were considered to alleviate flooding caused by urban stormwater runoff. The study concluded that a combination of large, central detention basins and smaller, onsite detention basins for individual developments was the most effective means. The construction of storm drains for peak flow was rejected because of the cost of installing the large diameter pipe needed to accommodate the high peak flow from the cloudbursts common to the area.

The study also examined alternatives to control or reduce the pollutant load that would accompany summer storms. Physical treatment processes were judged to be the most effective, but they were also the most expensive. Since no stormwater collection system or combined sewers are in use in Davis and Weber Counties, this alternative was rejected in favor of the detention basins.

Because a large fraction of the total pollution load is carried during the early stages of runoff, *it is important to design detention basins that will have all runoff detained for a period of time.* This measure allows for the reduction of the pollutant load by settling, rather than using the more conventional detention basins which accept runoff only during the peak flow.

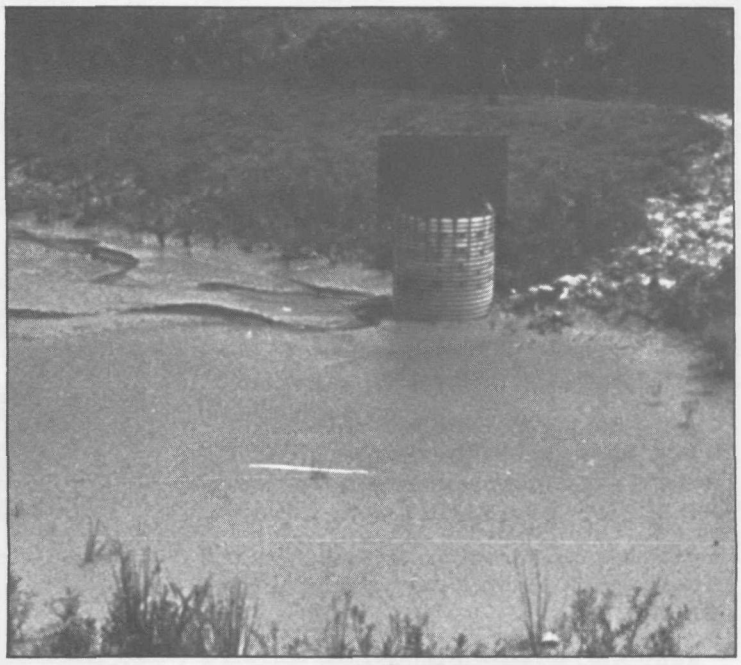
Implementation

For Davis County, where all sixteen municipalities have implemented the master plan, the county government was selected as the management agency. The creation of a new and separate agency was considered, but it was rejected because it would not have authority for land use planning, developmental regulations, or the broad powers of county government.

The Davis County Commissioners have:

- established a committee to set drainage project priorities for the county
- adopted a stormwater runoff control ordinance for new development.

This ordinance enables the county to assess a fee for any additional stormwater facilities that are needed due to development. The fee is seven percent of the fair market value of the improved real estate. This was a major step in improving water quality in Davis County.



Detention basin with riser pipe.

Case Study

Pollution Source Analysis in Planning

Central Piedmont, North Carolina

The planning area of the Triangle J Council of Governments (TJCOG) consists of 1,750 square miles in the central Piedmont section of North Carolina. Sixty-eight percent of the region's population is contained in three major urban centers (Raleigh, Durham, Chapel Hill). The surrounding area is predominantly rural. In 1974, 22 communities participated in the water quality planning process.

Data Collection and Analyses

One of the major elements in this program was an in-depth study of nonpoint source pollution in the region. The approach used was a comprehensive pollution source analysis. Existing and projected water quality were assessed. The source, duration, magnitude, and extent of nonpoint sources specific to the planning area where identified. This was the first such study conducted under Section 208 grants.

The program also served as a demonstration effort to determine the feasibility of characterizing nonpoint source pollution as it relates to land use. This 12-month program also used computer models, which have now been modified to serve as water quality planning and evaluation tools. The cost for this effort was $400,000.

The results of this program showed that nonpoint source pollution potential was closely related to density of development. Four primary land use categories were found to represent potential nonpoint source pollution.

