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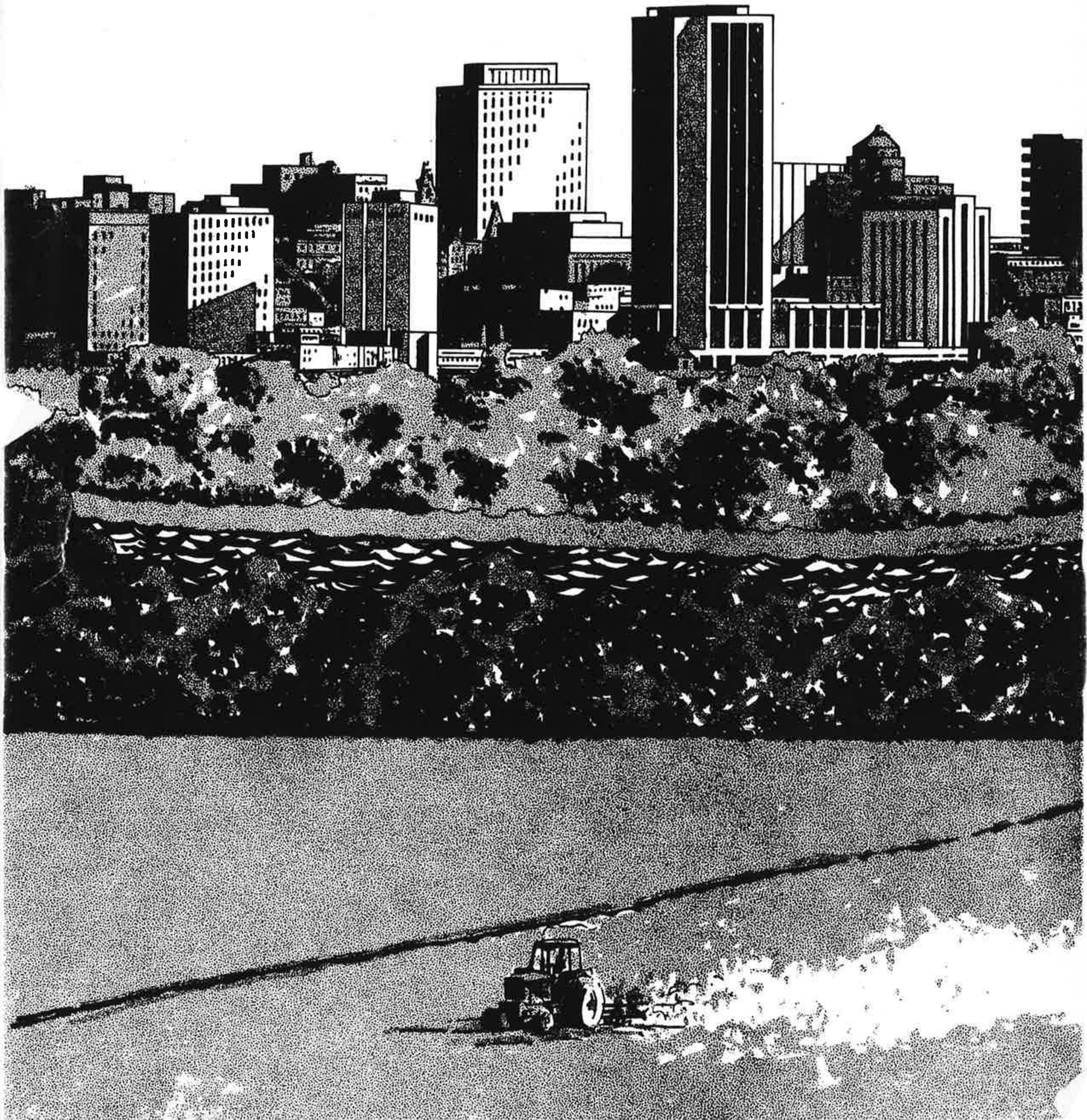
Chesapeake Bay Nonpoint Source Programs



CHESAPEAKE BAY NONPOINT SOURCE PROGRAMS

PREPARED BY THE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, REGION 3
CHESAPEAKE BAY LIAISON OFFICE
ANNAPOLIS, MARYLAND

JULY 1987

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PREFACE

The Chesapeake Bay Agreement of 1983 established the framework for a cooperative effort among Virginia, Pennsylvania, Maryland, the District of Columbia, and the U.S. Environmental Protection Agency to address all sources of pollution in the Bay basin. In response to this, the participating jurisdictions have developed new and expanded existing programs to address both point and nonpoint sources of pollution to the Bay and its tributaries.

This report describes the current programs to ameloriate nonpoint sources of pullution to the Bay that have been developed by the four jurisdictions in cooperation with other agencies; the achievements to date in terms of pollutant removal; and recommendations for future directions of the Bay program over the next several years. The report is organized into five chapters:

- Chapter 1, Nonpoint Source Strategy for Chesapeake Bay Restoration, provides an overview of Bay nonpoint source (NPS) problems and discusses the overall strategy for NPS control.

- Chapter 2, State Nonpoint Source Programs, describes the approaches that Virginia, Pennsylvania, Maryland and the District of Columbia are using to mitagate their NPS problems. The chapter describes the programs of these jurisdictions and cooperating agencies, with an emphasis on those aspects that are funded with EPA Chesapeake Bay Program grants.

- Chapter 3, Effectiveness of Best Management Practices, briefly summarizes the types of practices that are being used or studied by the Bay participants to manage or control nonpoint sources.

- Chapter 4, The Effect of Agricultural BMPs on Pollutant Loads Reaching the Bay, analyzes the available information on best management practices (BMPs) that have been implemented in 1985 and 1986.

- Chapter 5, Recommendations for Future Directions of the Chesapeake Bay NPS Program, presents recommendations and raises several issues for the Bay program over the next several years.

Much has been accomplished to date by the Bay program, yet much remains to be done. It is only with the continued support and cooperation of all agencies involved that the goal of Bay cleanup can be realized.

1. NONPOINT SOURCE STRATEGY FOR CHESAPEAKE BAY RESTORATION

INTRODUCTION

The U.S. Environmental Protection Agency's 1983 study of the Chesapeake Bay found that nonpoint sources of pollution were among the chief causes of the Bay's decline. [1] Consequently, in December 1983, the Governors of Pennsylvania, Maryland, and Virginia; the Mayor of the District of Columbia; and the Administrator of EPA pledged to address nonpoint as well as other sources of pollution to restore and protect the Chesapeake Bay. This commitment, known as the Chesapeake Bay Agreement of 1983, established the Chesapeake Executive Council to coordinate Bay cleanup efforts undertaken by the signatories to the Agreement. EPA provides funding to support this effort, as well as technical and administrative assistance. Implementing programs to reduce nonpoint source (NPS) pollution is one of the most significant elements of the cooperative cleanup effort.

Since the signing of the Agreement, substantial progress has been made by the four Chesapeake Bay jurisdictions and by cooperating Federal agencies to strengthen existing NPS programs and establish new ones. Effective interagency networks have been developed. States have built many new programs that deliver educational, technical, and financial assistance.

Since Bay programs are constantly evolving, any description of them can be at best a "snapshot" of current conditions. Thus this strategy provides an overview of NPS problems in the Bay, the cooperative structure developed to implement the Chesapeake Bay Program (CBP), the current approaches to implementing NPS controls, and the future directions for NPS control in the Chesapeake Bay.

WHAT'S WRONG IN THE CHESAPEAKE BAY?

EPA's 1983 study found that the Chesapeake Bay is an ecosystem in decline. [2] The study was initiated because of the disturbing trends observed in Bay resources. Submerged aquatic vegetation was disappearing; fishermen were landing fewer of certain freshwater spawning fish; and oyster harvests were declining. In very simplified terms, these problems were traced to excess levels of nutrients and toxic pollutants in the Bay system. The study concluded that these contaminants were also causing--among other phenomena--depressed oxygen concentrations in the water column, algal blooms, increased turbidity, and high concentrations of heavy metals in sediments. [3] The sections that follow highlight the NPS aspects of nutrients and toxic pollutants as reported in the CBP study.

Nutrients Are Clearly A Serious NPS Problem

Excessive nutrients appeared to account for much of the decline in living resources as well as many of the trends in water quality identified in the 1983 study. To identify the sources of the nutrients, the CBP developed a comprehensive data base and a model of the entire Chesapeake Bay watershed to simulate the behavior of all point and nonpoint sources of pollution and the delivery of the resulting pollutant loads to the Bay. [4] A map of the river basins draining into the Chesapeake Bay is shown in Figure 1.1.

This watershed model estimated 1980 point and nonpoint source nutrient loadings to the Bay. The input data for the watershed model used direct measurements of effluent quality from major point sources. NPS loading estimates were derived from field measurements of runoff composition from urban/suburban, agricultural, and forested areas coupled with basinwide land-use, soil, and hydrologic data. The model estimated the relative importance of different nutrient sources and land-use patterns in particular river basins and their importance for the Bay as a whole.

These watershed model calculations indicated that in a year of average rainfall, nonpoint sources contribute 67% of the nitrogen and 39% of the phosphorus entering the Bay; point sources contribute the difference in the nitrogen and phosphorus loads, 33% and 61%, respectively. [5] Most of the nitrogen entering Chesapeake Bay waters is transported from nonpoint sources throughout the Bay basin, while phosphorus loadings originate mostly from point sources adjacent to the Bay (below the fall line*). [6]

A survey of 1985 point source loads below the fall line showed a 33% reduction of phosphorus loads due to point source controls between 1980 and 1985. [8] In addition, NPS phosphorus loads below the fall line were reduced by an estimated 10% between 1980 and 1985 due to NPS controls.

NPS runoff from cropland was estimated to contribute the largest share of the NPS nutrient load to the Bay (see Table 1.1). Although urban runoff is a relatively minor contributor to the Bay-wide nutrient load, it does cause localized water quality problems. Unless properly controlled, urban runoff will increase along with burgeoning development.

The watershed model, along with other information, has provided the basis for understanding the relative contributions of point and nonpoint sources by major river basins, and for linking nutrient loadings with specific areas where nutrient and dissolved oxygen concentrations potentially limit aquatic resources (see Table 1.2 and Figure 1.2). For example, the watershed model demonstrated that point source loads of phosphorus exceed the NPS loads from the Potomac and James River basins in almost all rainfall conditions. [9] In

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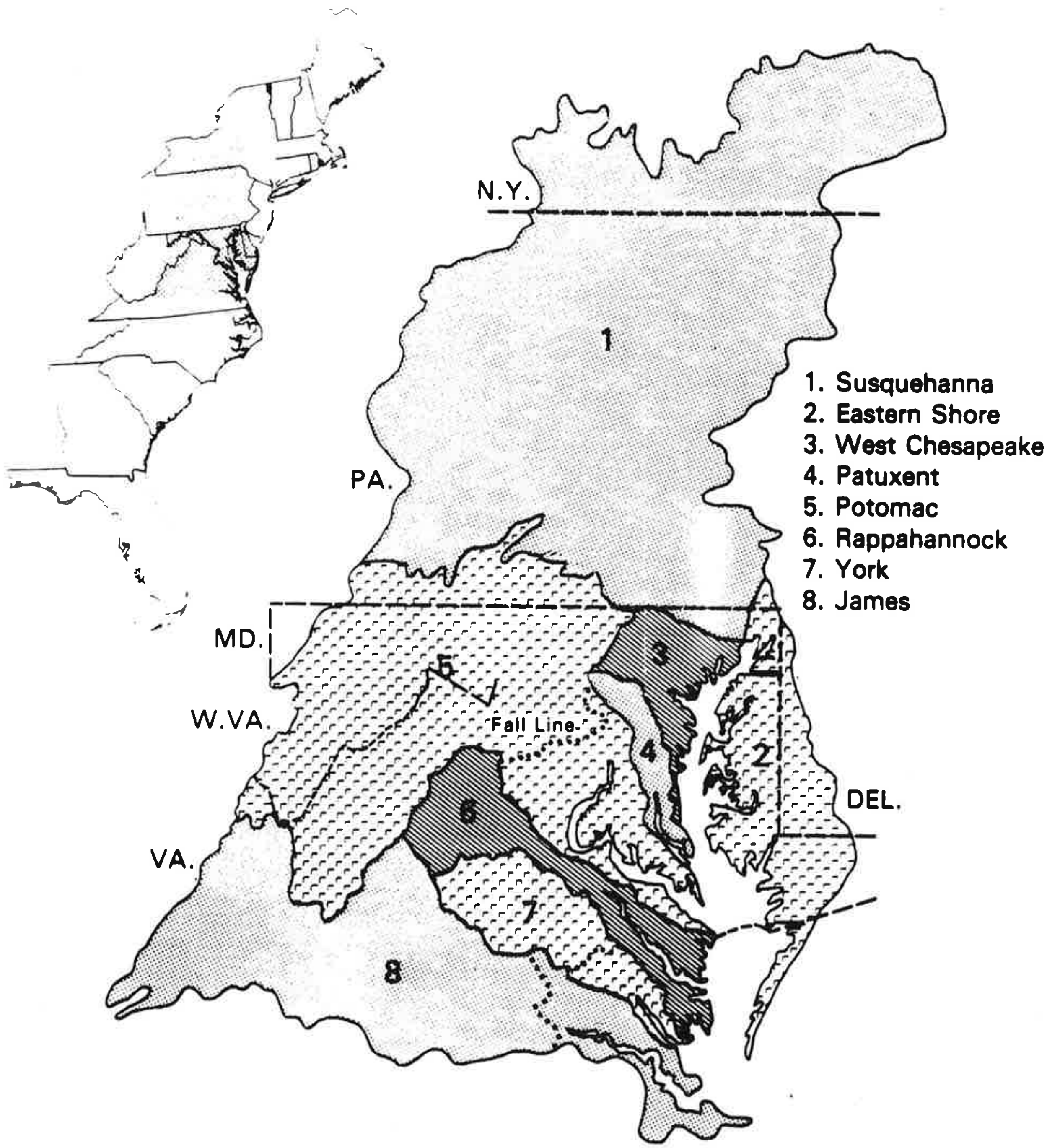
* The fall line forms the boundary between the coastal plain and the piedmont plateau. Waterfalls and rapids clearly mark this line, where the elevation sharply increases to approximately 1,100 feet, due to the erosion of the soft sediments of the coastal plain. Cities such as Baltimore, Washington, D.C., Richmond, and Fredericksburg have developed along this fall line. [7]

FIGURE 1.1 THE CHESAPEAKE BAY DRAINAGE BASIN



Source: Chesapeake Bay: A Framework for Action, U.S. EPA, Region 3, Philadelphia, PA, September 1983, p.5.

TABLE 1.1 NUTRIENT LOADS REACHING THE CHESAPEAKE BAY: NPS PORTION BY LAND USE TYPE

LAND USE TYPE	TOTAL NITROGEN FROM NPS	TOTAL PHOSPHORUS FROM NPS
Cropland	45-70%	60-85%
Pasture	4-13%	3-8%
Forest	9-30%	4-8%
Urban/Suburban	2-12%	4-12%
Subtotal for Agriculture (Cropland+Pasture)	49-83%	63-93%

Source: Chesapeake Bay Program Technical Studies: A Synthesis, U.S. EPA, Washington, D.C., September 1982, p. 18.

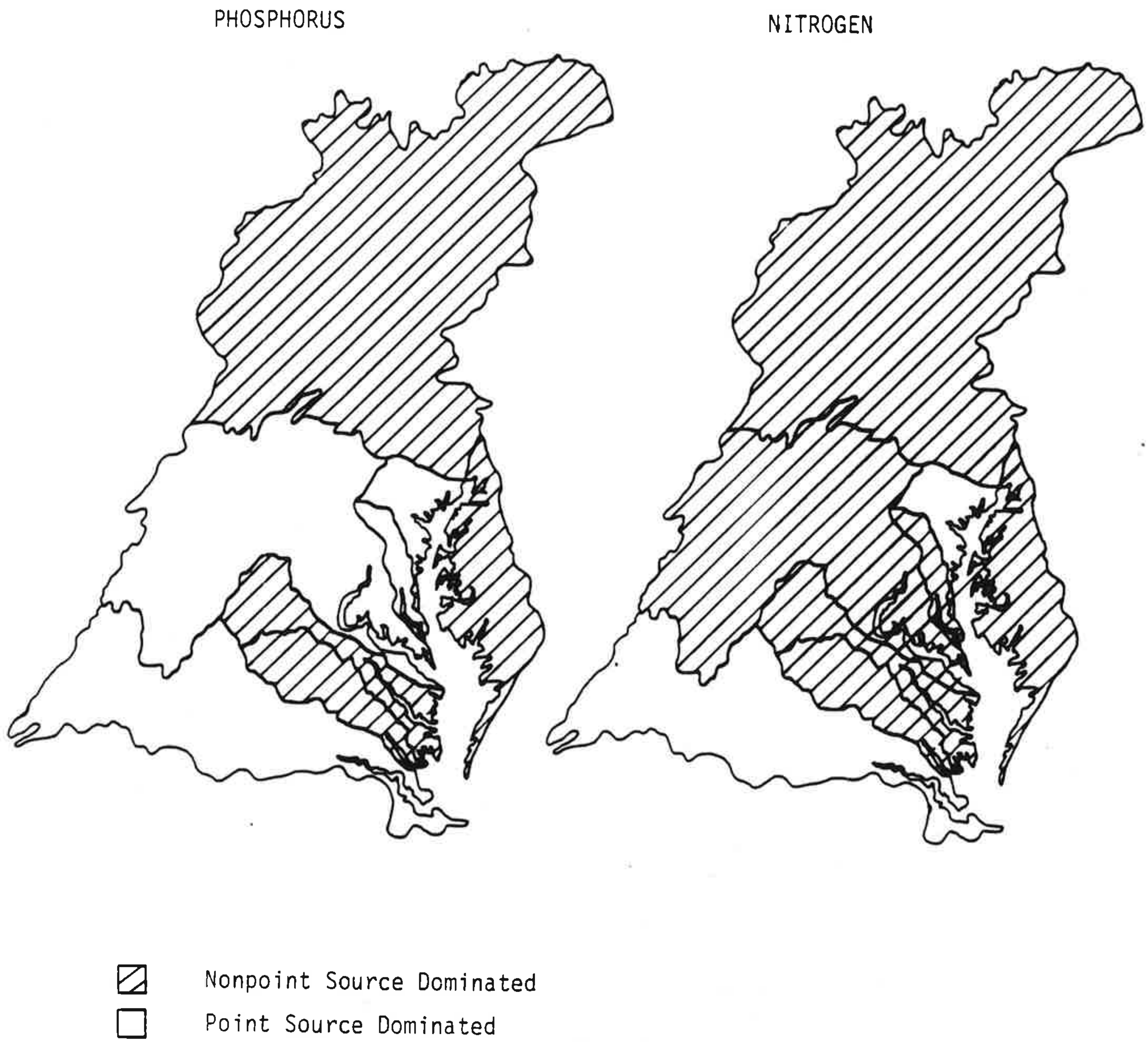
TABLE 1.2 NUTRIENT LOADS FROM POINT AND NONPOINT SOURCES: NITROGEN AND PHOSPHORUS BY BASIN*

BASIN	% OF TOTAL LOAD				TOTAL LOAD (millions of pounds)			
	NITROGEN		PHOSPHORUS		NITROGEN		PHOSPHORUS	
	Point Source	Nonpoint Source	Point Source	Nonpoint Source	Point Source	Nonpoint Source	Point Source	Nonpoint Source
West Chesapeake	72%	28%	85%	15%	11.50	4.48	2.03	0.36
James	62%	38%	81%	20%	12.70	7.79	3.07	0.76
Patuxent	49%	51%	83%	17%	1.22	1.27	0.40	0.08
Potomac	44%	56%	59%	41%	15.40	19.60	1.69	1.18
Rappahannock	13%	87%	39%	61%	0.38	2.56	0.11	0.17
York	39%	61%	35%	65%	0.91	1.42	0.08	0.14
Eastern Shore	10%	90%	40%	60%	0.87	7.87	0.33	0.50
Susquehanna	10%	90%	23%	77%	5.82	52.40	0.67	2.23

* These data are based on watershed model estimates of 1980 point and nonpoint source nutrient loads delivered to the Bay between March and October.

Source: Chesapeake Bay: A Framework for Action, U.S. EPA, Region 3, Philadelphia, PA, September 1983 (data compiled from basin profiles).

FIGURE 1.2 RELATIVE IMPORTANCE OF POINT AND NONPOINT SOURCES OF NUTRIENTS WITHIN MAJOR BASINS



Source: Chesapeake Bay: A Framework for Action, U.S. EPA, Region 3, Philadelphia, PA, September 1983, p.44.

contrast, nonpoint sources contribute most of the phosphorus from the Susquehanna River basin under all conditions. These findings reflect the fact that while the Potomac and James River basins contain major population centers contributing large point source loadings to tidal waters, the Susquehanna basin is more rural. Correspondingly, it is not surprising that in the urbanized Patuxent and West Chesapeake basins, the phosphorus loadings from point sources exceed those from nonpoint sources, and in the largely rural Eastern Shore, Rappahannock, and York River basins, nonpoint sources of phosphorus dominate. [10] Since 1980 there have been major point source upgrades throughout the Chesapeake Bay basin, and Table 1.2 and Figure 1.2 do not reflect these improvements. For example, since 1980 major point source improvements have been implemented at the Blue Plains sewage treatment plant serving the Washington, D. C. metropolitan area. As a result, phosphorus removal levels at this facility are now at or near the limits of technology. With these improvements, it would be more accurate to characterize the Potomac River basin as nonpoint source dominated as opposed to point source dominated for phosphorus.

These estimates of nutrient loadings provide a basis for targeting management and control strategies. The Bay states have used this and other information as a basis for targeting their NPS programs. For example:

- Pennsylvania is focusing its efforts on the high nutrient loads associated with agricultural lands in the lower Susquehanna River basin, which were identified by the watershed model.

- Virginia is focusing its agricultural cost-share program on the more rural sub-basins identified by the watershed model and is developing a geographic information system to further refine its targeting strategy.

- Maryland has developed a more detailed statewide ranking of its watersheds using information other than the watershed model.

- The District of Columbia, one of the largest urban areas in the basin, is focusing its efforts on the urban NPS problems within its boundaries and is giving special emphasis to restoring the Anacostia River.

The Toxics Problem Is Not Fully Defined

While the nutrient loads from nonpoint sources have prompted greater NPS control activity, toxic materials from diffuse nonpoint sources are also of concern. Toxic compounds of concern in the Bay include heavy metals such as cadmium, copper, and lead; organic chemicals such as pesticides and PCBs; and other chemicals like chlorine. [11] These toxic materials enter the Bay from a variety of sources including: industrial and municipal sources; contaminated dredge spoil; the atmosphere; and runoff from urban, agricultural, and shoreline areas.

The 1983 CBP study found that toxic compounds are affecting the Bay's resources, especially in urbanized areas. [12] While low concentrations of toxic compounds may have little effect on organisms, high concentrations can reduce hatching and survival, cause gross effects such as lesions or fin erosion in fish, and eventually destroy an entire population. Toxic pollutants can affect the ecosystem by eliminating sensitive species. The result is a biotic community dominated by a few pollution-tolerant forms. The 1983 study found evidence of such toxic stress in localized areas of the Bay. [13]

Research showed a relationship between the levels of toxic compounds found in the sediment in certain areas, and the survival of individual organisms. For example, those areas of the Patapsco River that have highly toxic sediments support only a few types of organisms, primarily worms. Uncontaminated areas support many different organisms, including crabs, clams, and oysters. [14] These findings reinforce the need for control of toxic compounds.

The CBP study estimated the metal loadings delivered to the Bay from the entire drainage basin, and also sampled organic compounds in the water and sediments of the Bay. In general, the CBP found the Susquehanna, Potomac, and James Rivers to be the major sources of toxics from urban and agricultural land to the Bay. [15] Toxic discharges from point sources and urban runoff appear to be most significant in urbanized/industrialized areas such as Baltimore, Norfolk, and Washington, D.C. [16]

Herbicides Are Not Primary Culprits

The CBP study also intensively evaluated the question of whether herbicides were responsible for the recent decline of submerged aquatic vegetation (SAV) observed in the Bay. In the study, two of the commonly used herbicides in the Bay basin, atrazine and linuron, were selected for detailed monitoring. CBP-sponsored research found ambient atrazine concentrations in the main Bay rarely exceed 1.0 to 5.0 ppb; linuron concentrations were between 2.0 and 3.0 ppb. High concentrations of both herbicides were found in near-field waters (up to 140 ppb); such levels would have significant impacts on SAV in these areas. But with half-lives of 2 to 26 weeks, the levels of these herbicides in the main estuary and the sediments remain relatively low. [17]

It was concluded that herbicides were not the the primary culprit in the decline of the SAV; the study concluded that light was the limiting factor for the Bay grasses. The CBP study was not totally conclusive, however, in excluding pesticides as a problem. Pesticides are just one of many pollutants that, when combined with each other, can cause problems in specific areas.

Over the past several years there has been increasing concern about the impact of pesticides on ground-water quality. Previously, pesticide leaching was considered insignificant. Today, more and more pesticides are being found in ground water, albeit at low levels. [18] Nonetheless, there remains a great deal of uncertainty as to the amount of pesticides entering surface and ground water and the effect these pesticides have on the environment and human health.

TRIBUTYLTIN: TOXIC NPS PROBLEM BRINGS QUICK RESPONSE

Tributyltin (TBT) is an anti-fouling chemical used in boat-bottom paints. TBT is toxic to aquatic organisms at extremely low concentrations--at the parts per trillion level. [19] And yet there is an unusually optimistic aspect to this particular NPS problem. State and Federal agencies and universities are closing in on TBT, quickly developing techniques to study its impacts, devising strategies, and taking actions to restrict its use:

- Maryland and Virginia and the U.S. Navy have all supported separate monitoring programs in the Chesapeake Bay to measure concentrations of TBT in selected harbors and rivers.

- Researchers in Maryland and Virginia have continued to conduct toxicity tests on marine organisms to better understand how toxic TBT may be to Bay organisms.

- At the request of the EPA Office of Pesticide Programs, the EPA Chesapeake Bay Program Office carried out a sampling study of selected harbors in northern Bay waters during the 1986 boating season. [20]

- As part of its special review of the pesticide registration of TBT for use in anti-fouling paints, the Office of Pesticide Programs will incorporate the monitoring and research findings from Bay scientists to determine whether a restriction on the use of TBT is necessary.

- In addition, separate efforts have been pursued by participants in the Bay Program. For example, the Chesapeake Executive Council urged the U.S. Navy not to use TBT-based paints on its fleet until it developed an environmental impact statement or until EPA completed its special review of TBT. Since then, Maryland and Virginia have passed similar legislative actions restricting the distribution and application of TBT in the Chesapeake Bay.

NPS Toxics and Nutrients Need Controls

While various steps have been taken to understand the impact of toxics on the Bay and to address the problems, there is a need for a better understanding of the toxics problem and increased program emphasis. Managers are recognizing this need: they are focusing on eliminating point sources of toxicity and closely examining the use of pesticides like TBT.

In summary, the CBP study found that nutrient and, to a lesser degree, toxic pollutant loadings from nonpoint sources were among the major causes in the decline of the Chesapeake Bay. The study concluded that action was needed to strengthen existing NPS programs and establish new ones. Following is a discussion of the cooperative structure developed to address the point as well as nonpoint source problems in the Bay.

BAY CLEANUP IS GUIDED BY A COOPERATIVE STRUCTURE

The Chesapeake Bay Agreement established the framework for cooperative efforts between Maryland, Virginia, Pennsylvania, the District of Columbia, and EPA to address all pollutant sources in the Bay basin. An Executive Council, representing the signatories to the Agreement, was established in 1984, along with an Implementation Committee, five subcommittees (including a Nonpoint Source Subcommittee), and two advisory boards (see Figure 1.3).

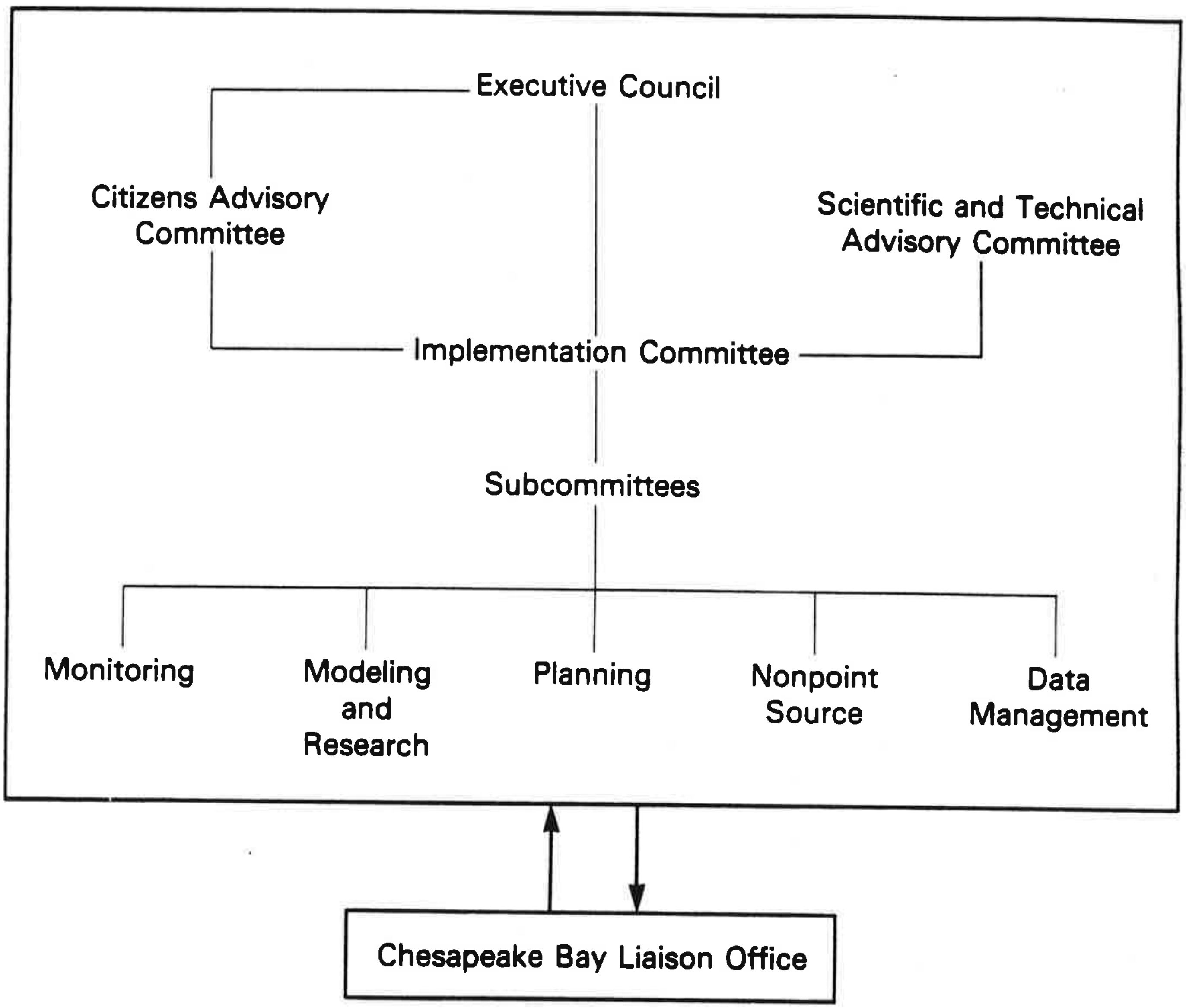
The Chesapeake Bay Liaison Office was set up in Annapolis, Maryland to coordinate and support the activities of the various groups. Also in 1984, several Federal agencies joined the Bay states and the District to expand the partnership to clean up the Bay. To enhance interagency cooperation and coordination, Memoranda of Understanding (MOU) were negotiated and signed between EPA and the U.S. Fish and Wildlife Service (F&WS), the Soil Conservation Service (SCS), the National Oceanic and Atmospheric Administration (NOAA), the U.S. Army Corps of Engineers (COE), and the U.S. Geological Survey (USGS). EPA and the Department of Defense signed a Joint Resolution on Pollution Abatement in the Chesapeake Bay.

FUNDING REFLECTS PRIORITY FOR NPS ABATEMENT

This Federal support and cooperation was spurred by President Reagan's reference to the Chesapeake Bay as a "special national resource" in his January 1984 State of the Union message and his pledge of $10 million a year for 4 years--beginning in FY 1985--to enhance cleanup efforts. [21] In FYs 1985 through 1987, EPA has provided approximately $7 million of CBP implementation grant funds each year to the Bay jurisdictions for implementing programs to protect and restore the Chesapeake Bay. The remaining funds are used to support the operations of the EPA Chesapeake Bay Liaison Office. Among its activities are a variety of monitoring and modeling projects, management of data on Chesapeake Bay cleanup efforts, coordination with the participants in the Bay agreement, and support for the Chesapeake Bay Executive Council and its committees and subcommittees.

Each state has received 30% of the CBP implementation funds and the District has been granted 10%. The four jurisdictions are required to match the Federal grants dollar for dollar. In 1984, the Executive Council adopted a policy requiring that not less than 75% of the CBP implementation grant funds must support NPS pollution control efforts, a policy that was affirmed in 1986. The rationale for this decision was twofold: the documented but largely uncontrolled nutrient and toxic loadings to the Bay from nonpoint sources, and the recognition that Federal, state, and local agencies had already done much to control point sources of nutrients (wastewater treatment plants) in the Bay basin.

FIGURE 1.3 CHESAPEAKE BAY PROGRAM MANAGEMENT STRUCTURE



For example, between 1972 and 1983, the Federal government and state/local jurisdictions spent nearly $3.3 billion to improve wastewater treatment facilities in the Chesapeake Bay basin. [22] These efforts resulted in dramatic reductions in phosphorus loadings from point sources in many areas of the Bay and are reflected in the point source load reductions estimated for the Bay. Nonpoint sources have traditionally not received the same level of recognition, emphasis, or funding as have point sources. The Executive Council recognized the need to use the new CBP implementation grant funds to strengthen existing state NPS control programs and to develop new ones.

THE WATER ACT GIVES THE BAY EFFORT NEW IMPETUS

The Federal commitment to the Bay was reinforced by the new statutory recognition of the Chesapeake Bay Program in the recently enacted Water Quality Act of 1987. A new section of the Act (Section 117) directs EPA to continue the CBP, to maintain an office to coordinate Federal and state cleanup efforts, and to continue to assess and report on the problems of the Bay. Section 117 authorizes $3 million for FY 1987 through 1990 for these support activities and also provides $10 million per year in grants to the states. These grants support continuing implementation of portions of the management programs identified in the Chesapeake Bay Restoration and Protection Plan. (This plan, developed in 1985, contains the agreed-upon goals for Bay cleanup and a summary of programs being implemented to achieve those goals.) [23]

The Water Quality Act of 1987 also established a new section requiring all states to develop programs to manage nonpoint sources of pollution (Section 319). Section 319 specifically requires states to prepare, within 18 months of enactment, an assessment report of their NPS problems and a management program for addressing NPS problems in the next 4 fiscal years. The Act authorizes $400 million over the next 4 years for grants to states for implementation of approved management programs. Thus, given this new mandate in the Act, the Bay states and the District will have additional support for NPS management efforts both within and outside the Bay basin.

BAY PROGRAM DATA REVEAL PROGRESS

Since 1984, the four Bay jurisdictions have intensified their existing NPS programs and have developed new ones. Each has made major strides in its NPS programs. As noted above, among the major accomplishments since 1984 has been the development of the institutional structure to address the NPS challenges in the Bay. Programs have been developed to address agricultural, urban, and other nonpoint sources of pollution and have resulted in a significant increase in the number of conservation practices being put on the ground.

After nearly two years of BMP implementation, funds leveraged with CBP grants enabled the three Bay states to install agricultural BMPs on approximately 203,640 acres, and reduced erosion on those acres by about 1,446,900 tons. BMPs reduced phosphorus losses from cropland and animal waste by more than 23 million pounds within the Bay basin, while nitrogen losses were cut by about 11.5 million pounds from those sources. In the same timeframe, 544,000 tons of animal waste were managed. ASCS funds contributed very significantly to these totals.

In general, these three states have placed greater emphasis on controlling agricultural nonpoint sources than other nonpoint sources due to the documented nutrient loads associated with cropland and the relatively well understood transport of these nutrients to the Bay. In contrast, the nutrient loadings from urban areas in the Bay basin are much smaller and the impact of toxics in urban runoff is not nearly as widespread as the nutrients from other nonpoint sources.

STATE APPROACHES DIFFER BUT SHARE BASIC SIMILARITIES

The Bay states and the District have developed a variety of approaches to address the NPS problems in the Bay. Their programs reflect the diverse problems and priorities in each of the jurisdictions. Furthermore, each jurisdiction began with a different base of laws and regulations for its NPS programs and a varying, but finite, amount of resources. Given these differences, direct comparisons between the NPS budgets and programs of the Bay states are inappropriate.

Nonetheless, there are commonalities among approaches in the agricultural and urban NPS programs, as well as programs for other nonpoint sources, some of which are highlighted in the following sections.

Agricultural Programs Involve Vital Support from USDA

The Chesapeake Bay states are relying primarily on voluntary cost-sharing programs to carry out their NPS objectives for agriculture. Cost-share programs are helping farmers throughout the region to reduce soil loss and associated nutrient loads to the Bay. Farmers are also learning how to save money by implementing management practices designed to reduce fertilizer use, which also helps decrease nutrient loss in runoff. Program components common to all the agricultural NPS programs include: education, technical assistance, financial assistance, targeting strategies, limited regulatory/enforcement backup, monitoring, and demonstration projects. In all the states, the conservation districts play an important role in program activities. In cooperation with staff supported by states, local governments, and the USDA, district personnel help disseminate information, demonstrate BMPs, provide technical assistance, and administer funds.

State NPS programs for agriculture all build upon the soil erosion control programs begun in the 1930s with the establishment of the network of soil and water conservation districts. State programs are also founded upon the NPS work initiated in the 1970s under Section 208 of the Clean Water Act (P.L. 92-500), which encouraged, among other things, a greater emphasis on water quality in agricultural programs. The administrative structures of the new, intensified agricultural NPS programs in the three Bay states, however, were developed very recently to address the water quality problems of the Chesapeake Bay. These relatively new state agricultural NPS programs are still in a period of evolution and refinement.

Several USDA agencies, including the Soil Conservation Service (SCS), the Agricultural Stabilization and Conservation Service (ASCS), and the Cooperative Extension Service (CES), have provided substantial support to the states and individual conservation districts in carrying out the objectives of the new state agricultural NPS programs. For example, in an MOU with EPA, the SCS promised to help train state and Federal agency personnel to apply best management practices, provide technical supervision, and provide technical standards and specifications for the cost-share programs. [24] ASCS has provided support in carrying out the administrative aspects of some state agricultural NPS programs. CES assists with the educational component of the programs, including the dissemination of information to farmers on nutrient management, including manure and fertilizer application.

These programs involve direct contacts with land managers and are a key to NPS control in agriculture, as well as other nonpoint activities such as forestry. USDA's new Conservation Reserve Program (CRP), for example, will help address the NPS problems in the Chesapeake Bay basin by removing highly erodible land from production. During the four sign-ups of the CRP completed by March 1987, about 45,000 acres of highly erodible land in the Chesapeake Bay Basin were retired and will be converted to grass or trees. [25] Other USDA programs such as the Dairy Termination Program, the Agricultural Conservation Program (ACP), and the Rural Clean Water Program help address the agricultural NPS problems of the Bay.

All States Practice Multi-level Targeting

Although each of the Bay states has developed a different approach to targeting its agricultural NPS program, all of them conduct targeting at several levels:

- First, each of the states has targeted general geographic areas where it will emphasize implementation of agricultural NPS controls.
- Second, once a general area has been identified, all the states have procedures to target the critical areas and management needs within these areas.
- Third, state and local staff identify cost-effective, site-specific management practices for individual landowners and users.

In addition, each CBP state has identified demonstration/research watersheds where agricultural NPS controls are being implemented, and is assessing the impact of these controls on surface and ground water and fishery habitat. States will use the results of these monitoring efforts to refine their targeting strategies. Educational programs are also being targeted to the agricultural community. Maryland, Virginia, and Pennsylvania recognize the need for basinwide educational efforts, since the agricultural NPS problems in the Bay are not isolated to a few small watersheds, but are Bay-wide.

In 1985, the Executive Council reinforced the need for targeting of NPS implementation efforts. Specifically, it refined the CBP state implementation grant funding criteria to emphasize that "NPS implementation efforts should be concentrated in targeted hydrologic units or targeted to types of sources for which solutions are not known." [26]

Examples of types of sources for which innovative approaches are being developed include urban runoff controls and approaches for managing excessive quantities of animal waste. The criteria were also revised in 1985 to emphasize that a project funded with CBP implementation grant funds should represent "an incremental step in a phased, long-term commitment to determine effective new programs or [be] part of a comprehensive abatement program in a specific hydrologic unit or watershed." [27]

Urban Programs Lean More Toward Regulation

There are similarities in the urban NPS control programs as well. First, the urban programs in each of the four jurisdictions tend to be more regulatory than the agricultural programs. For example, all the Bay states and the District have enacted regulatory programs to control erosion and sedimentation from construction activities in developing areas. Typically, builders must submit plans to conservation districts or other local government agencies for certain land-disturbing activities, showing how they will minimize erosion and sedimentation. If the plans are approved, permits are then issued and follow-up inspection/enforcement is done as necessary.

In addition, the CBP jurisdictions either have or are considering new programs to address stormwater management from developing urban areas. While these programs differ in scope and authority, they generally involve review, approval, implementation, and enforcement of stormwater management plans. Historically, stormwater management has focused on water quantity, but state and local staff are increasingly emphasizing consideration of water quality.

The urban sediment control programs in the CBP states and the District have existed since the 1970s, but the stormwater management programs for developing areas are much newer. Several of the Bay jurisdictions participated in EPA's Nationwide Urban Runoff Program (NURP), which was among the first attempts to assess the impact of stormwater runoff on receiving waters and the effectiveness of urban control measures in reducing such impacts.

There is a continuing effort in the basin, with the support of CBP funds, to demonstrate the effectiveness of innovative urban stormwater management practices. These include porous pavement, infiltration trenches, dry extended-detention basins, and grassed waterways. Such practices are being demonstrated in urban developments and being used to "retrofit" existing urban areas.

Urban NPS programs also rely upon the support and assistance of state, conservation district, and USDA agency staff. In addition, staff in local public works departments are often involved in carrying out the sediment control and stormwater management programs. All the jurisdictions face the challenge of having simultaneously to develop and implement new practices to control urban runoff. Various innovative approaches to urban NPS control are being tested for the first time in the region.

Urban NPS controls have been targeted within the urban areas in each of the jurisdictions in the Bay. To date, the efforts have generally not been concentrated in any particular watershed areas. The first attempt at developing a watershed-wide approach to urban NPS problems will likely be in the Anacostia River basin.

All Programs Also Address Other Nonpoint Sources

The CBP states and the District also have various programs to address other nonpoint sources such as forestry and mining activities, shoreline erosion, and highway runoff. Their components are similar to those in agricultural and urban programs and include education, technical assistance, financial assistance, demonstration projects, and regulatory aspects.

Each of the Bay states has a well-developed forestry program that encourages proper forestry management and provides incentives like tax benefits for tree planting. Keeping land in forest land use or reestablishing trees on marginal land is an important management practice. Studies in the Bay basin and elsewhere indicate that NPS pollutant loadings are lower from forests than from other land uses.

The Bay states also have mining programs to address existing as well as abandoned mines. New mining activities in the Bay basin must have permits that contain reclamation requirements. The Bay states also have programs for reclaiming abandoned mines; reclamation activities for an abandoned sand and gravel pit in the Anacostia basin has been supported with CBP implementation grant funds.

Maryland and Virginia have programs to assist landowners in installing both structural and non-structural practices for shoreline erosion control. These programs involve providing advice to landowners on approaches to shoreline protection and also include projects to demonstrate effective shoreline protection measures; CBP implementation grant funds have supported several shoreline erosion control demonstration projects.

The Bay state highway departments require management of runoff from highway construction projects. Highway departments typically have standards and specifications for erosion/sediment and runoff control for highways, and these standards must be met in highway construction.

EPA AND OTHER FEDERAL AGENCIES SUPPORT STATE NPS INITIATIVES

While the four CBP jurisdictions actually carry out the various NPS control programs in the Bay watershed, EPA's Chesapeake Bay Liaison Office provides administrative support and analytical services that knit their efforts together. These functions include overall coordination, public information and participation, data management and analysis, grant and contract administration, committee support, and provision of technical advice.