Pollutant Loading Rates Based on Model Predictions

Land Use	Pollutant Loading Rates (lbs/acre/day)			
	BOD	*Suspended Solids*	*Total Nitrogen*	*Total Phosphorus*
Urban	0.42	11.6	.027	.008
Commercial	0.29	21.5	.026	.010
Residential	0.17	18.5	.016	.004
Rural	0.12	15.0	.008	.003

The study also found that despite the high level of sampling and monitoring, some nonpoint source problems cannot be adequately documented. Pesticides, for example, were not modeled because of the large number of different chemicals used, and the expense of sampling and analysis for this parameter.

Best Management Practices

The TJCOG study also reviewed a wide range of best management practices (BMPs). Each was assessed on the basis of effectiveness in reducing nonpoint source pollutant loads which had been identified as problems by the sampling and modeling effort. Each BMP was analyzed in terms of its usefulness in reducing stormwater runoff and suspended solids levels, as well as its cost and effectiveness.

The least costly and most effective techniques controlled the pollutants at their sources. These options were much better than collecting and treating wastewaters containing the pollutants. Although the nonpoint source assessment concluded that the control of sediment was of primary importance, other nonpoint sources of pollution were identified.

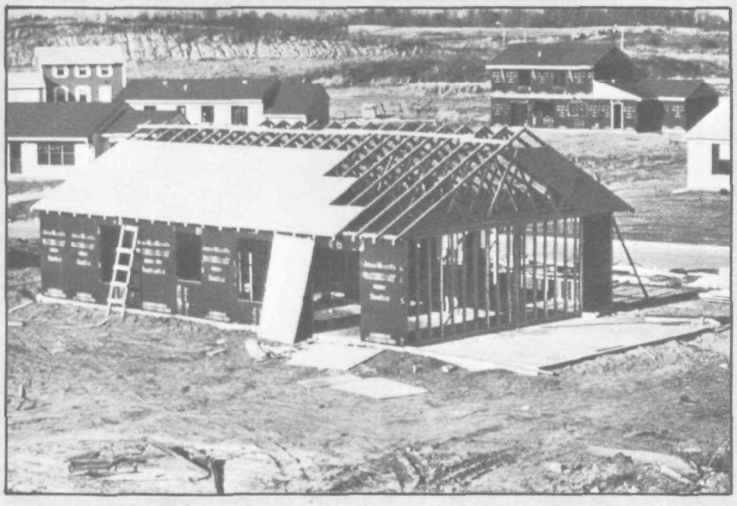
Implementation

The implementation of nonpoint source BMPs focused on correcting problems through existing institutional and legislative authorities and strengthening those authorities where possible, rather than attempting to control all potential sources.

Immediate controls were recommended for implementation if they were practical and inexpensive. Improved water quality could be expected by instituting better street sweeping, passage of local ordinances, and the employment of construction site inspectors.

TJCOG's sedimentation and erosion control program includes erosion control during all phases of construction. Better land management of construction sites is necessary to reduce suspended solids and associated pollutants, such as phosphorus and lead.

In order to control suspended solids, local governments have indicated they will consider requiring erosion and sedimentation control plans. Annual administrative costs for this approach will range from under $1,000 for small towns to over $65,000 for a countrywide program.



Residential construction site.

Street sweeper.

Need More Information?

Amy, Gary, et al., *Water Quality Management Planning for Urban Runoff,* Report No. EPA-440/9-75-004, Washington, DC: U.S. Environmental Protection Agency, December 1974. 247 pp.

This manual describes procedures for quantifying nonpoint source problems in an area without the need of extensive data. It can be useful in assisting planners in the preliminary evaluation of cost-effective abatement and control practices. This publication is available as Order #0993A from the EPA Library Services, Maildrop 35, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

The Hidden Dangers of Urban Stormwater, Washington, DC: Office of Water Program Operations, U.S. Environmental Protection Agency. 10 pp.

An easy-to-read introduction to the basic problems of urban stormwater runoff. Should be one of the first resources consulted. Available as Order #5734 from EPA Library Services, Maildrop 35, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

Setting the Course for Clean Water, Washington, DC: National Wildlife Federation, March 1978. 64 pp.