In the NPS area, EPA's role in funding state and District NPS initiatives for the Bay has been significant. The NPS Subcommittee, established in 1985, has provided an important mechanism for information transfer regarding NPS programs in the Bay. To date, this Subcommittee has emphasized discussion of the new agricultural NPS initiatives for the Bay. Recently an urban work group has been established under the Subcommittee to address approaches to this nonpoint source. The NPS Subcommittee was also integrally involved in producing this report.

Other Federal agencies have given special geographic focus to the Chesapeake Bay and provide important support for addressing the various NPS problems discussed above. The Bay states particularly rely on the USDA agencies for personnel and expertise to help deliver the agricultural NPS programs in the Bay. Other agencies such as USGS, F&WS, COE, and NOAA also provide important information for problem assessment.

RECOMMENDATIONS FOR THE FUTURE IDENTIFY AREAS OF CONSENSUS AND EMERGING ISSUES

Issues and recommendations regarding the future directions for the Chesapeake Bay nonpoint source programs over the next four years were developed through a series of discussions with the Chesapeake Bay Nonpoint Source Subcommittee in 1987. The consensus reached by the NPS Subcommittee was then reviewed by the Chesapeake Bay Implementation Committee and others. Chapter 5 presents these recommendations in full, along with the action plans supporting each. The sections that follow here highlight the main features.

NPS Program Recommendations

These recommendations represent a clear consensus among Bay jurisdictions on the nature of the problem and how to address it, often expanding on current program efforts.

- Recommendation 1: Assure program continuity by enhancing long-term institutional structures. Recommended actions include developing staffing plans and assessing the existing institutional structure for the various elements of the program such as the institutional capability in the urban area.

- Recommendation 2: Expand technical capabilities and cooperation needed to solve Bay problems. Actions include developing interdisciplinary teams at the state level to manage NPS programs, developing a NPS information clearinghouse, and expanding training opportunities.

- Recommendation 3: Bring additional Federal agencies into the program. Establishing MOUs with such agencies as USDA's Cooperative Extension Service and Forest Service, and DOI's National Park Service will formalize and help augment their involvement in achieving program goals. Actions include establishing MOUs between EPA and those agencies having land management or program responsibilities in the Bay, and providing guidance to EPA Regional Offices on development of such agreements.

- Recommendation 4: Increase analyses/assessments of BMP effects on ground water. Recommended actions include accelerating the rate of research activities in this area, modifying programs based on research results, and developing long-term monitoring strategies to determine program effects.

- Recommendation 5: Develop ways to improve program efficiency and effectiveness. Recommended actions include developing incentives to increase the life of cost-effective BMPs, increasing the water quality emphasis of stormwater management programs, and assessing options in all programs (e.g., structural vs. nonstructural BMPs).

- Recommendation 6: Expand public outreach efforts to enhance voluntary BMP implementation. Recommended actions include using models to target critical land areas for outreach, adjusting incentives, developing educational materials, and conducting award programs.

Moving Beyond Traditional NPS Efforts

These recommendations are supported by at least some Bay program participants, but agreement has not yet been reached on the best ways to implement them.

- Recommendation 7: Integrate Bay program activities into comprehensive state NPS programs. Action items include having Bay states review all available funding sources and maximize NPS efforts related to the Bay, and encouraging Delaware, New York, and West Virginia to address Bay-related problems as part of their NPS programs.

- Recommendation 8: Nutrient reduction goals should be set for the program. Some states are currently involved in this type of effort. A Bay-wide effort would provide direction and assist the states in this undertaking. Action items recommend that nutrient reduction goals be set for agricultural lands within each major basin.

- Recommendation 9: Add sediment criteria to existing tools for achieving program goals. Sediment criteria are needed; current research and modeling results show that sediment is a key factor in undermining Bay water quality. Action items include research to develop sampling and analysis techniques for sediment in fresh and marine waters, and development of sediment criteria.

- Recommendation 10: Integrate appropriate toxics control into NPS programs. To date no Bay-wide effort has been made to address toxic pollutlants. The impact of toxics on Bay resources needs to be better understood and appropriate actions taken to address problem areas. Action items include establishing a workgroup and conducting additional monitoring to investigate and better define the problem.

- Recommendation 11: Enhance land management programs for areas adjacent to the Bay. These lands contribute pollutants directly to waterways. There is little or no opportunity for removal or settling. Both intensely developed areas and more rural ones should be addressed. Action items include encouraging localities to develop land management techniques that protect water quality, providing the technical support that will aid that effort, identifying critical areas and enlisting landowners' cooperation, and conducting an educational effort to heighten public awareness.

Emerging Issues

As the Bay program continues to develop, issues arise that may affect its future direction. These issues will be subject to discussion among participants and will need resolution. Background on these issues is provided in Chapter 5. Some current issues facing the program include:

- Issue 1: Improved understanding of remaining problems may suggest revised allocation of funds among states and watersheds. The rate of progress in cleaning up the Bay may be increased if funding allocation is more closely tied to the relative impact of individual jurisdictions and watersheds on water quality and living resources. Improved targeting for decision-making and resource allocation will result as better data on living resource impacts become available.

- Issue 2: Cost-effectiveness studies may affect BMP decisions. Some BMPs are more cost effective than others. To what extent should program decisions be based solely on this factor? Currently there appears to be no clear rationale for dividing cost-share funds between cropland treatment and animal waste management.

- Issue 3: Regulatory control of animal waste may be appropriate and effective. It has been suggested that permit programs already in place could be used as the main method to gain control of animal waste, with cost-sharing limited to technical assistance for nutrient management.

Given that each jurisdiction in the Bay program is at a different point in its efforts, the recommendations discussed above will not apply equally to each. The Bay states, the District, and other participants should review these recommendations and assess what they can do better in relation to each. Further discussion among program participants to resolve remaining issues and new issues as they develop will ensure continued progress. The success of the Bay effort clearly relies on the continued cooperative efforts of all agencies involved at the Federal, state, and local levels.

CHAPTER 1: REFERENCES

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2. STATE NONPOINT SOURCE PROGRAMS

THE CHESAPEAKE BAY PROGRAM JURISDICTIONS

The Chesapeake Bay Program (CBP) is a voluntary, cooperative effort among the three Bay states, the District of Columbia, EPA, and other Federal agencies. CBP initiatives may address both point and nonpoint source (NPS) problems as part of a comprehensive effort to clean up the Bay. However, EPA funds are primarily directed toward nonpoint source controls.

The four jurisdictions that are part of the Chesapeake Bay Program are working on a common problem, each seeking to reduce its share of that problem and thus achieve a joint solution. The balance of this chapter must likewise respect state lines and describe the discrete efforts of Virginia, Pennsylvania, Maryland, and the District of Columbia. Each has a different nonpoint source "profile" in its mix of problem sources, level of available resources, and organizational and programmatic structure.

Following are four sections that provide a very brief overview of NPS programs, approaches, resources, and problems in Virginia, Pennsylvania, Maryland, and the District of Columbia.

Virginia

Approximately two-thirds of Virginia's land area is drained by Bay tributaries, and Virginia comprises about one-third of the Bay's drainage area. Nonpoint sources are significant contributors to the pollution problem in most of Virginia's river basins, accounting for as much as 80% of the phosphorus and 86% of the nitrogen load to the rivers and the Bay.

Virginia has received a total of $5.13 million from EPA in Bay program grants from 1984 to 1986. The program has focused on agricultural problems, but includes management of urban and other nonpoint sources as well. The state has built its program around a combination of research and education, technical assistance, and financial incentives. Program activities are managed overall by the Division of Soil and Water Conservation in the Department of Conservation and Historic Resources and involve a significant degree of cooperation with Federal, State, and local agencies, as well as citizen groups.

Pennsylvania

About 35% of the Chesapeake Bay basin is located in Pennsylvania, and the basin drains about 50% of the State. The Susquehanna River is the only major river basin in Pennsylvania draining to the Bay and has been identified as the largest riverine source of nitrogen and phosphorus to the Bay. EPA has noted that runoff from agricultural lands is responsible for the largest fraction of these nutrients: 60% of the phosphorus and 85% of the nitrogen entering the Bay from this basin comes from cropland runoff. Forty-one percent of the Susquehanna's NPS load to the Bay comes from the lower Susquehanna basin (below Sunbury).

Pennsylvania has chosen to pursue a non-regulatory approach to its Bay program, with voluntary cooperation solicited from landowners. However, the State is prepared to expand regulatory measures and increase enforcement of existing regulations if the voluntary programs do not achieve expected results.

To date, EPA implementation grants totalling $5,256,475 between 1984 and 1986 have gone to support Pennsylvania's NPS Bay program effort. These funds have been used to conduct watershed assessments, monitoring, and educational activities; support technical assistance to conservation districts and landowners; and provide financial support to landowners through the cost-sharing program.

Maryland

More than 96% of Maryland's territory--which includes both highly agricultural and intensely urbanized areas--drains into the Chesapeake Bay. The State makes up around 15% of the entire basin. Among the Bay Program jurisdictions, Maryland is second only to the District of Columbia in the portion of its urban land use (18%) within the Bay drainage. [1] Consequently, Maryland has focused a great deal of attention on both agricultural and urban nonpoint sources. In addressing problems related to agriculture, the State is emphasizing voluntary compliance supported by education, technical assistance, and research, although State enforcement authority is an avenue when voluntary compliance fails. The program's approach for urban erosion control and stormwater management combines technical assistance to localities and regulatory controls.

Maryland's long history of management attention to water quality and other vital resources was enhanced by the 34 Bay-wide initiatives it developed in 1984. Many of these initiatives are directly related to NPS pollution control. These new and expanded programs have helped sharpen the focus on NPS pollution in the Bay. The State has received $5 million in EPA grants since 1984 to support the Chesapeake Bay Restoration and Protection Plan.

District of Columbia

The entire District of Columbia drains to the Chesapeake Bay, but its land area is small compared to the other jurisdictions: less than 1% of the Bay drainage. Urban runoff is the sole nonpoint source, although management efforts must be applied to diverse urban pollution problems like soil erosion and oil from vehicle repair facilities.

The District has received a total of $1,418,825 in Bay program implementation grants. These funds are split between two agencies--the Department of Consumer and Regulatory Affairs and the Department of Public Works--that work on different aspects of the problem.

Table 2.1 summarizes the EPA implementation grants awarded for Bay cleanup. The 50% state match is included in these figures.

TABLE 2.1 CHESAPEAKE BAY IMPLEMENTATION GRANT FUNDS: COMBINED FEDERAL AND STATE MONIES

	FY 1984	FY 1985	FY 1986
Virginia	$1,750,000	$4,350,000	$4,162,950
Pennsylvania	2,000,000	4,350,000	4,162,950
Maryland	1,750,000	4,350,000	4,402,550
District of Columbia	454,546	1,450,000	1,387,650

ROAD MAP TO STATE PROGRAM DESCRIPTIONS

The remainder of Chapter 2 provides the details of each jurisdiction's NPS programs. The material has been written primarily from the States' perspective, with an emphasis on those parts of the program that have been funded with EPA Chesapeake Bay Program grants. The State program descriptions were based upon interviews with State staff and review of program documentation.

Because each jurisdiction's program is unique, the descriptions that follow were not tractable to a wholly consistent format. However, each description has a basic structure:

- An introduction, including the organization of the agencies that administer the NPS program
- The Agricultural NPS Control Program (except for DC)
- The Urban NPS Control Programs
- Other NPS Control Programs

Descriptions of the agricultural and urban NPS programs contain the following elements:

- Introductory material on program goals, history, approach, NPS problems, etc.
- Targeting Approach
- Implementation: BMPs and Technical Assistance
- Research and Demonstration Projects
- Education
- Enforcement

VIRGINIA

BALANCING INCENTIVES AND ASSISTANCE

Virginia's philosophy about nonpoint source management is that an effective program must carefully support three basic components: research and education, technical assistance, and financial incentives. The program's effectiveness would be seriously impaired if any one component were eliminated. The voluntary nature of the program increases the importance of the three-part approach.

Several agencies are involved in managing NPS pollution in the Commonwealth of Virginia, as described in the sections that follow. The Division of Soil and Water Conservation in the Department of Conservation and Historic Resources serves as the lead agency for both agricultural and urban programs and coordinates overall program efforts. The Division's Technical Services staff manages both programs, while District Operations implements the cost-share and technical assistance programs.

Virginia has received a total of $5.13 million in Bay Program grants from 1984 to 1986. The program has focused on agricultural problems, but includes management of other nonpoint sources as well. The allocation of State and Federal funds for the Bay Program is summarized in Table 2.2.

Although primary emphasis of the State program is on control of agricultural nonpoint sources, the State is addressing all forms of NPS pollution. State programs have been designed to dovetail with existing programs to augment both the agricultural and other NPS control efforts. For example, USDA's Agricultural Stabilization and Conservation Service (ASCS) takes applications for State cost-share assistance along with applications for its own Agricultural Conservation Program. Advice, technical assistance, and education are provided by the Soil Conservation Service (SCS) and Cooperative Extension Service. Other participating State programs are discussed later (see "Other NPS Programs," below). One of the highlights of this program has been the degree of cooperation achieved among the wide spectrum of Federal, State, and local agencies and citizen groups involved.

The contribution of nonpoint sources to the Bay's pollution from any state is difficult to quantify because monitoring is incomplete and models are imprecise. The Chesapeake Bay watershed model indicates that 67% of nitrogen and 39% of phosphorus come from nonpoint sources Bay-wide. Agriculture is estimated to contribute 45-70% of the nonpoint nitrogen load and 60-85% of nonpoint phosphorus Bay-wide. Some of Virginia's river basins draining into the Bay vary considerably from these figures, however. As Table 2.3 shows, the NPS contribution of nitrogen ranges from 42% in the James basin to 86% in the Rappahannock basin (based on 1985 data). NPS phosphorus contributes 20% of the load in the James basin and 80% in the Potomac watershed. [2]

TABLE 2.2 COMBINED STATE AND FEDERAL FUNDING FOR VIRGINIA'S BAY PROGRAM*

PROGRAM AREA	FY 1984-85 FUNDING	FY 1985-86 FUNDING	FY 1986-87 FUNDING
BMP Cost Share	$730,000	$1,671,500	$1,260,000
Program Management	$80,000	$156,000	$177,400
Technical Assistance	$390,000	$450,000	$585,000
Agricultural Education	$120,000	$131,850	$143,700
Nutrient Management	$0	$0	$70,000
Research/Demonstration	$160,000	$270,922	$367,800
Data Base	$85,000	$252,839	$358,600
Urban BMP Demonstrations	$185,000	$422,889	$174,400
Urban Education Programs	$0	$72,500	$29,775
Other NPS Programs	$0	$171,500	$339,800
Chlorine Discharge Control (in-kind match)	$0	$750,000	$0
Land Management Program (in-kind match)	$0	$0	$656,475
TOTAL (Federal+State)	$1,750,000	$4,350,000	$4,162,950
State Funds	$875,000	$2,175,000	$2,081,475

*Includes Chesapeake Bay Program implementation grants only (EPA funds and State match).

Sources:
1. Agricultural Pollution Control Plan for the Chesapeake Bay and Chowan River Drainage Basins (FY 1984 Application for Federal Assistance from the Chesapeake Bay Program), Dept. of Conservation and Historic Resources, Division of Soil and Water Conservation, 1984.
2. Chesapeake Bay NPS Pollution Control Program Implementation Plan for FY 1985-86 (FY 1985 Application for Federal Assistance from the Bay Program), Dept. of Conservation and Historic Resources, Division of Soil and Water Conservation, 1985.
3. Chesapeake Bay NPS Pollution Control Program Implementation Plan for FY 1986-88, Dept. of Conservation and Historic Resources, Division of Soil and Water Conservation, 1986.

TABLE 2.3 VIRGINIA'S RIVER BASIN CHARACTERISTICS AND NONPOINT SOURCE CONTRIBUTIONS (1985)

	POTOMAC	RAPPAHANNOCK	YORK	JAMES	EASTERN SHORE
Nonpoint Nitrogen Contribution (% of Total)	59	86	74	42	63
Nonpoint Phosphorus Contribution (% of Total)	80	60	42	20	36
Land use Percentages:					
• Cropland	11	15	16.8	10	40
• Pasture Land	26	20	13	14	8.5
• Urban	7	1	0.2	3	1.5
• Forest	56	64	70	73	50
Basin Size (Square Miles)	14,669*	2,631	2,986	10,495	<1,000

* 42% in Virginia

Source: Progress Report of Virginia's Chesapeake Bay Program, Council on the Environment, February 1987.

The overall contribution of urban and other sources appears to be small compared to agricultural sources, as most of the land in the Chesapeake Bay drainage area is rural. The Potomac basin has the highest percentage of urban area (7%) and also the largest amount of urban land, since it is the largest watershed. Highway construction, forestry operations, shoreline erosion, and other sources such as mining and on-site waste disposal systems contribute to NPS pollution, but their effects have not been quantified.

CBP Funds Have Leveraged Virginia's NPS Programs

The Bay program has had the effect of organizing and focusing State efforts on NPS problems. In the 1970s, the State NPS program only consisted of water quality management plans under Section 208 of the Clean Water Act. While Virginia has had an erosion and sediment control law since 1973, the urban demonstration projects are entirely the result of the Bay program. Local governments have provided partial funding for the projects implemented in most cases. Local governments have also funded 25% of the cost of the staff positions provided to conservation districts for erosion and sedimentation plan review and technical assistance for agricultural and urban efforts through Bay program funding.

Virginia's agricultural cost-share program was initiated in response to the Chesapeake Bay program. The Bay program has accelerated the cropland BMP program and has greatly increased the installation of animal waste facilities beyond what USDA programs could fund. Farmers must contribute part of the cost, but they could not afford the whole cost, particularly of the expensive animal waste facilities.

VIRGINIA'S AGRICULTURAL NPS CONTROL PROGRAM

History and Approach: A Three-Pronged Assault on Agricultural Pollution

Virginia's agricultural NPS control program, as described in the following sections, is based on a three-part approach of education, technical assistance, and incentives for implementing BMPs. It places considerable emphasis on education and demonstration projects as ways to gain program participation and otherwise improve farm conservation practices. Table 2.4 shows how Federal and State funds have been used to support these activities.

Virginia's agricultural erosion control program began in the 1930s with the establishment of the network of soil and water conservation districts. In 1983, the program began to focus on particular water quality problems. The Chowan River received early attention because of water quality problems identified by North Carolina, and the State established a limited cost-share program to begin to address these problems. A full-scale State cost-share program was established in 1984 by the General Assembly to address NPS problems in the Chesapeake Bay basin of Virginia as well as in other areas of the State. The General Assembly appropriated $1.75 million for a 2-year period, which was supplemented by $843,655 in EPA funding from the Bay program. This cost-share program is designed to encourage voluntary application of BMPs by farmers.

TABLE 2.4 COMBINED STATE AND FEDERAL FUNDING FOR VIRGINIA'S AGRICULTURAL NPS PROGRAM

PROGRAM AREA	FY 1984-85 FUNDING	FY 1985-86 FUNDING
Agricultural BMP Cost Sharing	$817,466	$1,495,603
Agricultural Program Management	$90,675	$143,123
Technical/Administrative Assistance	$415,883	$705,237
Agricultural Education	$140,104	$174,188
Agricultural Research/ Demonstration	$152,020	$283,268
Data Base	$68,678	$248,141
TOTAL (Federal+State)	$1,684,826	$3,049,560
State Funds	$838,653	$1,184,763

Sources: Chesapeake Bay Nonpoint Source Pollution Control Program First Annual Report, July 1, 1984-June 30, 1985, Division of Soil and Water Conservation, Dept. of Conservation and Historic Resources, 1985, p. 23.

Chesapeake Bay Nonpoint Source Pollution Control Program Annual Report, July 1, 1985-June 30, 1986, Division of Soil and Water Conservation, Department of Conservation and Historic Resources, 1986, p. 25.

Staffing for the agricultural program includes both State-level staff and support staff for the conservation districts. Currently, one State staff position in the Technical Services group is assigned to the agricultural program. He is assisted by three individuals on assignment from federal programs (USDA's SCS and Cooperative Extension Service), through Intergovernmental Personnel Act transfer. The six District Operations staff provide field support and technical assistance to the agriculture program and are shared with the urban program.

Originally, the erosion control program's home was under the Secretary of Commerce and Resources as the Soil and Water Conservation Commission. In 1984, the Commission became a division of the Department of Conservation and Historic Resources--the Division of Soil and Water Conservation (DSWC). A committee assembled by the Commission helped develop a comprehensive agricultural pollution abatement program with emphasis on the Chesapeake Bay, expanding upon past efforts.

Targeting Approach: Choose Problem Cropland and Animal Concentrations

The Virginia agricultural NPS program is designed to improve water quality through a cost-share program to encourage farmers to implement BMPs. Conservation districts distribute the funds. They receive Bay funds on the basis of an analysis of agricultural factors that affect water quality within their jurisdiction, such as cropland cultivation, intensity of use, soil erosiveness, and numbers of animals.

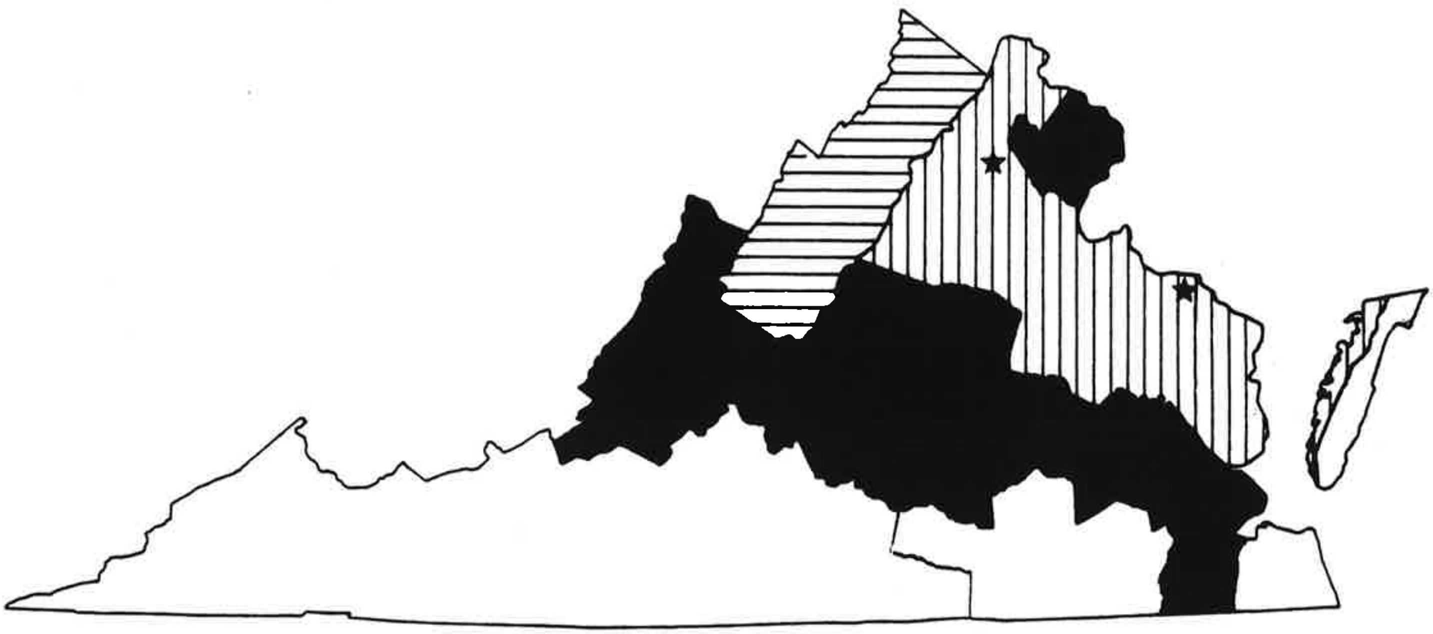
Since the funds available to pay for BMPs cannot possibly match the existing need, State staff developed a multi-level approach to allocating funds. The general areas of the State that contribute to Bay pollution were established as described in the results of the Chesapeake Bay study published in 1983.

The dominant problems are cropland in some areas and animal waste in others. Thus, the State established priority areas to focus on different problems based on the 1983 study's modeling results, which showed that the largest agricultural nutrient loads came from the York and Rappahannock River basins and the Eastern Shore. This area was designated as the Cropland Priority Area and receives 50% of the available Bay program cost-share funding. The Shenandoah Valley contains many intensive animal-waste producing facilities, and was chosen to receive 30% of the cost-share funds. The remaining 20% of the program's cost-share funds have been allocated to the remaining portion of the Bay drainage area. It should be noted that BMP funding for this area comes entirely from State sources; EPA funds are targeted to the higher priority areas. The priority areas are illustrated in Figure 2.1.

The use of funds in each area is restricted to certain BMPs:

- Level I, Chesapeake Bay Program Area--Includes 13 local conservation districts covering 31 counties in addition to those included in Levels II-A and II-C. Districts were funded at base level and allowed to choose from 14 BMPs offered. A maximum of 30% of the district allocation could be utilized for animal waste control facility BMPs.

FIGURE 2.1 AREAS TARGETED FOR AGRICULTURAL BMP COST-SHARE FUNDS IN VIRGINIA



Chesapeake Bay Program Area (Level I) (68 Counties)

Animal Waste Priority Area (Level II-A) (7 Counties)

Cropland Priority Area (Level II-C) (23 Counties)

★ Demonstration Watersheds (Level III)

Portion of Virginia not draining to the Bay (includes Virginia Program Area [29 Counties] and Chowan River Program Area [6 Counties])

Source: 1987 Virginia Agricultural BMP Cost-Share Program, Virginia Department of Conservation and Historic Resources, Division of Soil and Water Conservation, July 1986, p.1.

- Level II-A, Animal Waste Priority Area--Includes three districts covering seven counties. Districts were funded at an accelerated rate due to high animal waste production. A minimum of 85% of the district allocation must be spent for animal waste control. Up to 15% could be allocated for other BMPs.

- Level II-C, Cropland Priority Area--Includes nine districts covering 24 counties. Districts were funded at an accelerated rate due to the high percentages of cultivated land and the resulting water problems in the York and Rappahannock River basins and the Eastern Shore. A minimum of 70% of the district allocation must be spent on soil erosion BMPs. Up to 30% can be utilized for animal waste control.

- Level III, Demonstration Watersheds--The Bay program includes two demonstration watersheds indicated on Figure 2.1.

- Level III, Shellfish Enhancement Area--Funds are available for BMP cost sharing for identified sources of pollution, typically animal waste, contributing to closure of shellfish harvesting areas in the Bay.

In each area where applications for assistance exceed available funds, the applications are ranked on the basis of cost effectiveness. A cost-effectiveness factor is developed using the estimated cost of the BMP, the life of the practice, the gross erosion rate, and the delivery ratio (pollution reduction potential to the nearest stream divided by distance to the nearest stream). The result is the relative cost of keeping one ton of sediment out of the nearest stream over the life of the practice.

The current program has shifted to try to target problem lands within each area (i.e., Levels I, II-A, and II-C) with outreach efforts focused on those lands. This targeting effort is based on the information in VirGIS, the Virginia Geographic Information System. The data base is complete for the York and Rappahannock watersheds, and the Shenandoah Valley area counties will be ready for analysis by July 1987. VirGIS provides a water quality basis for conservation districts to use in deciding which application to fund. EPA Chesapeake Bay program funds supported development of this targeting tool.

Implementation: Eligible BMPs are Updated Yearly and Technical Assistance Is Available

BMP implementation is based on a handbook entitled "1987 Virginia Agricultural BMP Cost-Share Program," which lays out the eligible practices, cost-share rates, signup procedures, and other program elements. Table 2.5 shows the practices and cost-share rates. The program is evaluated each year, and practices are added or dropped as needed to adequately address problems. In addition, there is a limit of $3,500 per landowner per year for cropland/pastureland BMPs and $7,500 per year for animal waste BMPs.

TABLE 2.5

ELIGIBLE STATE COST-SHARED BMPS IN VIRGINIA (1987)

BMP	UNIT	STATE RATE
Animal Waste Control Facilities	No. of Systems	75% (ACP* + State) ($7500 maximum)
Diversions	Feet	65%
Grass Filter Strips	Linear Feet	$0.10
Grazing Land Protection	Acre	65%
No-Till Cropland	Acre	$15
No-Till Pastureland	Acre	$15
Permanent Vegetative Cover on Critical Areas	Acre	75%
Protective Cover for Vegetable Cropland	Acre	50%
Reforestation of Erodible Crop and Pastureland	Acre	$75
Sediment Retention, Erosion or Water Control Structure	No. of Systems	75%
Sod Waterways	Acre	75%
Stream Protection	AC/FT	65%
Stripcropping Systems	Acre	$30 + 65% of eligible component cost
Terrace Systems	Feet	65%

*USDA's Agricultural Conservation Program

Source: Chesapeake Bay Nonpoint Source Pollution Control Program: Annual Report, July 1, 1985 - June 30, 1986, Division of Soil and Water Conservation, Virginia Department of Conservation and Historic Resources, 1986.

GEOGRAPHIC INFORMATION SYSTEM: A TOOL FOR TARGETING OUTREACH AND COST SHARING

Realizing the importance of concentrating program efforts on areas with the greatest effect on water quality, Virginia has developed a sophisticated tool to identify potential problem areas. DSWC contracted with the Agricultural Engineering Department at the Virginia Polytechnic Institute and State University (Virginia Tech) to develop a computerized geographic information system and data base to calculate sediment loading potential from discrete land areas.

The Virginia Geographic Information System, called VirGIS, consists of the integration of soil, watershed, and elevation information from topographic and soil maps, with factors for rainfall, cover, and land uses. The Universal Soil Loss Equation (USLE) is used with a delivery ratio function to predict how much soil could reach a body of water. Using this information, it is possible to calculate potential sediment loading rates into receiving waters for 1-hectare cells (2.47 acres). Overall, the system identifies critical acreages within a watershed. The small size of the cells gives the system the capability of identifying areas within a farm that may need BMPs.

State personnel will visit farms in the identified areas to determine whether high erosion rates are actually occurring and to see if erosion control measures are needed. The intent is not to suggest that the farmer is the problem, but to be able to move from simply setting priorities among applicants (who already know about the program) to targeting outreach efforts to areas where problems are most likely to exist.

The program began with a pilot project in the Northern Neck Soil and Water Conservation District in 1984/85. Then, the program was expanded to the Rappahannock and York basins (Level II-C, cropland priority area). Current efforts include use of the system in conjunction with the 1987 program sign-up to evaluate methods for using the system to greatest advantage in the future. The data base is currently being expanded to include the Level II-A animal waste priority area (Shenandoah Valley).

The system has the potential for assisting with priority setting and critical area determination for other programs. Among these are the Conservation Reserve Program, forestry management efforts, and assessment of site suitability for on-site waste treatment.

Landowners who receive less than $7,500 for an animal waste system are eligible to receive up to $3,500 in cropland/pastureland funds, as long as the total payment to a landowner does not exceed $7,500 per year. Table 2.6 shows the number of farmers who have implemented cropland BMPs and the acres benefited, plus the amount of money spent (total BMP cost and cost-share amounts). The table also includes the estimated reduction in sediment and phosphorus, based on a BMP tracking system developed by the State using Bay funds. Table 2.7 presents data on animal waste cost-share results.

Program assistance comes from three sources. The Field Operations section of DSWC has six staff, one located in each region of the State. They support the conservation district programs, providing financial management assistance and various types of training, conducting spot checks for compliance with program specifications, and serving as an information source and coordination point related to other program components. Conservation districts also provide technical assistance, as do USDA staff through SCS and Cooperative Extension Service programs.

Research and Demonstration Projects: A Wide Variety

Virginia's philosophy has been to minimize program administrative costs and spend as much money in the field as possible. Still, the value of agriculturally oriented research and demonstration projects is well recognized. Several have been implemented under the Bay program:

- A Rainfall Simulator--The simulator was designed to demonstrate the difference in runoff and pollution load from tilled and no-till cropland. It has also been used to demonstrate the effect of grass filter strips and non-agricultural BMPs such as porous pavement.

- Innovative BMP Identification and Evaluation--Soil and water conservation districts and the State helped sponsor innovative BMP projects, which were evaluated for their effectiveness, efficiency, and feasibility. Some practices may be incorporated into the 1988 cost-share program. Table 2.8 lists the practices that were included in this program, which ended in 1986.

- Chippokes Model Farm--Various BMPs are demonstrated at this farm, including conservation tillage and several structural practices. Shoreline erosion will be a focal point of future program efforts.

TABLE 2.6

CROPLAND BMPS IN VIRGINIA'S CHESAPEAKE BAY BASIN

	1984	1985	1986*	Total
Farmers Participating	118	1326	436	1,880
Acres Benefitted	2,471	56,123	16,504	75,098
Phosphorus Reduction (lbs)	837	32,922	85,258	119,017
Sediment Reduction (tons)	888	30,371	77,768	109,027
Total BMP Cost	$158,654	$1,078,728	$456,459	$1,693,841
State EPA Cost Share ($)	$ 44,393	$ 793,451	$351,740	$1,189,584
ACP** Cost Share	$ 70,304	$ 184,470	$ 23,116	$ 277,890

*Data for 1986 are incomplete.
**USDA Agricultural Conservation Program

Source: Chesapeake Bay Nonpoint Source Pollution Control Program: Annual Report, July 1, 1985 - June 30, 1986, Division of Soil and Water Conservation, Department of Conservation and Historic Resources, 1986.

TABLE 2.7 COST SHARING OF ANIMAL WASTE BMPS IN VIRGINIA

MEASURE	1984	1985	1986*	TOTAL
Participating Farmers	21	27	13	61
Tons Animal Waste Treated	57,274	53,766	23,403	134,443
Total BMP Cost	$390,820	$479,477	$193,791	$1,064,088
State/EPA Cost-Share Amount	$137,313	$186,177	$65,634	$389,124
ACP** Cost-Share Amount	$67,700	$79,345	$28,435	$175,480

* 1986 data are incomplete.

** USDA's Agricultural Conservation Program

Source: Chesapeake Bay Nonpoint Source Pollution Control Program Annual Report, July 1, 1985-June 30, 1986, Division of Soil and Water Conservation, Department of Conservation and Historic Resources, 1986.

TABLE 2.8

INNOVATIVE BMPS SPONSORED IN VIRGINIA

YEAR	PRACTICE	LOCATION
1984	Aerial seeding of rye into F.S. soybean	Middlesex Co.
1984	Pasture demonstration with no-till annuals	King William Co.
1984	Aerial seeding of clover into soybeans under irrigation	Essex Co.
1984	Aerial seeding of clover into drilled soybeans	King & Queen Co.
1984	Aerial seeding of rye into D.C. soybeans	Richmond Co.
1984	Tile Outlet Terrace	Prince George Co.
1984	Rock Check Dam	King William Co.
1985	Parallel grassed field strips with subsurface drains	Prince George Co.
1985	No-till seeding of turnips for fall grazing	Highland Co.
1985	Three no-till methods of cover crop established	Loudoun Co.
1985	Aerial seeding of Austrian winter pea soybean	King & Queen Co.
1985	Aerial seeding of Austrian winter pea reduced N application	Prince George Co.
1985	Voisin rational grazing on dairy loafing lot	Augusta Co.
1985	Water control structure	Isle of Wight Co.
1985	Voisin pasture management system	Fauquier Co.
1986	Split application on no-till wheat	Piedmont SWCD
1986	Austrian winter pea cover	Piedmont SWCD
1986	Streambank erosion control	Nelson Co.
1986	Voisin pasture management system	Spotsylvania Co.
1986	Voisin pasture management system	Orange Co.
1986	Nutrient management - manure application rates	Rockingham Co.

Source: Chesapeake Bay Nonpoint Source Pollution Control Program: Annual Report, July 1, 1985 - June 30, 1986, Division of Soil and Water Conservation, Department of Conservation and Historic Resources, 1986.

- Nomini Creek Project--This project was undertaken to answer questions on downstream water quality improvements from BMP application. The DSWC has contracted with Virginia Tech to monitor a 3,700-acre watershed in Westmoreland County. Monitoring includes continuous hydrologic data, sediment and nutrient analysis (weekly and at discrete intervals or stages during storm runoff), and in-stream biological monitoring. A 10-year project period is planned. Groundwater sampling has been added to study the movement of pesticides and fertilizers. Conservation plans are under development for all farms in the watershed, and an incentive program and concentrated educational efforts will be implemented as well. Monitoring results from this project will be used in modeling efforts to extend the project's application to other parts of the State.

- Livestock Demonstration Watershed--The Owl Run watershed in Fauquier County has been selected to demonstrate and monitor animal waste BMP installation. This area has many livestock operations and few BMPs installed to date. Baseline monitoring is already underway at four sites, with BMP installation to begin in 1987. The watershed contains five large feeding operations, none of which have animal waste storage (all waste is applied daily). Initial readings in the watershed showed high levels of fecal coliforms and nutrients. Ten years of monitoring are planned.

Education: Outreach Motivates Participation

Both the Virginia Cooperative Extension Service and the DSWC are active in NPS educational efforts. Bay program funds have contributed to increased activities and the availability of grants to conservation districts in 1985 to help improve participation in the cost-share program and to educate the public about NPS problems, solutions, and activities. District activities supported by these funds include teacher seminars, BMP tours and field days, exhibits, and development of a soil and water conservation resource center offering educational materials for use by citizens. (A complete list of projects is available in Virginia's 1984-85 Annual Report.)

The DSWC had two contracts with the Cooperative Extension Service in 1984/85. One of these, which continued in 1985/86, involved funding a full-time position to coordinate educational activities of extension agents and other agencies working on CBP educational efforts. DSWC also paid for a secretarial position and for some travel costs for extension agents. These agents made numerous farm visits to explain BMPs and available assistance programs, conducted meetings for farmers, wrote news releases, and presented radio programs. The first and second annual reports include the total numbers of these activities.

The second contract in 1985 led to development of an educational strategy to promote the nutrient management program. Both meetings and mailings have been used to get information out to farmers. The nutrient education program focuses on fertilizer management in the coastal plain region, while animal waste nutrient management is concentrated in the Shenandoah Valley. In the fertilizer program, efforts are based on an existing program (Emergency Nutrient Management Program), which will be modified to undertake longer term management practices. The program related to animal waste focuses on correct implementation of management plans for proper use of animal waste as fertilizer. Both programs are directed to operators who apply large volumes of fertilizers or waste. Services include soil testing, analysis of expected crop rotations, etc. The program is currently a pilot project, designed to field test a complex analytical process; it will be expanded as results and resources justify.

To recognize farmers who have made great progress in reducing pollution potential from their farms, DSWC developed an award program--the Governor's Model Clean Water Farm Award. Besides rewarding cooperating farmers, the program helps show other farmers what needs to be done and can be done to reduce the pollution potential on their farms. In 1986, six regional winners were chosen from among 176 district-level awardees. The district-level winners receive an 18"x18" reflective sign and a certificate from the governor. The six regional winners receive additional awards: a plaque, a luncheon banquet, and attendance at a signing ceremony with the governor. Other educational efforts have included development of posters, brochures, newsletters, news releases, bumper stickers, displays, etc.

Enforcement: Keeping BMPs Operational

Cost-shared BMPs are subject to inspection for program compliance during the lifespan of the practice. Every BMP is inspected by a forestry, conservation district, or SCS technician before cost-share funds are released to the landowner. Additional spot checks are made to ensure inspection quality. Field staff are beginning to look back to practices implemented in previous years: spot-check inspections in the past have focused on the current year. Staff plan to inspect a random sample of 5% of each type of practice for the current year, plus 5% of the total number of practices from previous years.

The State has guidelines published in the "1987 Virginia Agricultural BMP Cost-Share Program" handbook for punitive action if the practice has not been maintained or has been removed. Participants have 6 months from the date of notification to bring the practice into compliance. Repayment of State cost-share funds is required if a re-inspection finds that the practice is still out of compliance. If funds are not repaid within 60 days, the district will take legal action.

VIRGINIA's URBAN NPS CONTROL PROGRAM

Virginia's urban nonpoint source efforts are split between regulatory activities related to construction erosion control and demonstration project/education efforts. Table 2.9 shows the funds available for these programs. A total of $339,029 in Federal funds has been spent for urban programs.

TABLE 2.9 COMBINED STATE AND FEDERAL FUNDING FOR THE URBAN AND OTHER* NPS PROGRAMS IN VIRGINIA

PROGRAM AREA	FY 1984-85 FUNDING	FY 1985-86 FUNDING
Urban BMP Demonstrations	$163,343	$435,864
Urban Program Management	$0	$29,629
Other NPS Programs	$0	$90,077 **
TOTAL (Federal+State)	$163,343	$555,570
State Funds	$134,517	$245,367

* "Other" category does not include agricultural NPS.

** Chippokes Shore Erosion Design, Forestry, Conservation Easements

Sources: Chesapeake Bay Nonpoint Source Pollution Control Program First Annual Report, July 1, 1984-June 30, 1985, Division of Soil and Water Conservation, Dept. of Conservation and Historic Resources, 1985, p. 23.

Chesapeake Bay Nonpoint Source Pollution Control Program Annual Report, July 1, 1985-June 30, 1986, Division of Soil and Water Conservation, Department of Conservation and Historic Resources, 1986, p. 25.

History and Overview: Support to Localities

The State has had an erosion and sediment control law since 1973, with the first technical standards established in 1974. These standards were revised in 1980 in the second edition of the Erosion and Sediment Control Handbook. The program as it relates to new construction is managed by the DSWC, with 172 independent local programs generally housed in the planning department or county administrator's office handling plan review and compliance. (About 110 of these are in the Bay drainage area.)

State roles include establishing minimum Statewide conservation standards, approving local ordinances, responding to citizen complaints, and providing technical assistance and training to local agencies. Local governments pass ordinances, approve erosion and sedimentation conservation plans for new construction projects, inspect projects to see that the approved plan is carried out in compliance with the ordinance, and take enforcement action when needed. Soil and water conservation districts assist with plan review, public education, and advisory programs. The DSWC directly administers the State agency erosion and sedimentation programs, including plan review and enforcement.

A stormwater management program has been in place since 1980, based on the Erosion and Sediment Control Law. Stormwater management is primarily oriented toward water quantity, but State and local staff have often found ways to increase consideration of water quality.

The urban program received an initial State appropriation of $750,000 for the 1984-86 biennium; the 1984-85 budget was later reduced by $100,000 and, although the grant from EPA made up for part of the reduction, some projects had to be delayed. The program operates with limited staffing at the State level; only two positions in the Technical Services group are allocated to urban NPS efforts. Six District Operations staff provide technical assistance for both the urban and agricultural programs. Thus, urban program efforts are carried out mainly by the staff of the 172 local agencies referred to above.

Program Goals and Approach: Focus on Education

Because of the small portion of the problem attributed to urban sources, the funding available for the urban program is relatively limited. DSWC believed that the available funds would be best used by supporting demonstration projects to promote BMP installation and to assist conservation districts in hiring staff for the erosion and sediment control program. An important focal point of both aspects of the program is to educate developers and the public about the problem and potential solutions. The erosion and sediment control program is currently undergoing a complete evaluation, including the legislation, local implementation effectiveness, and other funding sources. Recommendations are due in June 1987.

The stormwater management criterion under the Erosion and Sediment Control Law is intended to prevent off-site stream channel erosion. Developers must evaluate discharge before and after the project, and take action if effects are projected. Localities can institute stronger requirements: Fairfax County has done this in the Occoquan watershed where stormwater management practices related to water quality are required for new developments.

Targeting Approach: Priority Areas Under Development

The erosion and sediment control program has targeted its efforts based on priority areas of the State and on BMP effectiveness. The program started by considering the areas of overall Bay program priority and, within those areas, focused on the more developed or rapidly growing areas. Then, staff reviewed proposals and selected BMPs for funding that seemed to hold the most promise for water quality benefits and applicability to other situations.

Implementation: Technical Assistance Provided to Local Agencies

The initial program effort in the urban arena was to identify priority areas as possible sites for the urban BMP demonstration projects described below and for technical assistance. Because the erosion and sediment control programs are managed at the local level through 172 independent agencies, staffing for 13 local conservation districts has been provided to increase their ability to provide technical and administrative assistance on urban BMP projects and programs. DSWC Technical Services staff located in each of the six regions of the State provide technical assistance to local staff in the form of training, technical backup, and program review.

Research and Demonstration Projects: Clean Water Through Innovation

Demonstration projects promoting urban BMPs have been implemented in various areas. Proposals from local officials, land developers, and engineering consultants were reviewed based on innovativeness, water quality improvement potential, and participation by local project sponsors. Projects under this program include the following:

- A water quality monitoring project of porous asphalt pavement and an infiltration trench in Prince William County (Davis Ford Park) is in the second year of monitoring.