Subtitled "A Citizen's Guide to the Section 208 Water Quality Management Program," this handbook is must reading for those citizens who want to participate in the 208 program. Copies are available at $2 each from the Education Division of the National Wildlife Federation, 1412 16th St., N.W., Washington, DC 20036.

Water Quality Management: Compendium I, Report No. EPA-440/3-77-026, Washington DC: Water Planning Division, U.S. Environmental Protection Agency, December 1977. 117 pp.

Presents 58 successful case studies of water quality management planning agencies that are implementing 208 programs. The activities and solutions of these agencies are documented. Available as Order #4567 from EPA Library Services, Maildrop 35, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

Glossary

Best Management Practice (BMP) — technique which deals most effectively with a given problem.

Biochemical Oxygen Demand (BOD) — amount of dissolved oxygen required by bacteria to decompose organic matter in water; measure used to indicate the amount of organic wastes in water.

Catch Basin — basin located at the point where a street gutter discharges into a sewer; catches and retains matter that would not pass readily through the sewer.

Combined Sewer — pipe that carries both sewage and stormwater runoff.

Computer Modeling — the programming of a computer to use related input data for analyses or problem solving.

Demography — statistical study of populations.

Detention Basin — collects water until the settling of particulates picked up by rain water occurs naturally; the rate of drainage can be controlled for natural runoff (similar to retention basin).

Erosion — the wearing away of land surface by wind or water.

Heavy Metals — metallic elements such as mercury, chromium, cadmium, arsenic, and lead with high molecular weights. They can damage living things at low concentrations and tend to accumulate in the food chain.

Infiltration — seepage of effluent through the ground to the water table, or groundwater leaking into cracked or broken sewers.

Nonpoint Source — a contributing factor to water pollution that can't be traced to a specific spot, such as agricultural fertilizer runoff or construction sediment.

Nonstructural Management Alternatives — land use controls such as zoning ordinances, improved urban maintenance programs, etc. Often more effective and less costly than structural alternatives.

Point Source — a stationary location such as a pipe where pollutants are discharged.

Pollutant Loading — amount of pollution contributed by a given pollution source over a time period.

Ponding (Parking Lot, Rooftop) — occurs when a structure is designed so that rain water will collect within its boundaries and will exist at a specific location at a controlled flowrate, rather than running off uncontrolled.

Secondary Treatment — treatment of wastewater to remove all floating and settleable solids; biochemical oxygen demanding substances (BOD) and suspended solids are reduced to a concentration of no more than 30 mg/L in the effluent.

Sedimentation — a nonpoint source of pollution caused when construction disturbs the soil and sediment is washed from the construction site and enters urban stormwater.

Structural Management Alternatives — involve physical entities for delaying, blocking, or trapping pollutants. As compared to nonstructural approaches, they are often expensive.

Suspended Solids (SS) — tiny pieces of solid pollutants in sewage that cause cloudiness and require special treatment to remove.

Working for Clean Water is a program designed to help advisory groups improve decision making in water quality planning. It aims at helping people focus on essential issues and questions by providing trained instructors and materials suitable for persons with non-technical backgrounds. These materials include a *citizen handbook* on important principles and considerations about topics in water quality planning, an *audiovisual presentation*, and an *instructor guide* for elaborating points, providing additional information, and engaging in problem-solving exercises.

This program consists of 18 informational units on various aspects of water quality planning:

- Role of Advisory Groups
- Public Participation
- Nonpoint Source Pollution: Agriculture, Forestry, and Mining
- Urban Stormwater Runoff
- Groundwater Contamination
- Facility Planning in the Construction Grants Program
- Municipal Wastewater Processes: Overview
- Municipal Wastewater Processes: Details
- Small Systems
- Innovative and Alternative Technologies
- Industrial Pretreatment
- Land Treatment
- Water Conservation and Reuse
- Multiple Use
- Environmental Assessment
- Cost-Effectiveness Analysis
- Wastewater Facilities Operation and Management
- Financial Management

The units are not designed to make technical experts out of citizens and local officials. Each unit contains essential facts, key questions, advice on how to deal with the issues, and clearly-written technical backgrounds. In short, each unit provides the information that citizen advisors need to better fulfill their role.

This program is available through public participation coordinators at the regional offices of the United States Environmental Protection Agency.□

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This project is dedicated to the memory of Susan A. Cole.