- A computer model is being developed to compare alternative stormwater management strategies. Field evaluations of the model are in progress.

- Monitoring of a wet pond and level spreader in Charlottesville is currently underway. The level spreader project consists of allowing water from a pipe to level out in a ditch and converting it to sheet flow to allow infiltration.

- A porous pavement parking lot at Riverfront City Park in Fredericksburg has been built.

- A porous pavement project has been completed on a new motel parking lot in James City County.

- Construction of a porous pavement at the Henrico County Park is complete.

- A dry, long-term detention basin is being monitored in Fairfax County. The outfall has been modified for the second year of the project.

- Sites in Fairfax County have been selected for streambank stabilization with biotechnical measures. Installation is scheduled for winter 1987-88. These measures consist of building bundles of dormant woody plant shoots such as willow trees into the bank where root growth will bind the soil and remove water through plant uptake. Sprouting vegetation also provides surface stabilization.

- A commuter parking lot (porous pavement) is under construction in Fauquier County.

- An urban marsh project will be constructed and monitored in Fairfax County during the spring of 1987.

Program staff work closely with their counterparts in Maryland and other states to ensure that they are not duplicating efforts. Table 2.10 shows the Federal funding for these projects and their projected completion dates, where available.

Education: From Conferences to Videos

An important purpose of the urban demonstration projects implemented under the Bay program has been to educate developers and local officials about the benefits, effectiveness, and other characteristics of urban stormwater BMPs. This educational effort included initiation of an urban BMP conference, held in 1985 with several co-sponsors (Virginia Homebuilders Association, American Society of Civil Engineers, Virginia Municipal League, and the Northern Virginia and Prince William soil and water conservation districts). In 1986, educational activities included development of a BMP brochure ("Land Development for Water Quality") and review of the technical standards in the "Virginia Erosion and Sediment Control Handbook."

In addition, slide/tape and video training modules are planned related to erosion control and stormwater management. Stormwater management and erosion control seminars to inform developers and consultants have been held quarterly in many areas of the State. State staff prepare a quarterly newsletter focusing on erosion and sediment control issues and BMPs.

Enforcement Via Inspection and Penalties

Local governments inspect construction sites for compliance with the Erosion and Sediment Control Law and the applicable site plans. A limited stop-work authority was added in 1986. Penalties for noncompliance include fines of up to $1,000 or 30 days imprisonment, or both, for each violation.

TABLE 2.10 FEDERAL EXPENDITURES TO DATE
FOR URBAN BMP DEMONSTRATION PROJECTS IN VIRGINIA

NAME	FEDERAL* FUNDING	DATE OF COMPLETION
Davis Ford Park Porous Pavement Monitoring	$ 33,700	6/85
Four Porous Pavement Projects	$103,000	
• Fredericksburg		9/01/86
• Henrico County		9/31/86
• James City County		8/01/85
• Warrenton		1987
Fairfax Extended Detention Dry Pond	$ 29,800	1/15/86
Four Seasons Pond and Level Spreader Site in Charlottesville (Infiltration Practice)	$ 94,800	2/06/86
Fairfax Urban Marsh	$ 42,000	1987
TOTAL	$303,300	

*FY'86 Funds

Source: Data from U.S. Environmental Protection Agency, Chesapeake Bay Liaison Office, Annapolis, Maryland.

OTHER NPS PROGRAMS IN VIRGINIA

Highway construction activities are monitored by the Department of Transportation after approval of standards and specifications annually by the DSWC, plus a monthly review of plans by the environmental agencies. Among Department of Transportation activities are seminars in each highway district about environmental issues and requirements.

Mining is regulated by the Department of Mines, Minerals, and Energy. Permits and reclamation are required for the sand and gravel operations and other types of mining in the Bay drainage basin.

The DSWC initiated a program in 1985 in cooperation with the Department of Forestry to expand the scope of the Chesapeake Bay NPS pollution control program beyond agricultural and urban sources. A grant of $61,500 per year pays for education and information projects and forest hydrology studies to assess BMP effectiveness. Forestry staff have undertaken a project to identify eroding cropland and pastureland areas that should be converted to forest, as well as forest sites needing stabilization of logging roads and skid trails. Part of the funding paid for a U.S. Forest Service hydrologist (on interagency personnel assignment) and two interns to conduct these projects. Outreach efforts included contacts with landowners to explain the availability of cost-share funds to correct problems. Although forestry is exempt from the Erosion and Sediment Control Law, voluntary BMP guidelines emphasize soil protection. The Department policy is to inspect every tract to be harvested and contact the landowner/operator about BMPs. For sites implementing an alternate management plan under the Seed Tree Law (all trees are cut and the site is revegetated artificially), the owner/operator must maintain BMPs to be eligible for assistance.

The Shoreline Erosion Advisory Service, part of the DSWC, was established in September 1980. Its purpose is to provide nonbinding advice to private property owners on how to control shoreline erosion. Its efforts are limited to tidal areas. The Service encompasses more than 5,000 miles of shoreline in 27 counties and 19 cities. While there are no requirements for implementing shoreline erosion controls, the Service has issued nearly 2,000 advisories since its inception.

The Department of Health has conducted surveys of drainfields and other waste disposal systems in an effort to reduce the contribution of pollutants to waterways and to reopen shellfish areas that have been closed because of pollution. The Shellfish Enhancement Task Force advises the DSWC of areas with problems from agricultural sources. Special funds within the cost-share program are available to pay for solutions at a higher-than-normal cost-share rate. Other task force participants include DSWC, Virginia Marine Resources Commission, and Virginia Water Control Board, Department of Housing and Community Development, Council on the Environment, and Virginia Institute of Marine Science.

A program to seek donation of conservation easements is managed by the Chesapeake Bay Foundation, using a staff person from the U.S. Forest Service (on an interagency personnel assignment). The program is designed to establish perpetual natural buffers along the banks of Bay tributaries to reduce future NPS pollution potential from changes in land use. The Virginia Outdoor Foundation is the recipient of the easements. In some cases, the donation may include the land itself, not just an easement. The program is now in its second year. Next year the program may be expanded to include a cooperative program with local governments for planning growth in waterfront areas.

The Council on the Environment uses Bay funds to provide staff support for eight river basin committees, which are citizen advisory committees established in 1985 and appointed by the governor. The 200 members are required to review and comment on Bay-related programs, suggest new projects, and facilitate outreach to groups and individuals in the river basins.

The Division of Parks uses State funds for a youth conservation employment program related to the Bay. It provides job opportunities for disadvantaged youth and addresses problems such as erosion and streambank stabilization that can be abated through short-term, labor-intensive projects.

PENNSYLVANIA

INTRODUCTION

Pennsylvania Stresses Cooperative Environmental Goals

The overall goal of Pennsylvania's Bay program is to reduce pollutants entering the Chesapeake Bay--especially nitrogen, phosphorus, and sediment--by focusing on management of nutrients from agricultural sources. The following elements are central to the State's approach:

- Water Quality--To improve and protect water quality and the living resources of the Bay, focusing on nutrient reduction, manure management, conservation tillage, and regenerative farming.*

- Ecology--To accommodate growth in an environmentally sound manner through land use management.

- Citizen Participation--To foster public awareness.

- Regional Cooperation--To address areawide needs where they cross political boundaries and jurisdictions.

Agriculture Is the Chief NPS Problem for the Bay

According to State staff, acid mine drainage is the worst nonpoint source pollution problem Statewide, and agriculture is the second largest. Construction and urban/suburban runoff have also been identified as NPS problems in Pennsylvania. However, agriculture is by far the most significant source of nonpoint source pollution to the Bay.**

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* Regenerative farming involves the use of farming methods that reduce fertilizer and pesticide inputs and rely more on natural restorative properties of the soil.

** Mining does not constitute a significant problem for the Bay. First, much of the mining throughout the State is not located within the Susquehanna drainage area. Second, mining activities within the Susquehanna River basin are located in the upper reaches, allowing the natural buffering capacity of the river to neutralize the acid conditions as the waters flow downstream.

The Susquehanna River has been identified as the largest riverine source of nitrogen and phosphorus to the Chesapeake Bay. EPA has noted that runoff from agricultural lands is responsible for the largest fraction of these nutrients--60% of the phosphorus and 85% of the nitrogen entering the Bay from this basin comes from cropland runoff. Forty-one percent of the Susquehanna's NPS load to the Bay comes from the lower Susquehanna Basin (below Sunbury). [3]

Animal wastes have constituted a growing problem, due to rapid expansion of the livestock and poultry industries in the 1970s. In Lancaster County, where the problem is particularly acute, enough animal waste is produced annually to cover every acre of cropland in the county with 13.5 tons of manure. Farmers have traditionally either stored the waste in pits, lagoons, or slurries, or spread it over fields as fertilizer. The excess nutrients that cannot be absorbed by crops or other vegetation travel into ground water and nearby streams and rivers. This has been a major cause of the excess nutrient load in the Susquehanna.

Sediment in the waters has also been identified as a problem. Annual soil loss from untreated cropland in the lower Susquehanna basin may be as high as 17.7 tons per acre, compared to a basin average of 7.4 tons per acre. [4]

Pennsylvania's NPS Program:
The Bay is the Focal Point

Pennsylvania's NPS program as a whole is administered by the Bureau of Soil and Water Conservation (BSWC) within the Department of Environmental Resources. BSWC serves as staff to the State Conservation Commission (SCC), which is responsible for policy decisions governing the NPS program. BSWC is divided into two divisions and one branch:

- The Division of Conservation Districts oversees $1 million in funds for the 66 soil conservation districts in the State. The Division provides a consultation and liaison function for the districts, and employs seven field representatives to assist the conservation districts Statewide.

- The Soil Resources and Erosion Control Division administers the erosion and sedimentation control program, and supports soils engineers in the field throughout the State.

- The Watershed Branch operates Pennsylvania's Chesapeake Bay program and other special NPS projects.

With respect to point sources and toxics, the SCC plays a minor coordination role with other State agencies. The Chesapeake Bay effort and the erosion and sedimentation control program comprise the bulk of Pennsylvania's NPS program.

Pennsylvania strives to maintain citizen involvement in development and implementation of the program. The Chesapeake Bay Advisory Committee (formerly the Nonpoint Steering Committee to the SCC) advises the program. A coalition of State and Federal agricultural agencies and farm organizations, the Advisory Committee gives the agricultural community--as well as legislative, environmental, and civic interests--input into the process of remediating NPS pollution.

To date, EPA implementation grants totalling $5,256,475 between 1984 and 1986 have helped support Pennsylvania's NPS program for the Bay, with an equivalent match by the State. These funds have been used to provide financial assistance to landowners through the cost-sharing program; support technical assistance to conservation districts and landowners; and conduct watershed assessments, monitoring, and educational activities. Table 2.11 summarizes the Bay program funding levels for FY 1984-86 by program area.

The CBP Has Focused Attention on Nutrient Management and Supported Cost-sharing

Since the Chesapeake Bay Program was initiated, the essential change has been the new awareness of water quality and nutrient management as a goal--not only within the traditional environmental agencies, but by other government agencies, private organizations, and individuals, as well. For example, the recently completed attitude survey of Pennsylvania farmers found that 47% of those surveyed recognized nutrients as a problem, and 98% acknowledged that farmers should pay a share of the cost to prevent further pollution of the waters. In addition, the conservation districts, traditionally farm-oriented entities, are expanding beyond their strictly agricultural focus and becoming multi-purpose conservation organizations addressing water quality and other environmental issues.

The Bay program has made the cost-share program possible in Pennsylvania, has reoriented the local infrastructure related to soil and water conservation plans, has increased technical field staff support throughout the Susquehanna River basin, and has increased the emphasis on nutrient management throughout the State. The Chesapeake Bay Program has grown in Pennsylvania to the point where it now constitutes a major activity of the BSWC.

PENNSYLVANIA's AGRICULTURAL NPS CONTROL PROGRAM

Program Goals and Approach: Keep Soil and Nutrients at Home

Pennsylvania's Chesapeake Bay program focuses on agriculture. It is based on the premise that a benefit to the farmer is a benefit to the Bay. BMPs can keep soil and nutrients on farm land, maintaining soil productivity and reducing operating expenses. Pennsylvania also stresses the benefit of protecting the ground-water resources used for drinking-water supplies. (Unlike Maryland and Virginia, Pennsylvania does not border the Bay and therefore does not receive the direct benefits of water quality improvements to the Bay.) The agricultural program is implemented through the cooperation of numerous agencies and organizations, including DER, the Pennsylvania

TABLE 2.11 COMBINED STATE AND FEDERAL FUNDING FOR PENNSYLVANIA'S BAY PROGRAM*

PROGRAM AREA	FY 1984-85 FUNDING	FY 1985-86 FUNDING	FY 1986-87 FUNDING
Watershed Assessments and Monitoring	$115,000	$455,215	$458,405
Education (including Demonstration Projects)	$635,000	$908,500	$1,114,784
Technical Assistance	$150,000	$576,500	$489,761
Financial Assistance	$1,050,000	$2,409,785	$2,000,000
Other	$50,000	$0	$100,000
TOTAL (Federal+State)	$2,000,000	$4,350,000	$4,162,950
State Funds	$1,000,000	$2,175,000	$2,081,475

*Includes Chesapeake Bay Program implementation grants only (EPA funds and State match).

Source: Pennsylvania Chesapeake Bay Program Annual Grant Applications, FY 1984-85, FY 1985-86, and FY 1986-87.

Department of Agriculture, Cooperative Extension Service (Pennsylvania State University), Soil Conservation Service, Agricultural Stabilization and Conservation Service, conservation districts, farm organizations, and volunteer groups.

History: An Evolution From Soil Conservation

The Conservation District Law of 1945 established soil conservation districts throughout Pennsylvania, and made them responsible for soil and water conservation. The SCC was created simultaneously as the policy-making body for the districts. The focus of the districts' program was agricultural soil erosion, which has since been expanded to include reduction of water pollution by sediment, as discussed in more detail under "Urban NPS Control Program," below.

Pennsylvania signed the Chesapeake Bay Agreement in 1983, initiating its agricultural NPS pollution control program for the Bay in 1984 under the authority of the Conservation District Law. Procedures for the program were established through a Statement of Policy (25 PA Code Chapter 83, Sections 101-148), adopted in April 1985 and revised in January 1986. The first contracts for cost-sharing assistance for BMPs were signed in November 1985, with the first monies going to farmers in December 1985.

Targeting Approach: Decentralized Decisionmaking Based on Priority Watersheds

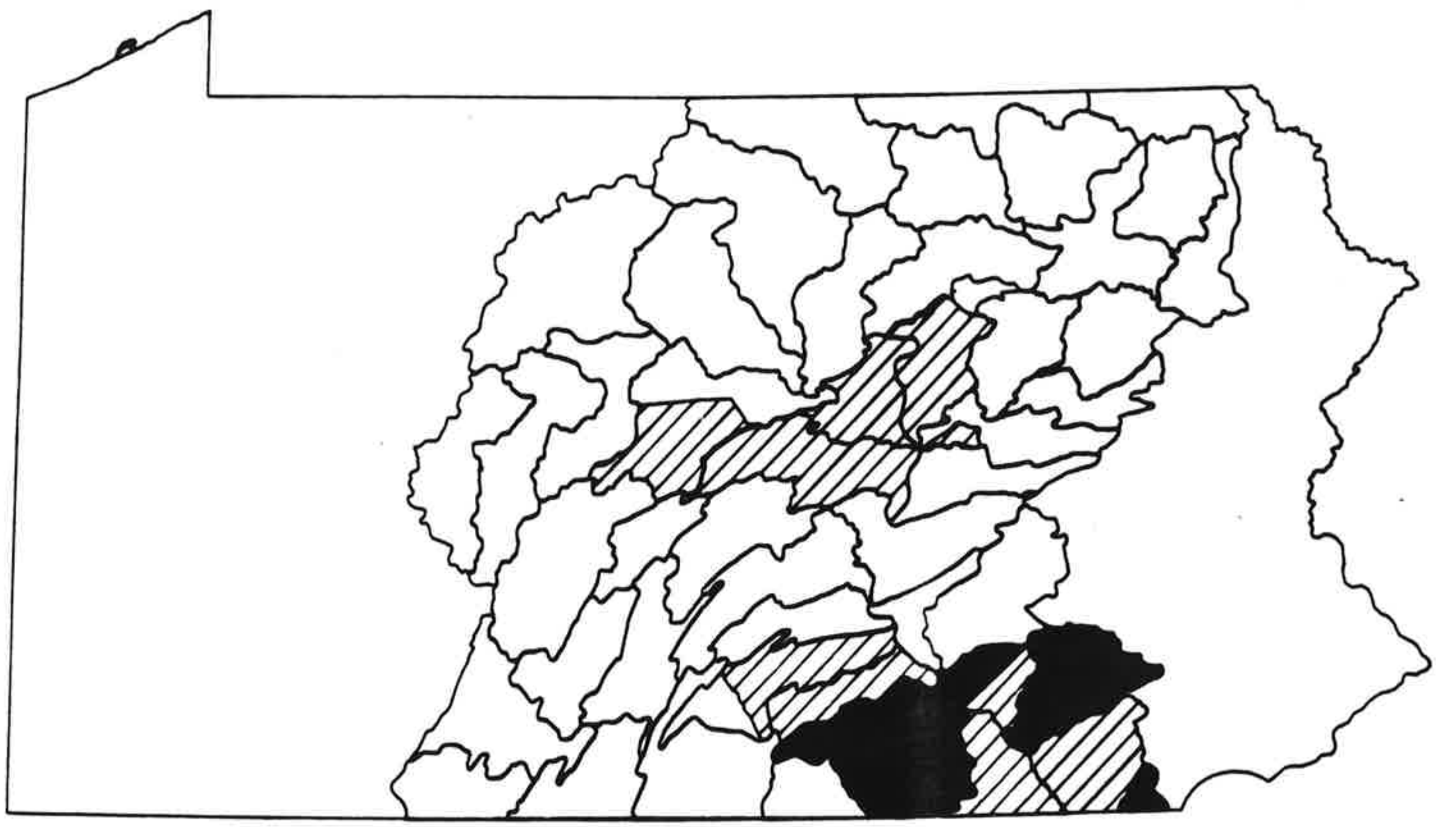
Pennsylvania's Bay program targets its efforts and funds on the basis of several past planning efforts and ongoing evaluations, as well as on the 1983 EPA study identifying the lower Susquehanna as a significant problem area for nutrients. [5]

Priority Watersheds

The initial planning effort supporting priority watershed selection predates the formal Bay program. The planning effort began as part of the agriculture component to the State's water quality management plan. All sub-basins within the major river basins of the State were analyzed for their potential to contribute agricultural NPS pollution; factors such as slope erodibility, soil type, agricultural acreage, and animal density were used. Staff devised a formula for comparing these factors among basins, resulting in a final ranking of areas for potential agricultural pollution problems Statewide. A total of 20 sub-basins and 104 watersheds were studied and ranked. [6]

BSWC, the conservation districts, and the Soil Conservation Service then conducted a more detailed assessment of the ten highest priority watersheds. In-depth agricultural assessments must be conducted as a prerequisite for financial assistance in Pennsylvania. These assessments resulted in the targeting of 5 priority watersheds for BMP financial assistance. On the basis of additional detailed assessments, the project area has been expanded to include an additional nine watersheds, three of which exhibited high phosphorus loadings. The target area, therefore, includes a total of 14 watersheds spanning 13 counties (see Figure 2.2).

FIGURE 2.2 PENNSYLVANIA'S PRIORITY WATERSHEDS FOR AGRICULTURAL BMP IMPLEMENTATION UNDER THE CHESAPEAKE BAY PROGRAM



■ **Initial** Watersheds Selected for Implementation

▨ **Additional** Watersheds Selected for Implementation

NOTE: Areas on map without watershed details do not drain to the Bay.

Source: Pennsylvania Department of Environmental Resources, Bureau of Soil and Water Conservation

In addition, the DER, through the Susquehanna River Basin Commission, continues to monitor watersheds to track existing problems and identify new ones as they appear. The Department maintains 13 monitoring stations at selected watersheds in the Susquehanna River basin to collect base flow data and samples for chemical analysis.

Selection of Projects for Cost-Share Funding

The SCC allocates EPA implementation funds for the Chesapeake Bay to the conservation districts containing priority watersheds in the Susquehanna River basin. Thus, decisions about the ultimate distribution of cost-share funds for implementing BMPs are decentralized to the individual conservation districts. The conservation district and the SCC sign a contract requiring the conservation district to comply with SCC policy in distributing the cost-share funds and approving BMPs. The SCC has developed a list of acceptable BMPs (see Table 2.12), which is updated as new information becomes available, and the individual conservation districts select those they will approve for their districts. Policy guidance for the districts is contained in the "SCC Chesapeake Bay NPS Pollution Abatement Program--Statement of Policy" (25 PA Code Chapter 83).

BSWC allocates other funds on the basis of how well proposed projects satisfy program requirements. When financial assistance is requested, projects are assessed for their contribution to the final goal of reducing nutrients in the Susquehanna basin.

Implementation: Cost-shared BMPs Supported by Planning and Engineering Help

BMP Financing

A cost-sharing program provides incentives to landowners to install BMPs. Eligibility for the cost-share funds is limited to the designated priority watersheds. To obtain cost-share monies, a landowner signs a contract with the conservation district to develop and implement a nutrient management program, for the life of the BMPs installed (up to 10 years). In this contract, the conservation district and the landowner also agree on the BMPs needed, the length of time they must be maintained, and the cost-share rates for them. The specific BMPs and cost-share rates to be used are left to the discretion of the conservation district, with a ceiling of 80% of the total cost for each practice, or a combined total of $30,000 for assistance to any one landowner. Monies are paid out on a reimbursement basis.

Regulations governing financial assistance were adopted in April 1985, and by November 1985 the first contracts were signed. As of February 1987, there were 368 signups and 110 contracts signed, committing approximately 38% of the money (or $2,092,172) for the first 3 years. [7]

TABLE 2.12

BMPS QUALIFYING FOR COST SHARING IN PENNSYLVANIA

BEST MANAGEMENT PRACTICE	COMPONENT	MAINTENANCE LIFE (YEARS)
PERMANENT VEGETATIVE COVER	Pasture/Hayland Management	5
	Pasture/Hayland Planning	5
ANIMAL WASTE MANAGEMENT SYSTEM	Waste Management System	10
	Waste Storage Structure	10
	Waste Treatment Lagoon	10
	Fencing	10
	Filter Strips	5
	Waste Storage Pond	10
	Subsurface Drain	10
STRIPCROPPING AND CONTOUR FARMING SYSTEMS	Obstruction Removal	10
	Stripcropping, Contour	5
	Stripcropping, Field	5
	Contour Farming	5
	Subsurface Drain	10
TERRACE SYSTEM	Obstruction Removal	10
	Terrace	10
	Subsurface Drain	10
	Underground Outlet	10
DIVERSION SYSTEM	Diversion	10
	Obstruction Removal	10
	Subsurface Drain	10
GRAZING LAND PROTECTION SYSTEM	Pond	10
	Fencing	10
	Pipeline	10
	Pond Sealing or Lining	10
	Spring Development	10
	Trough or Tank	10
	Well	10
WATERWAY SYSTEMS	Grassed Waterway or Outlet	10
	Lined Waterway or Outlet	10
	Subsurface Drain	10

TABLE 2.12 (Continued)

BMPS QUALIFYING FOR COST SHARING IN PENNSYLVANIA

BEST MANAGEMENT PRACTICE	COMPONENT	MAINTENANCE LIFE (YEARS)
CROPLAND PROTECTIVE SYSTEM	--	5
CONSERVATION TILLAGE SYSTEM	Conservation Cropping System	5
	Conservation Tillage System (no-till)	5
	Contour Farming	5
	Crop Residue Use	5
	Stubble Mulching	5
STREAM PROTECTION SYSTEM	Channel Vegetation	10
	Fencing	10
	Filter Strip	10
	Streambank Protection	10
	Tree Planting	10
PERMANENT VEGETATION COVER ON CRITICAL AREAS	Critical Area Planting	5
	Fencing	10
	Filter Strip	5
	Livestock Exclusion	5
	Mulching	5
	Spoilbank Spreading	5
	Field Borders	5
	Tree Planting	10
	Subsurface Drain	10
	Roof Runoff Management	10
SEDIMENT RETENTION, EROSION, OR WATER CONTROL STRUCTURES	Sediment Basin	10
	Fencing	10
	Grade Stabilization Structure	10
	Structure for Water Control	10
	Water and SedimentControl Basin	10
	Roof Runoff Management	10
SOIL AND MANURE ANALYSIS	Soil Analysis	--
	Manure Analysis	--
	Recommendations of Commercial Fertilizer and/or Manure Application	--
EXCESS MANURE TRANSPORTATION	Excess Manure Agitation and Loading	--
	Excess Manure Transportation	--
	Excess Manure Application and/or Incorporation	--
FERTILIZER MANAGEMENT	Fertilizer Management	5

Source: Pennsylvania Chesapeake Bay Program Handbook, Section V, March 1986

Technical Assistance

Provision of technical assistance is a primary responsibility of the conservation districts. The nutrient management program required of a cost-share farmer must include an annual manure and waste summary, soil testing, manure testing, a recommended nutrient application summary, and provisions for documentation to verify nutrient and pollution reductions. Technical assistance in developing nutrient management plans is provided by conservation districts with Chesapeake Bay funds. DER's nutrient management specialists monitor the design and implementation of BMPs in priority watersheds.

The BSWC has also helped fund several engineer positions in the conservation districts to help farmers with specific conservation BMPs and to assist district staff with sediment control activities. In addition, the State's conservation district engineer program provides technical assistance to support 32 conservation districts within the Susquehannna River basin.

Research and Demonstration Projects: Innovation, Education, and Self-help

Numerous research-related efforts are underway in the State, including the following:

- The planning assistance program provides funds to conservation districts, agencies, and other cooperating organizations to identify NPS problem areas, develop strategies, monitor water quality runoff, and evaluate the effectiveness of BMPs. The Phase I evaluation of high-priority watersheds under the planning assistance program evaluated over half of the acreage in the lower Susquehanna drainage area qualified for cost-sharing funds. Phase II will assess the remainder of those high-priority watersheds. Phases III and IV will continue and finish the assessment process by surveying the medium-priority watersheds. Information obtained from these studies will be used in BSWC planning activities.

- The Susquehanna River Basin Commission and the U.S. Geological Survey are currently involved in a 5-year program to assess nutrient sources and loadings from the main stem of the Susquehanna and selected watersheds, and to evaluate agricultural BMPs.

- A Pesticide Use Profile Survey in high-priority watersheds was completed by the National Agricultural Statistics Service under contract to the Pennsylvania Department of Agriculture in September 1986, as the first part of a program to reduce runoff of toxics from agricultural lands. This involved the quantification of pesticide usage in the Chesapeake Bay priority watersheds. An education program will then be developed by the Cooperative Extension Service, the Pennsylvania Department of Agriculture, and representatives of pesticide manufacturers. This educational program will be oriented toward instructing users on how to use pesticides in a manner that is more efficient for the farmer and less hazardous to ground water and the Bay.

Pennsylvania is developing a wide variety of demonstration projects. These projects advance research in nutrient management, test and encourage innovative conservation techniques, and educate farmers and the general public on issues of conservation.

A major project funded through the educational assistance program is the mobile nutrient laboratory. The laboratory travels throughout the Susquehanna basin, stopping to provide demonstrations to farmers of the value and application of soil, water, and manure testing.

Other demonstration projects, funded as educational assistance projects, have stimulated interest in continuing innovative approaches. For example, a demonstration project in Lebanon County entailed the development of a truck-mounted machine that uses computers and lasers to spread manure in accordance with fertilizer needs on an individual section of cropland. This machine is the only one of its kind in the country. The project, developed by the John Deere Corporation, is an example of the kind of public/private sector cooperation the Pennsylvania program has been working to foster.

Other cooperative efforts with the private sector include: (1) the Pennfield-Weaver Corporation feasibility study of cogeneration of electricity and steam from chicken manure; and (2) development of digestion processes to create methane gas from animal waste. Educational tourist stops are being established for demonstrating these latter processes.

Some "demonstration projects" are oriented toward self-help for farmers. The BSWC is funding the initiation of crop management associations (CMAs). These non-profit groups hire technical specialists for recommendations on manure management, fertilizer and pesticide usage, crop selection, etc. CMAs have been set up in Chester and Lebanon Counties. A project in Lancaster County encourages farmers to develop on-farm analytical skills by demonstrating the use of simple testing devices. Nitrogen meters and hydrometers can give farmers a rough analysis of manure, and obviate the need to send a sample to a laboratory.

MOBILE NUTRIENT LABORATORY: HELPING FARMERS TO HELP THEMSELVES

Some Pennsylvania farmers apply more nutrients to their crops than needed, often without realizing it. Soil and water tests have indicated that excess applications of animal manure and commercial fertilizer can cause water quality problems. This means that nutrients such as nitrogen and phosphorus get into ground and surface waters, and can affect local water supplies. In addition to water quality problems, these fertilizers cost farmers money.

Pennsylvania DER and Pennsylvania State University have developed a mobile nutrient laboratory to provide rapid analyses of soils, water, and animal wastes. The laboratory travels throughout the lower Susquehanna River basin to conduct tests on local farms and help improve farm nutrient management. Results tell the nutrient values of a farm's soil and manure so that the farmer can apply only the precise amounts of commercial fertilizer or manure needed to obtain desired crop yields.

Equipment on the mobile laboratory include standard tools for soil, water, and manure analysis, as well as a computer to interpret results. Computer software developed by Penn State's Cooperative Extension Service calculates proper application rates for manure and commercial fertilizer. Soil samples are tested for water-soluble phosphate, potassium, and nitrate-nitrogen; farm water is examined for nitrates; and manure is analyzed for organic and ammonium nitrogen, phosphorus, and potassium.

Proper farm nutrient management can mean a significant cost savings for farmers for fertilizers, protection of local water supplies, and benefits to Chesapeake Bay waters downstream.

Education: Multi-Media Approaches

The educational assistance funding program provides information to landowners and the general public on the need for nutrient management and water quality programs. It funds numerous "mini-demonstration projects" with EPA funds through the Pennsylvania Association of Conservation Districts (under $500 per project, for a total of $9,000) as well as projects in conjunction with other agencies and organizations to demonstrate conservation management techniques. Some of these projects are described below:

- The Bureau of State Parks provides information to the general public and to educators. It has developed a series of seminars and workshops for secondary students, which was introduced at the Chesapeake Bay Conference at Gettysburg College in February 1987. The program also sponsors contests for elementary and secondary students, and programs geared toward visitors to State parks.

- The Pennsylvania Department of Education established an Environmental Education Office which works closely with the Chesapeake Bay Program.

- The Pennsylvania Association of Conservation Districts has produced and distributed television programs, newsletters, fact sheets, brochures, and other information on the Bay Program.

- Various educational projects have been developed by the Pennsylvania State University, including demonstrations of soil and tissue tests, educational materials and programs for farmers, and water quality education materials for the general public.

- Numerous other education projects are organized by the local conservation districts.

Enforcement: Maintain or Repay

The field staff specialists in the Watershed Branch of BSWC evaluate the contracts between the conservation districts and the landowners. These specialists ensure that the districts are carrying out SCC policy in the financial assistance program. Conservation districts are urged to conduct annual reviews of farms in the cost-share program to make certain that BMPs are being implemented and maintained. Where BMPs are not properly maintained, the landowner must return State cost-share monies to the district.

The financial assistance program currently applies to a small geographical area, making oversight relatively simple and informal. As the program expands, more formal procedures may be necessary to ensure that the conservation districts and landowners are implementing SCC policy.

In general, farmers who use the State's manure management manual are not required to obtain a DER permit for either animal manure storage facilities or land application of animal manure. However, if manure is stored in an impoundment having either a maximum storage elevation greater than 15 feet or storage capacity greater than 50 acre-feet, a DER permit is required. Regardless of whether a permit is required, farmers are responsible for any pollution of surface or ground water caused by their farming operation.

Other Agriculture-Related Projects in Pennsylvania

Mason-Dixon Erosion Control Project

This project of the Soil Conservation Service is still in the development stage. Fourteen counties in Pennsylvania and eight counties in Maryland will receive special treatment to reduce soil erosion. Currently, the annual soil erosion rate in these untreated areas is estimated to be as high as 17.7 tons per acre.

RCWP Conestoga River Project

The Conestoga River Basin in Lancaster County was found to have excessive NPS discharges of sediment, nitrogen, and phosphorus associated with agriculture. A project to install BMPs in this area has been funded by the Rural Clean Water Program and administered by the Agricultural Stabilization and Conservation Service in cooperation with other agencies. As part of this project, BMPs will be implemented on up to 300 farms to assess the transport of sediment, nutrients, and pesticides in the Upper Conestoga River basin; the movement of nitrate into ground water aquifers from fertilizer and manure applications; the transport of water-soluble pesticides to ground water; the effectiveness of specific BMPs in controlling the movement of nitrates and other contaminants into ground water; and the cost and effectiveness of individual agricultural BMPs. The results of this study (scheduled for completion in 1992) will provide useful input to the Chesapeake Bay Program.

PENNSYLVANIA'S URBAN NPS CONTROL PROGRAM

History: Ten Years of Erosion and Sediment Control

The erosion and sedimentation control program has been in place for more than 10 years and is the basis for Pennsylvania's urban NPS program. The Clean Streams Law was revised by the State legislature in 1972 to require DER to develop an erosion and sedimentation control program to reduce water pollution by sediment. The program is implemented by DER, and the conservation districts implement it at the local level. The thrust of this program is contained in two major provisions of the erosion control regulations:

- Any landowner, person, or municipality engaged in earthmoving activities must "develop, implement, and maintain erosion and sedimentation control measures which effectively minimize accelerated erosion and sedimentation."

- In addition, a DER permit is required if an earthmoving activity involves 25 or more continguous acres. (Agricultural plowing and tilling are exempted from the permit requirement.)

While the erosion and sedimentation control program applies to all earthmoving activities, most conservation district efforts under the program are related to urban sources. Approximately 14.5 million tons of soil are eroded from construction sites in Pennsylvania each year.[8]

Stormwater management plans are required under a 1978 Stormwater Act (Act 178) establishing a Statewide planning process by county governments. However, stormwater plans are designed only to reduce flooding problems, and have no water quality orientation beyond reducing flow velocity.

Implementation: Technical Assistance in Plan Development

Control measures to minimize accelerated erosion and sedimentation must be specified in a plan and must be implemented and maintained according to the schedule specified in the plan. The plan must also be prepared by a person experienced in control methods and techniques. It should consider erosion and sedimentation control both before and after the earthmoving activity has been completed. The regulations further require a DER earth disturbance permit if 25 or more contiguous acres are disturbed, with the exception of agricultural plowing and tilling activities; activities affecting less than 25 contiguous acres are exempt from the permit requirement.

The districts process applications for earth disturbance permits and review erosion control plans. The conservation district coordinates the review of the plan, usually through the Soil Conservation Service (SCS) district office, the Fish Commission, and a BSWC soils engineer. The soils engineer evaluates the submitted plan and permit application, including all comments from the district and SCS offices, and submits recommendations to the BSWC's central office. This office issues the actual earth disturbance permits. When a proposed activity requires other permits from DER, the erosion and sedimentation control plan will either be coordinated with, or become a part of, these other permits. Generally, no separate earth disturbance permit is issued by DER when other permits are required.

Plans are often submitted for sites that do not require a permit. The districts review these plans and ensure that adequate erosion control facilities are provided. Some local governments require such a review before they will issue a building permit.

Education Through Training

BSWC has conducted training sessions for the districts to explain program requirements. Conservation districts have always promoted conservation education and are currently active in conducting training related to soil erosion control, program requirements, and the benefits of conservation measures. Education is important in obtaining voluntary compliance.

Enforcement: When Voluntary Compliance Fails

Inspection and surveillance activities are conducted primarily by the conservation districts. Voluntary compliance is encouraged, but, in cases of noncompliance, enforcement actions may be taken. Extensive court actions have been avoided to date through use of consent orders and agreements that establish penalties and requirements for correcting erosion problems.

BSWC places a great deal of emphasis on helping districts obtain voluntary compliance, often in response to complaints. In addition to complaint response, district staff inspect permitted sites and non-permitted activities and document violations. Inspection reports form the basis of enforcement actions when needed.

Enforcement penalties are paid into the State's Clean Water Fund, which is used to address various environmental problems such as spill cleanup. Between September 1981 and June 1987, payments totalled $374,154 from 249 administrative enforcement actions.

OTHER NPS CONTROL PROGRAMS IN PENNSYLVANIA: A DIVERSE MIX

A number of other NPS-related programs and activities are being conducted in Pennsylvania. Some of these are listed below:

- Act 319, the "Clean and Green Act," provides for tax incentives to owners of agricultural and forest lands if they meet certain eligibility criteria, agree to preserve the agricultural or woodland use of the property into perpetuity, and have a land management plan. These plans are developed either by the Bureau of Forestry or a State-approved independent private forester on a consultant basis. The local tax assessor has the authority to ensure plan implementation and determine the amount of the tax reduction.

- Under the erosion and sedimentation program, soils engineers in the Soil Resources and Erosion Control Division conduct erosion and sedimentation permitting and inspection activities for earth disturbance projects, including land development, timber harvesting, and solid waste disposal facilities.

  Earthmoving disturbance permits are required for forestry operations when the activity exceeds 250 acres, compared with 25 acres for other activities. Federal activities are subject to the permit requirements, although agricultural plowing and tilling activities are exempt.

- With funding from the Department of the Interior's Office of Surface Mining, soils engineers are also working to reduce nonpoint source damage from acid mine drainage by monitoring erosion plans and assisting with the development of mine restoration plans. Although this is a severe problem in the State overall, it is not significant within the target watersheds draining to the Chesapeake Bay.

- To receive a solid waste permit under the Solid Waste Management Act of 1980, operators of landfills must have erosion and sedimentation controls, which are reviewed by BSWC engineers.

- The Dam Safety and Encroachments Act of 1978 requires a permit from DER for any obstructions or encroachments upon streams or waterways in the State. The Bureau of Dams and Waterways Management issued over 1,000 permits and waiver letters in 1983 alone.

- Some educational assistance funding program activities are addressing non-agricultural problems. For example, the State's Bay program has presented workshops demonstrating conservation and nutrient/toxic management programs for homeowners. Such workshops have included identification and disposal of household hazardous materials, and the discussion of the role of the homeowner in soil and water conservation.

MARYLAND

A COMPLEX NETWORK OF COOPERATION

Rather than residing in one centralized program office, Maryland's NPS program involves a complex network of participants in several agencies and offices. The three that share the primary responsibility for various aspects of NPS management are:

- The Office of Environmental Programs (OEP) within the Maryland Department of Health and Mental Hygiene, which takes the lead in administering EPA implementation grant funds and is responsible for Statewide water quality management planning to address all nonpoint sources. This office also coordinates management approaches for point and nonpoint sources and is responsible for urban stormwater demonstration projects in established urban areas. The Department of Health and Mental Hygiene initiates enforcement actions when needed in agricultural pollution situations.

- The Maryland Department of Agriculture (MDA) directs a multi-faceted conservation program based on a complex network of cooperation. Maryland's agricultural program delivery system synthesizes components involving USDA (Soil Conservation Service, Agricultural Stablization and Conservation Service, and the Cooperative Extension Service); the University of Maryland's Agricultural Experiment Station; other Maryland State agencies (e.g., Department of Health and Mental Hygiene/Office of Environmental Programs, Department of Natural Resources); local county agencies; and local soil conservation districts. MDA's Soil Conservation Administration funds and coordinates technical and financial assistance, outreach, education, and research. The agricultural nonpoint source program is implemented primarily through conservation districts.

- Maryland's Department of Natural Resources (DNR) regulates a variety of nonpoint sources of pollution: urban stormwater and construction erosion (Sediment and Stormwater Division, forestry (Forest, Park, and Wildlife Service), and silvicultural sediment (Water Resources Administration). This department also oversees surface mine reclamation and shoreline protection programs. Local conservation districts and local government provide technical assistance to carry out many of the programs administered by DNR.

In addition to the efforts of these three departments, the Chesapeake Bay Critical Area Commission was established to control growth within a critical area surrounding the Bay. The Commission oversees and reviews locally prepared protection programs.

Table 2.13 summarizes State and Federal funding for Bay programs in Maryland.

CBP Funds are Enhancing Programs and Promoting Innovation

Federal funds have been instrumental both in providing needed enhancements of existing State NPS programs and in supporting cleanup efforts of a more innovative nature. EPA funds, for example, supplement state funding for its agricultural cost-share program.

A large portion of EPA's implementation grant monies has been requested for innovative projects in non-structural shoreline erosion control, forestry, and stormwater mnagement. Many of these projects are solely or largely dependent upon EPA grant monies for their initiation. For example, the Susquehanna River basin is the focus of a proactive forest management project that encourages landowners on highy erodible soils to plant trees as buffers along streams. EPA grant funding has helped develop nine urban stormwater BMP projects. One is complete and one is under construction, while others are in various design phases. EPA grant funds also supported the Patuxent River model watershed project to help realize the integrated point/nonpoint source nutrient reduction goal through innovative design, construction, and operation of sewage treatment facilities.

MARYLAND's AGRICULTURAL NPS CONTROL PROGRAM

Program Goals and Approach: Comprehensive Solutions Within a Short Time

Maryland has committed major funding and program effort to installing BMPs on farms, since agricultural sources contribute significantly to Bay pollution. The goal of one of the State's 34 Chesapeake Bay initiatives is to have conservation plans in place on all farms in priority watersheds within 5 years and on all Maryland farms within 10 years.

The lead agency for agricultural activities in the State, MDA administers funding and develops programs in support of agriculture and water quality. Maryland's agricultural conservation program is based on five key elements:

- Technical Assistance--The State helps farmers to plan, design, and install BMPs.
- Financial Assistance through Grants--Individuals receive a portion of the cost of BMP installation through the Maryland Agricultural Cost-Share (MACS) Program, EPA implementation grant monies, and other Federal funding sources.

TABLE 2.13 **COMBINED** STATE AND FEDERAL FUNDING FOR MARYLAND'S BAY PROGRAM*

PROGRAM AREA	FY 1984-85 FUNDING	FY 1985-86 FUNDING	FY 1986-87 FUNDING
Maryland Agricultural Cost-Share Program	--	$3,175,000	$3,201,275
Non-structural Shore Erosion Control Projects	$225,000	$450,000	$500,000
Susquehanna Forestry Project	--	$82,250	$82,250
Anacostia Surface Mine Reclamation	--	--	$200,000
Point Source Nutrient Reduction	--	--	$419,025
Shallow Marsh Stormwater Project	--	$200,000	--
Patuxent River Basin Proj.	--	$107,000	--
Stormwater Projects in Urban Areas	$1,075,000	$335,750	--
Towser's Branch Project	$160,000	--	--
Marine Pumpout Projects	$90,000	--	--
Rtes. 2 and 50 Stormwater Retrofit Projects	$200,000	--	--
TOTAL (Federal+State)	$1,750,000	$4,350,000	$4,402,550
State Funds	$875,000	$2,175,000	$2,201,275

*Includes Chesapeake Bay Program implementation grants only (EPA funds and State match); additional State monies are used for the NPS program.

Source: Maryland Chesapeake Bay Program Annual Grant Applications, FY 1984-85, 1985-86, and 1986-87, Office of Environmental Programs.

- Education and Outreach to Farmers--Current ideas are spread about agricultural NPS control related to agricultural productivity and water quality.

- Continuing Research on Agricultural Practices--The University of Maryland Agricultural Experiment Station studies the effects of agricultural practices on resources and their relative cost-effectiveness. USDA's Agriculture Research Service assists these investigations.

- Incentives and Enforcement--Federal and State grant assistance and technical support provide incentives for voluntary corrective actions by farmers. OEP holds authority for formal enforcement action.

Targeting Approach: Focus on High-Nutrient Watersheds

State resources for agricultural cleanup activities are allocated to the priority watersheds with the greatest potential for NPS loading. The State Conservation Committee appoints a technical team that identifies the priority watersheds. Ranking is based on the potential for NPS nutrient pollution, which is, in turn, derived from factors such as soil and land characteristics and management, general cropping patterns, and animal waste load.

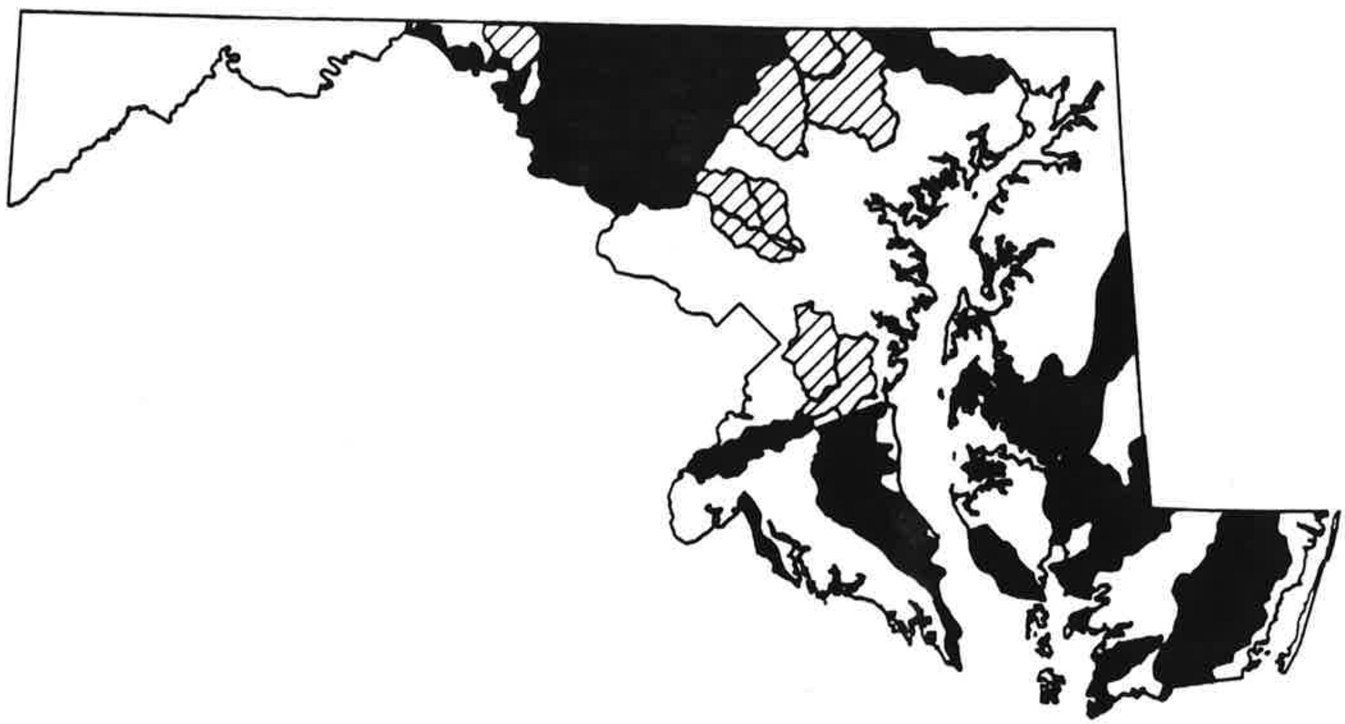
Conservation districts are the implementing agencies for the agricultural NPS program, which includes the agricultural cost-share program. Conservation district efforts are concentrated on Statewide priority watersheds and the identification of critical local conditions, including providing assistance to farms with confirmed water quality violations. The MACS Program directs funds to 25 priority watersheds on the basis of their potential to release phosphorus. In addition, State funds are targeted to three subwatersheds in the Patuxent River basin and five subwatersheds in reservoir watersheds for a total of 33. These priority watersheds are shown in Figure 2.3. EPA grant funds in the cost-share program are directed only to the top 24 priority watersheds. [9]

Implementation: Cost-shared BMPs for Critical Areas Plus Technical Assistance in Planning and Analysis

Through the soil conservation district outreach program, staff work with landowners to develop conservation plans. In 1985 and 1986, more than 2,000 conservation plans were developed, resulting in the installation of over 5,000 BMPs and reduced erosion on 179,222 acres of cropland. In addition, 165 animal waste control facilities were constructed. [10]

District staff also encourage farmers whose lands have reached "critical conditions" to apply for funds as part of the MACS Program. The program provides up to 87.5% cost sharing, which is supplemented by private funds. One million dollars in EPA implementation grants was applied to MACS in FY

FIGURE 2.3 MARYLAND'S AGRICULTURAL COST-SHARE (MACS) PROGRAM PRIORITY AREAS



■ Top 24 Watersheds (EPA Grant Funds Are Targeted Here)

▨ Other MACS Priority Watersheds (Funded with State and Non-EPA Monies)

Source: Maryland Department of Agriculture.

1985 and again in 1986, with an additional $1 million requested for 1987. In addition, the Maryland General Assembly appropriated $22 million between 1984 and 1987 to support the MACS program through use of State bond funds. State-funded projects may also use cost-share funds from the Agricultural Stabilization and Conservation Service (ASCS). ASCS provides up to $3,500 per project as part of its cost-share program. The cost-share ratio varies from 50% to 75%. ASCS paid out a total of $1,694,017 in Federal FYs 1985 and 1986 for BMPs. [11]

Table 2.14 provides a summary of the 1,978 BMPs installed Statewide under the MACS program during the 3-year period ending June 30, 1986. Cost-share funding was provided for 18 types of BMPs and has been refined to include 14 BMPs. Maximum cost-share available is $10,000 per project and $25,000 per farm. A pooling agreement for mutual problems on adjoining farms allows $20,000 maximum per project.

The Cooperative Extension Service's Soil Testing Lab is offering a 2-year program of free manure analysis for farms. This technical assistance is being sponsored with MDA funds to encourage proper use and management of animal waste. Soil conservation district staff, together with extension agents, work to inform farmers of the availability of these services.

Research and Demonstration Projects: Showcase Tours, Monitoring, Modeling, and Research

The Chesapeake Bay initiatives provided funding for a study of the effect of BMPs on water quality. This study is being conducted at Indian Town Farm along the Chester River in Queen Anne's County. This demonstration project is designed to determine costs of installing BMPs and effects on farm income, as well as determining the extent to which BMPs protect water quality. This "showcase" project is intended to educate the agricultural community on the reduction of agriculturally related NPS pollution. Between October 1985 and November 1986, local extension agents gave 11 tours for 295 people. [12] USDA's Soil Conservation Service (SCS) and the local conservation district cooperate with the University of Maryland and MDA in this effort.

MDA has entered into a Memorandum of Agreement (MOU) with the University of Maryland Cooperative Extension Service and Agricultural Experiment Station for activities that include evaluating demonstration farm results and other research findings and incorporating them into the State's agricultural NPS program. State funding for this program has totalled $943,000 from 1985 to 1987.

Maryland has funded additional research through a separate MOU with the University of Maryland Agricultural Experiment Station. State funding for these programs has exceeded $400,000 from 1985 to 1987. Research activities include:

TABLE 2.14 CONSERVATION PRACTICES COMPLETED UNDER MACS PROGRAM BETWEEN JULY 1983 AND JUNE 1986

TYPE OF BMP	NUMBER INSTALLED
Cropland Protection	
No-till/minimum till	94
Contour farming	1
Cover crop	63
Diversion	85
Strip-cropping	28
Terrace	45
Permanent Vegetation Cover	
Critical areas planting	139
Filter strip	5
Windbreak	3
Grazing Land Protection	
Spring development and troughs	199
Water Protection Grade Stabilization	
Structure	315
Grassed waterway	674
Lined waterway	18
Sediment basin	17
Water Control	
Pond	171
Animal Waste	
Waste storage pond	27
Waste storage structure	87
Waste treatment lagoon	7
TOTAL	1,978

Source: Maryland Agricultural Water Quality Cost-Share Program, Program Summary, Maryland Department of Agriculture, December 31, 1986.

- Small plot evaluations of nutrient movement under varying fertilization and management schemes in Clarkesville, MD;

- Investigation on coastal plain research watersheds at Wye Research and Education Center, measuring runoff from no-till and conventionally tilled cropland;

- Ground-water monitoring of nitrates; and

- Economic analysis of selected BMPs.

MDA and the Agricultural Experiment Station recently agreed to study the effectiveness of controlling nitrogen discharge from agricultural land by managing riparian vegetation. The FY 1987 budget for this effort is $64,000.

OEP gathers and compiles data on ambient water quality for the Bay and its tributaries. In August 1982, the Office began to develop a major monitoring and modeling program that will identify critical NPS regions in the Patuxent River basin. This effort will also allow evaluation of the effectiveness of BMPs in minimizing water quality impacts and permit forecasting of the water quality impacts of various land-use policies. The principal objective is to develop a water quality management tool that will permit OEP to address a broad range of point and nonpoint source pollution assessment goals for the Patuxent River basin. After an extensive evaluation of alternatives, OEP now proposes to undertake a 7-year program in cooperation with the Maryland office of the U. S. Geological Survey. OEP will participate in the development of certain components of the system, including a compatible data base for the Patuxent watershed monitoring and modeling study.

OEP also conducts a number of special studies, which, for instance, test the relationships among BMPs, land use, and NPS loads. OEP is currently monitoring three agricultural sites in the Chester River basin to determine potential contributions from various land uses.

Another monitoring effort, sponsored by EPA and the USDA Rural Clean Water Program, was conducted at ten sites over 2-1/2 years in the Monocacy River basin to characterize NPS discharges from various land uses.

Education: Plans, Brochures, and Outreach

Maryland has expanded its information and education programs at the State and local levels and has directed them toward promoting water quality BMPs and developing conservation plans. MDA and the University of Maryland education and outreach program for the agricultural community focus on conservation and farm management planning for the control of soil erosion and agricultural NPS pollution. MDA, the Cooperative Extension Service, and conservation districts together have published and disseminated brochures on maintaining agriculture productivity and water quality. These brochures describe the assistance available, report research results, and describe BMP strategies to deal with problems.

A subcommittee of the State Soil Conservation Committee has put together a comprehensive education program. Conservation districts, assisted by the SCS, also provide education to landowners and include outreach as part of their annual plans. The various demonstration projects described in the previous section are also effective in educating farmers.

Enforcement: Fostering Voluntary Compliance

Maryland law authorizes the OEP to take enforcement action against all known polluters of Maryland waters. The 1979 agricultural water quality plan spelled out basic procedures to be followed when water pollution incidents from farm activities were suspected. These procedures, evolved over the last 7 years, resulted in the MOU signed in December 1986 by Maryland's Departments of Agriculture, Natural Resources, and Health and Mental Hygiene. This MOU formalized roles and responsibilities, and defined a multi-step process for coordination and cooperation among agency staff in attaining compliance by farmers. The procedures provide for immediate "formal" enforcement actions in cases of deliberate water pollution, and a graduated "voluntary compliance" approach for all other cases of farm-based pollution.

Of the 56 complaint cases received by OEP since 1984, 18 farmers reached compliance voluntarily, three were referred to the Waste Management Administration of OEP after voluntary compliance failed, four were immediately referred to the Waste Management Administration, and eight are pending. No action was required in 23 cases. [13]

MDA also has a procedure for spot-checking BMPs cost shared under the MACS program to assure that they are properly maintained during their lifespan. Each year, staff inspect 10% of the projects completed to date to assure their maintenance and continued compliance.

MARYLAND'S URBAN NPS CONTROL PROGRAM

Program Approach: Firm Standards Demanded

The laws Maryland has passed since 1970 have resulted in programs that control stormwater runoff and erosion and sediment. Revisions to these laws and regulations have led to improved legal tools and alternative system designs that address NPS pollution and water quality concerns.

The 1970 Erosion and Sediment Control Law directed local governments to adopt and implement sediment control ordinances. This law involves the review and approval of sediment and erosion control plans by local governments including conservation districts. In 1984, long-standing concerns over enforcement caused the State to assume jurisdiction over all local programs. Delegation of enforcement authority was offered to localities whose enforcement program was comparable to the State's. In 1985, the Water Resources Administration within Maryland's DNR developed new regulations requiring submission of erosion and sediment control plans and stabilization of graded land within 14 days of disturbance. Training seminars and additional staff have resulted in 11 counties receiving renewed responsibility for program management. [14]

The 1982 Maryland Stormwater Management Act required counties to adopt stormwater management ordinances for new development. By July 1984, all localities had adopted ordinances. The State hired staff and formed the Sediment and Stormwater Division within DNR to oversee programs Statewide.

The regulation of urban nonpoint sources is centered in DNR; its Water Resources Administration regulates sediment and erosion control and stormwater management through the Sediment and Stormwater Division. However, OEP leads the State's "demonstration grant" program on stormwater management for existing urban areas.

Targeting Approach: Various Factors are Analyzed

Urban BMPs are concentrated on growth areas and on redesigning stormwater management systems in developed areas. No targeting procedure is followed per se, but factors like site suitability for demonstration design, local NPS problems, availability of land, and local participation and cooperation are part of the process of project selection.

Implementation: Technical Assistance for New Developments and BMPs Cost-shared in Established Areas

The costs of BMP implementation are not shared for new developments. However, OEP's program does provide a cost-sharing program at the local level for retrofitting established urban areas with stormwater management practices. The program has a 75%/25% State/local split. Projects may be located on public or private lands. As of April 1986, six projects were underway with more than $1 million in FY 1984 State funds, and now a further $1 million has been made available. [15] This funding has been enhanced by implementation grants from EPA totalling $560,000 in 1984 and $642,750 in 1985. In addition, a 1984 Bay initiative resulted in installation of stormwater management systems on State lands at two locations at a total cost of $500,000 in State funds.

In FY 1986, DNR awarded more than $1.46 million in State general funds for local government staff positions in stormwater management through 100% grants-in-aid to 17 counties and 6 municipalities. [16] State general funds now total $1.7 million for local staff to review plans and inspect projects. The Sediment and Stormwater Division has prepared a series of manuals, guidelines, and technical papers addressing minimum water quality objectives for infiltration practices, maintenance of stormwater management structures, and design of wet ponds. State staff advise developers and practitioners on the design and review of projects.

Research and Demonstration Projects: Practices Tested in Many Locations

The EPA funds that OEP has provided to DNR and several local jurisdictions have resulted in a series of urban demonstration projects. Nine urban stormwater demonstration projects have been funded via the EPA implementation grants between 1984 and 1986. [17] By the end of 1986, five of the nine EPA-funded demonstration projects were in the final design stage, and four projects were either ready to start or had begun construction. These projects demonstrate a cross-section of BMPs, including infiltration, artificial wetlands, first flush interceptors, and redesign of existing detention basins. Among the EPA-funded projects underway are:

- A project to demonstrate the effectiveness of infiltration BMPs for stormwater control along Maryland Routes 2 and 50.
- An infiltration BMP with water quality monitoring at Towser's Branch.
- A regional stormwater project at Washington Suburban Sanitary Commission's Hanover Parkway, including the creation of a shallow marsh.
- Three separate stormwater management retrofit projects in Baltimore City.
- Shallow marsh stormwater projects at two locations to demonstrate effectiveness in controlling stormwater pollutants;
- An infiltration BMP at a county school and park near Town Point, St. Mary's County, Maryland; and
- A first flush interceptor installed upstream from a wet pond as part of the Foxhill Pond project.

Many of the urban NPS projects under design or construction have an experimental component. The State plans to fund continued monitoring of selected projects so that long-term effectiveness for controlling water quality can be assessed. These results will reinforce the technical assistance and education elements of the demonstration projects.

DNR'S Water Resources Administration is involved in several ongoing research activities selected to improve program effectiveness. Its Sediment and Stormwater Division is involved in a series of efforts including: working cooperatively with the U.S. Geological Survey on a 5-year project to investigate the impact of infiltration practices on ground water; development of criteria and investigation of water quality improvements from placement of marshes and shallow swales in urban areas; a study of the maximum discharge rate from stormwater outfalls for prevention of channel erosion; and revision of the standards and specifications for sediment control practices.

Education: Training Engineers, Planners, Developers, and Teachers

An important component of the educational program related to urban NPS is demonstrating the feasibility of new and innovative systems to engineers, planners, and developers. Many of these systems are designed to place major emphasis on water quality considerations. Educational opportunities are considered in developing each project. In one instance, the selection of a site for an artificial wetland adjacent to a school parking lot has provided students with an opportunity for field instruction. Several of the demonstration projects described previously also entail educational opportunities.

Training and conferences also enhance education. A day-long training session for inspectors and developers was organized in February 1987. The meeting attracted 157 participants and provided a forum for discussion of BMPs as part of the development process. Future annual winter meetings are planned. In addition, an annual State conference has been organized since 1985 on urban NPS control.

NPS issues are an integral part of certain special training programs. Teacher training curricula and special field-based programs comprise the Maryland environmental education initiative. This initiative is an aggressive effort by the State's educational community to enhance and expand environmental education programs for students. In addition to classroom work, students are encouraged to become actively involved in solving environmental problems. Whether planting trees to improve buffers, reviewing stormwater management at construction sites, or simply sharing their knowledge with adults, students are contributing to solving NPS problems.

Enforcement: Control at State and Local Levels

DNR has established rules and regulations that local programs must follow in managing urban runoff. A series of standards and specifications describes the techniques that localities must use to comply with DNR requirements. The State has the authority to require necessary corrective actions where local stormwater management programs are inadequate. In addition, the State must approve all local ordinances, guidelines, and practices. In this way, Maryland maintains control over both local and State-run programs. State inspection staff were recently expanded to approximately 30; Statewide there are a total of approximately 100 State and local inspectors for sediment control. [18]

MANY OTHER NPS PROGRAMS EXIST IN MARYLAND

The Critical Area Program seeks to control growth and protect resources around the tidal waters of the Bay and its tributaries. A 1,000-foot wide strip of land bordering these waters has been established as a "critical area." Within it, local jurisdictions seek NPS-related controls on (1) intensely developed areas, (2) limited development areas, and (3) resource conservation areas. Planned and existing developments, as well as farms, must assess adverse water quality impacts and strategize improvements. Localities must also consider future mining operations, combat shoreline erosion, and protect wetland habitat. Now in the planning stage, all local programs must be implemented by June 1988. Critical Area Program staff are focusing technical outreach attention on local planners.

CRITICAL AREA PROGRAM:
A SPECIAL APPROACH FOR A SPECIAL AREA

Maryland's Critical Area Program seeks to control growth in a 1,000-foot-wide strip of land around the tidal waters of the Bay and its tributaries. The program involves adoption of locally prepared protection programs based on criteria established by the Critical Area Commission. The Maryland General Assembly enacted a law in 1984 establishing the Commission and providing for its staff. Since its inception, the program has undertaken an intensive planning process, held hearings, and established criteria approved by the Maryland General Assembly in 1986 for local program plans. Local jurisdictions are now developing their implementation plans. Approximately $2.5 million is available to local governments for program plan development.

The criteria require local jurisdictions to classify their lands into one of three categories based on existing land use. In intensely developed areas, special attention is given to improving the quality of runoff from existing and proposed development. Retrofitting to solve stormwater problems is encouraged for local programs, and evidence of corrective measures must be provided. Also, an assessment must be made of the extent of adverse water quality impacts from existing developments in intensely developed areas and a strategy prepared for reducing these effects. In limited development and resource conservation areas, forests, non-tidal wetlands, and other habitat areas are to be protected by a variety of provisions (such as buffers) when the local jurisdiction reviews new development proposals. Another prescribed technique is to limit the density of future development (e.g., one dwelling per 20 acres in resource conservation areas).

For agricultural areas, soil conservation and water quality plans and BMPs are required for all farms inside the critical area within 5 years. Local programs must incorporate agricultural components of Maryland's water quality management plan. Local program regulations are to be established limiting the alteration of tidal and non-tidal wetlands.

The criteria also require local jurisdictions to adopt limitations addressing other nonpoint sources, such as future mining operations and shoreline erosion. Non-structural shoreline measures are to be used instead of structural measures, where possible. Habitat protection buffers will be required: 100-foot buffers for stream and tidal wetlands, a 25-foot setback for non-tidal wetlands, and protection of fish spawning streams. Local jurisdictions are also to provide for the protection of the watersheds of non-tidal wetlands when land disturbance activities are proposed.

Technical assistance under the Critical Area Program is designed to provide an understanding to local planners of how to interpret and work within the criteria for local critical area programs. With this in mind, the Critical Area Commission published a guide that provides a detailed description of the criteria and the process for development, approval, and adoption of local critical area protection programs. Local protection programs are to be submitted to the Commission in 1987 and must be implemented by June of 1988.

Nonpoint sources of pollution from forestry are controlled by various means. These include tax breaks for owners who maintain long-term BMPs, laws requiring a sediment control plan for activities affecting more than 5,000 square feet of forest, and several initiatives for controlling NPS in forested land inside the critical area, including a cost-share program for sediment and erosion control measures. In an effort to retain existing forest land within the 1,000-foot critical area, the Maryland Forest, Park and Wildlife Service has set a goal of preparing 1,500-2000 forest management plans for 40,000-60,000 acres over the next five years. Targets for implementing sediment control plans and reforestation have also been determined. Forestry operations are inspected for compliance with regulation and law. Staff of the Forest, Park, and Wildlife Service and the Water Resources Administration of DNR implement these programs.

The Susquehanna River Forestry Project is a special 10-year effort that targets property owners within an area of 4,300 acres of highly erodible land in the Maryland portion of the Susquehanna basin. EPA implementation grants provided $82,250 a year for this project over the past 2 years. Owners of property with highly erodible soils were identified and encouraged to participate in the program via a letter offering technical assistance in plan development. A forest management plan that outlines rehabilitation measures is prepared by the Service for landowners. Tree planting will be used to establish buffers along streams. As part of this project, several demonstration plots will be established to educate the public about good forestry practices designed to reduce erosion.

The Shoreline Protection Program seeks to reduce sediment loading from shoreline erosion. Both structural and nonstructural means are deployed. DNR implements these measures under the Shore Erosion Control Law, which was passed in 1968 and amended in 1971 and 1981. Program goals include educating the public about shore and bank erosion, assisting in formation of shore erosion control districts, and providing technical assistance to landowners and local governments.

Since 1985, EPA has provided implementation grants for numerous demonstration projects for non-structural shoreline protection in Bay counties. In FY 1986, EPA funded projects totaling $450,000. These monies are being used to develop projects at Jefferson Patterson Park Museum and in the upper reaches of the Choptank River. At the Jefferson Patterson Park Museum, innovative breakwater structures are being installed, and landward fill areas are being planted to accumulate sand and reduce future erosion. In the upper Choptank, properties are being selected that meet suitability criteria for non-structural shoreline protection measures and that have landowners who are willing to share the cost of implementing the measures. These projects will result in the creation of additional marsh land as well as reduction of sediment pollution in striped bass spawning grounds.

The Shoreline Erosion Control Construction Loan Fund supports the Shoreline Protection Program approach. Over its 19 years of operation, this revolving loan program has funded structural projects that have checked sediment loading from 25 miles of shoreline. The nonstructural approach uses cost sharing and implementation grants to establish intertidal marsh vegetation, build innovative breakwater structures, plant landward fill to retard erosion, and emplace BMPs on private land. CBP funding is used in this program.

Surface Mine Reclamation is one of the strategies for improving water quality in the Anacostia River. Maryland seeks to abate sediment derived from abandoned sand and gravel pits that contribute a large fraction of the sediment load. DNR's Water Resources Administration is carrying out an abandoned mine project to halt erosion and to plan reclamation activities. EPA grant funds of $200,000 were made available through OEP to cover the construction costs of this project in FY 1986. The total project cost is $739,000, with the balance of funds to be provided by the State Surface Mined Land Reclamation Fund.

Marine pumpout facilities are being planned and built with EPA implementation grants where boating effects are severe and in shellfish harvesting areas. Three of six planned facilities will be installed in 1987: at Crisfield, Annapolis, and Kent Island.

Innovative techniques for reducing nutrients are being applied at some point sources. The Patuxent River watershed is a model watershed for testing the State's integrated point/nonpoint source nutrient reduction strategy, and is being funded with $229,225 in EPA grant monies in FY 1986, and a projected $500,000 in FY 1987. Bay grant funds will be used by OEP primarily to develop and install demonstration processes, i.e., alternative treatment plant systems for small- and medium-sized plants (1 to 10 mgd). An additional $119,800 in EPA implementation grants was given to Maryland in 1986, to be applied to improvements of wastewater treatment plants located on confined embayments in the Eastern Shore. Inadequate flushing of embayments was resulting in water quality problems.

DISTRICT OF COLUMBIA

THE URBAN CHALLENGE

The District of Columbia's nonpoint source controls focus strictly on urban approaches, since the District has no agricultural land. Two agencies share responsibilities for managing nonpoint sources of pollution in the District. The Department of Consumer and Regulatory Affairs (DCRA) plays the lead role in developing regulations, approving construction plans, and conducting inspections of building sites. The Department of Public Works (DPW) installs stormwater management facilities and demonstration projects in the City, and carries out program planning activities.

Grant funding began in 1984 with a grant of $227,273 to DCRA. Most of 1985's $725,000 grant was transferred to DPW to assist its Bay efforts ($626,000); DCRA thus retained $99,000 for its program efforts. In 1986, each agency received a grant--DCRA received $250,000, while DPW's share was $443,825.

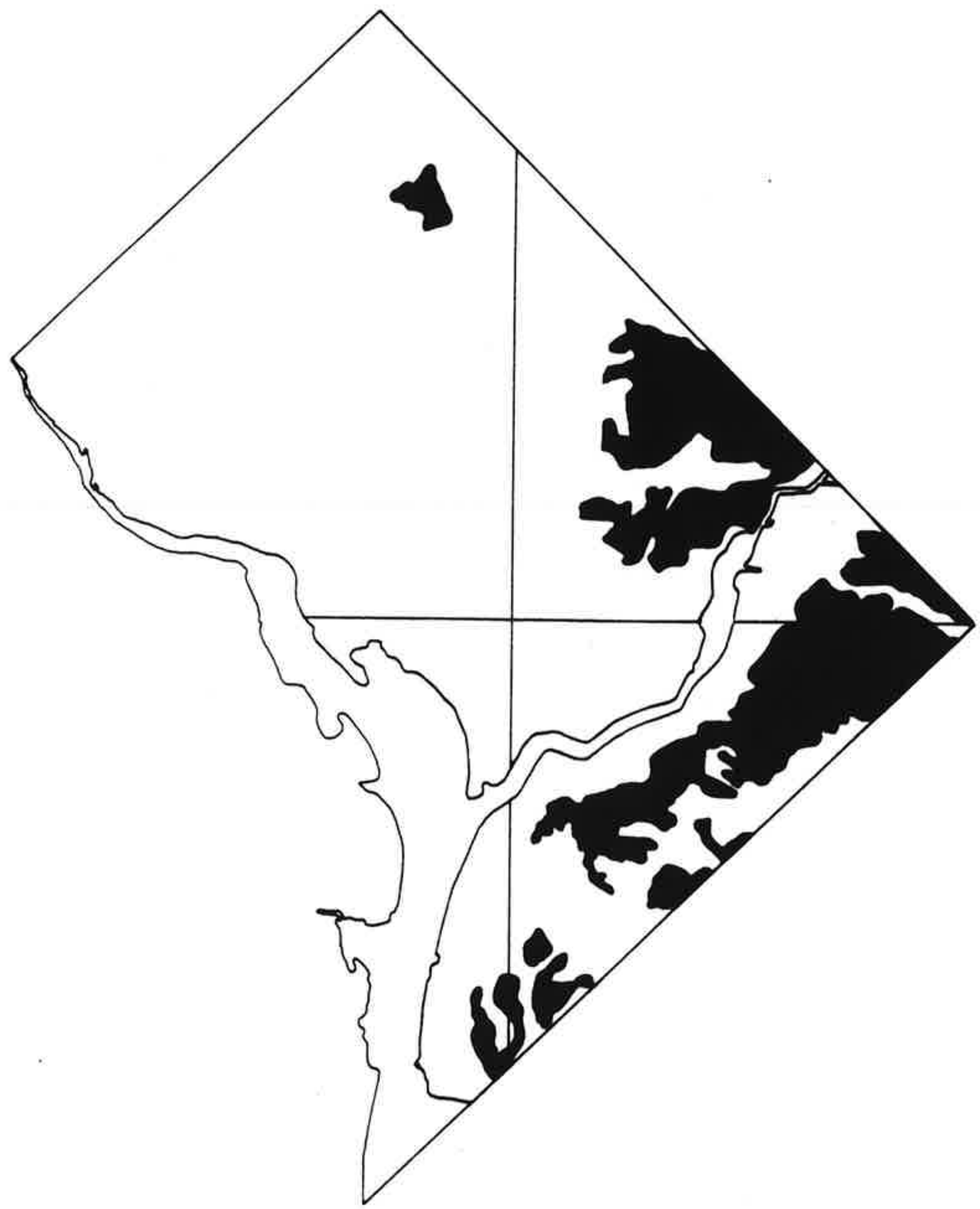
Urban runoff from the District of Columbia has been estimated by DCRA staff to contribute 40,000 pounds of phosphorus; 40,000 pounds of metal (copper, mercury, lead, and cadmium); and 40 million pounds of suspended solids. These amounts are in addition to combined sewer overflows. Certain specific problems typical of urban situations have specific solutions. For example, modifications to the yard of a public transportation repair shop and training of its employees are expected to help ameliorate the oil pollution it generates.

About 28% of the land area in the District is controlled by the Federal government. [19] These Federal lands are currently exempt from the erosion and sediment control law. In addition, most of the shoreline is under Federal control.

The most erosive soils in the District--a Christiana-Sunnyside soil association--are found mainly in the northeast and southeast quadrants (see Figure 2.4). Such soil is generally underlain by kaolinite and montmorilonite clays. These clay soils also cause problems with building foundations, since they are likely to shift and cause the foundations to slide.

The District has two river systems that drain into the Bay--the Anacostia and the Potomac. Each has several tributaries over which the District has jurisdiction. A major portion of the Anacostia watershed is in Maryland, so control efforts must be coordinated among the appropriate jurisdictions, i.e., the State of Maryland, Montgomery County, Prince Georges County, and the District. Most streams in the District have long been covered or piped, which further influences the program direction.

FIGURE 2.4 HIGHLY EROSIVE SOILS OF THE DISTRICT OF COLUMBIA



■ Christiana-Sunnyside association: urban land and deep, nearly level to steep, well drained soils that are underlain by unstable clayey sediment; on uplands

Source: General Soil Map District of Columbia, USDA Soil Conservation Service, US DOI, National Park Service, National Capital Press, 1975

THE DISTRICT HAS FOCUSED CBP FUNDS ON NPS IN THE ANACOSTIA RIVER

EPA funds have allowed the District to begin to address the Anacostia River's problems through monitoring (DCRA) and demonstration projects (DPW). With these funds, DCRA has also been able to develop stormwater regulations and hire additional staff for reviews and inspection. DPW actively tries to tie Bay and existing activities together, to gain maximum benefit and effectiveness from both. DPW conducts a spring cleanup program involving collection of large items and used chemicals, and advertises its benefits to the Bay. DPW is working with the D.C. Energy Office on programs to increase recycling of oil. The spring meeting of the Interstate Commission on the Potomac River Basin (ICPRB) is focusing on the Anacostia, providing an opportunity for the District to inform the public of its cleanup activities.

THE DISTRICT'S URBAN NPS CONTROL PROGRAM

Overview and History: Controlling Runoff from Intensive Development

Control of nonpoint sources in the District of Columbia is focused entirely on management of urban runoff. DCRA reviews erosion control and stormwater management plans, conducts inspections, and develops regulations, while DPW focuses on developing ways to remove pollutants from collected runoff before it reaches the river systems. These programs are described in the following sections. Table 2.15 describes how the program funds for fiscal years 1984 to 1986 were to be spent.

The goals of the stormwater management program are to control NPS pollution by establishing regulations that ensure developers will use the appropriate measures to control stormwater runoff from their projects, and by educating citizens about measures they can take to reduce pollution from runoff. The erosion control program operates with the goal of regulating land disturbing activities to prevent accelerated erosion and sedimentation of the Potomac and Anacostia Rivers and their tributaries.

The District of Columbia has had an erosion and sediment control law in place since 1977 (D.C. Law 2-23). DCRA staff use guidelines and criteria established under that law to regulate erosion from construction. More recently, the City has undertaken to regulate post-construction stormwater runoff, again using the authority of the 1977 law. Stormwater management regulations were developed by DCRA starting in 1985 and are currently awaiting final review by Corporation Counsel, with publication tentatively set for September 1987.

DCRA's Bay program efforts started in 1984; DPW's involvement in the Bay program began in 1985. Both agencies have focused on planning projects and developing important contractual relationships, as well as on hiring staff to implement the program. DCRA reached full staff strength in February 1986.

TABLE 2.15 COMBINED DISTRICT AND FEDERAL FUNDING FOR THE DISTRICT'S BAY PROGRAM*

PROGRAM AREA	FY 1984-86 FUNDING
Program Development and Administration	$1,490,000
Educational Program	160,000
Implementation Projects	1,640,000
TOTAL	$3,290,000
District Funds	$1,645,000

*Includes Chesapeake Bay Program implementation grant funds only (EPA and District match).

Source: Data summary from U.S. Environmental Protection Agency, Chesapeake Bay Program Office, Annapolis, Maryland.

An important tool in carrying out the District's program is cooperation with the Metropolitan Washington Council of Governments (COG). Cooperative efforts include contracting with COG to develop and install a sediment control project on the Anacostia River. COG is assisting with the monitoring project soon to be started by DCRA. These efforts allow a unified approach to solving the problems on the Anacostia, since must of the river is in Maryland.

Targeting Approach: Project Size, Timing, and Citizen Complaints Drive Inspections

The water that runs off District land surfaces very quickly enters a stream or sewer system whose ultimate destination is the Bay. In an overall sense, then, formal targeting is not a high priority. Because urban construction problems tend to be very localized in nature and because many more inspections are needed than can be performed by the three assigned inspectors, staff emphasize inspection of major construction sites, visiting them more frequently than smaller sites. However, inspection staff realize that it is important to visit sites at certain critical times, particularly early in the development process. In general, staff goals are to inspect major sites daily and single home sites weekly. Citizen complaints receive top priority.

Because of the attention given to the Potomac and its tributary Rock Creek by various programs in the past, their water quality has improved significantly. Thus, the District is focusing current efforts on the Anacostia River, which still requires a major cleanup effort. DPW is working on a project to reduce sediment loading to the Anacostia particularly in the River Terrace area. The lessons learned from this project will be transferred to other sites where retrofitting for stormwater management is needed. DCRA is also focusing on the Anacostia through a comprehensive program, described below.

Implementation: Guidance on BMPs and Technical Assistance through Inspection and Education

DCRA Soil Resources Branch activities related to the erosion control program include the following:

- Review and approval of construction erosion control plans;
- Inspections to ensure implementation of erosion control plans;
- Investigating and correcting sedimentation from land disturbing activities;
- Updating of erosion and sediment control standards and specifications;
- Conducting educational activities and developing informational materials; and

- Developing a monitoring program to assess effectiveness of erosion and stormwater management programs.

DCRA reviews between 1,000 and 1,600 construction plans each year. [20] In addition, the staff annually review about 200 stormwater management plans from developers who are complying voluntarily with the proposed regulations. [21] In addition to developing the stormwater management regulations, program activities include development of a guidebook for developers and homeowners containing criteria and guidelines for stormwater management, which will serve as a companion to the regulations. DCRA provides staff support to the soil and water conservation district through a full-time acting district manager.

The conservation district is managing two special projects: streambank rehabilitation on Watts Branch and stabilization of a large hillside that is eroding at the Phelps School. In addition, the conservation district is working with the District's fisheries management program to construct an outdoor education and conservation facility in 1987.

The construction erosion control program is paid for with District funds. Other program activities are funded jointly by the Bay program and the District. DCRA plans to cross-train staff to conduct both stormwater and erosion plan reviews and inspections. Currently, DCRA staff review voluntarily submitted stormwater plans. Much of the District's stormwater management effort has been in the demonstration project described below.

DPW also conducts a vigorous program of cleaning 27,000 catch basins to prevent discharge of sediment and debris into waterways. [22] This program is used as part of the District's matching funds.

Research and Demonstration Projects: Monitoring and Controlling Stormwater

DCRA is beginning a monitoring program in conjunction with COG to assess nonpoint source pollution by collecting data during precipitation events in tributaries and at storm sewer outfalls to identify and quantify NPS pollutants. Approximately $250,000 of FY 1986 EPA Chesapeake Bay funds have been allocated to this monitoring effort.

DPW is developing plans for a demonstration sediment control facility to relieve siltation and sedimentation problems from stormwater runoff reaching the Anacostia River in the River Terrace area. DPW obtained $626,000 of FY 1985 EPA Chesapeake Bay funds to study the problem and determine the best solution. Many constraints, such as National Park Service control of most of the shoreline, will shape the ultimate project. DPW obtained an additional $443,000 from EPA in FY 1986 to implement the findings of this project in other parts of the District.

Education: Publications and Outreach to Local Residents

DPW's public information efforts include developing publications such as "From the Waters of the District to the Chesapeake Bay." DPW also participates in outreach activities such as the annual "Riverfest" celebration, which includes educational booths on the District's environmental programs as well as other festivities. Informational materials focus on water quality issues to educate District citizens about how they can contribute to the Bay restoration effort. In addition, DCRA has developed a homeowner BMP brochure, "You Can Improve Your Natural Environment," to provide information about practices that individuals can implement to help improve Bay water quality through correct use of fertilizers, proper waste disposal, etc. While these outreach efforts have been successful, shortage of staff means that outreach activities are often given a lower priority than other program activities. Chesapeake Bay Program funds for 1984 to 1986 have supported development of these educational materials.

Another publication, "Homeowner's Urban Guide on Ground Maintenance for Washington, D.C." presents information on preventing soil erosion as well as a wide range of advice on planing and maintaining urban property. The conservation district prepared it with a grant from the Department of Housing and Community Development.

Enforcement: Cumulative Penalties

DCRA has three inspectors who monitor construction sites for compliance with site plans and erosion control standards. Violators are subject to a maximum fine of $300 per violation, or imprisonment for a maximum of 10 days. Once a notice of violation is issued, if the site does not come into compliance as ordered, each day out of compliance counts as additional violation. The District can also seek an injunction to force violators to halt activities until the problem is mitigated. The D.C. police have authority to issue citations for noncompliance, also, and this authority is used to augment the inspection capability of DCRA.

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3. EFFECTIVENESS OF BEST MANAGEMENT PRACTICES

INTRODUCTION

Best management practices (BMPs) are methods, measures, or practices that prevent or reduce water pollution. They include, but are not limited to, structural and non-structural controls and operation and maintenance procedures. While BMP selection is based on technical feasibility, site-specific conditions are also determinants. Environmental, topographical, political, social, and economic factors can all come into play [1]

Remedial control measures are needed for agriculture because acreages under monoculture and row cropping have steadily increased; also, conventional management practices expose the soil to the erosive forces of wind and rain. The use of pesticides and fertilizer without proper management practices increases the potential for water quality degradation. In developing and urban areas, control measures are needed to reduce the amount of runoff from impervious surfaces and from areas where soil is disturbed through construction activity; these control measures are designed to control both quantity and quality of runoff.

BMPs yield varying degrees of effectiveness. Success depends upon:

- Proper Targeting--The land areas and specific sites chosen must be those contributing pollution to the Chesapeake Bay.
- Skillful Planning--The farmer or developer must play a part in selecting BMPs that are not only effective, but compatible with the enterprise being conducted.
- Good Implementation--The plan must be carried out in a timely and high-quality way.
- Maintenance--BMPs must be kept up in ensuing years.

This chapter discusses specific BMPs being used by the Chesapeake Bay jurisdictions to control NPS pollution. The effectiveness of various agricultural and urban BMPs is presented. The chapter is separated into these two categories, although some of the BMPs can be used to control runoff from more than one type of nonpoint source.

AGRICULTURAL BMP EFFECTIVENESS

Effectiveness Hinges on the Nature of Pollutants

How effective is a BMP or a mix of BMPs at limiting the movement of pollutants into waterways? This determination depends on four characteristics of the pollutants themselves. Successful BMPs attack:

- The availability of pollutants--This factor can be influenced by reducing the amount of fertilizer or pesticide applied, or by changing the timing or method of its application. Nutrient and pesticide management are frequently used as BMPs that influence availability.

- The detachability of pollutants--The soil surface can be protected from raindrop energy that detaches soil particles and facilitates their transport in runoff. The important element of BMPs intended to reduce detachability (see Table 3.1) is the extent to which the land surface is protected by crop residue or live plants. The percentage of vegetative cover during a rainstorm event actually determines the effectiveness, regardless of which BMP is used.

- The solubility of pollutants--Potential pollutants like fertilizer can be influenced by using a less soluble or "slow release" form, which releases N or P over a period of time.

- The transportability of pollutants--can be influenced by controlling the rate and path of runoff waters in such a way that the pollutants are "captured" in transit before reaching the receiving waters. Transportability of pollutants can also be influenced by reducing the volume of runoff water during a rainstorm. This can be accomplished by increasing the infiltration rate of the soil with land cover. Another way to reduce the volume of runoff water during a rainstorm is to create surface storage at the point of raindrop impact. This strategy is very effective until the capacity of created storage is reached, then runoff occurs as if the storage did not exist. Table 3.1 shows how various BMPs affect these three transportability factors.

Effectiveness Depends on the Way BMPs are Combined

Understanding the way BMPs work together is essential to the effective control of pollutants in agricultural runoff. When a BMP "system"--more than one BMP, in other words--is applied to the same land, effectiveness is cumulative, but it is not additive. Here is an example. Assume that conservation tillage is applied to a field that has had an annual erosion rate of 45 tons per acre. If at least 80% of the ground is under cover at all times, the effectiveness of this BMP is 90%, and will yield a reduction in erosion of 40.5 tons per acre, leaving an annual erosion rate, then, of 4.5 tons/acre. If contour strip cropping with an assumed effectiveness of 50% is added to conservation tillage, the additional erosion reduction would be 2.25 tons per acre (one-half of 4.5 tons), resulting in an average annual predicted erosion rate of 2.25 tons per acre.

TABLE 3.1 BMP EFFECTS ON FACTORS AFFECTING POLLUTANT MOVEMENT

BMP	DETACHABILITY	TRANSPORTABILITY		
		Surface Storage	Rate and Path	Volume
Cover Cropping	X			X
Conservation Crop Sequence	X			X
Conservation Tillage	X			X
Diversions/Terraces			X	
Crop Residue Utilization	X			
Pasture Management/Planting	X			X
Contour Strip Cropping	X		X	
Contour Farming		X	X	
Grass Filter Strips			X	
Sediment Detention Ponds			X	
Grassed Waterways			X	
Soil Surface Roughness		X		

Soils, Topography, and Land Use Affect BMP Needs

Topography and soil texture determine the level of BMPs needed to provide adequate NPS pollution control. On steeper and longer soil slopes, the erosion potential is greater and so is the need for more effective BMPs.

As regards soil texture, pollutants often attach to tiny clay particles because these colloidal particles are electrically charged. Table 3.2 shows monitored loadings of nitrogen and phosphorus in the Occoquan/Four Mile Run watershed by soil type, land use, and management type.

TABLE 3.2 LOADINGS OF NITROGEN AND PHOSPHORUS IN OCCOQUAN/FOUR MILE RUN WATERSHED IN VIRGINIA

Land Use/ Management Type	Silt Loam Soils	Loam Soils	Sandy Loam Soils
		(lbs/acre/year)	
Conventional Tillage Cropland			
N	17.0	11.1	3.8
P	3.71	2.42	0.83
Conservation Tillage Cropland			
N	5.2	3.2	1.1
P	2.32	1.52	0.52
Pasture Land			
N	5.7	3.7	1.3
P	0.91	0.59	0.20
Forest Land			
N	1.67	1.09	0.37
P	0.19	0.12	0.04

Source: <u>Occoquan/Four Mile Run Nonpoint Source Correlation Study</u>, Prepared for Metropolitan Washington Water Resources Planning Board by Northern Virginia Planning District Commission, Falls Church, VA and Virginia Polytechnic Institute, Blacksburg, VA, 1978, p. 43-44.

The data in Table 3.2 indicate that: (1) loadings of N and P are greater from finer textured soils than from coarser textured (sandy) soils, (2) conservation tillage cropland produces less N and P in runoff waters on all soil types than conventional tillage, (3) pasture land yielded N loadings similar to conservation tillage but significantly less P loadings than conservation tillage, and (4) forest land yields the lowest pollutant loadings of all agricultural land uses.

Structural and Non-Structural BMPs

Non-structural BMPs are an integral part of the crop production system and must be reapplied each year as components of the crop production process. Each farmer's style of farming is based on personal preferences. Equipment and other resources are available to support a particular style of farming. Also, the farmer has developed confidence in following relatively standard procedures, which, for that farmer, have historically produced satisfactory results.

Structural BMPs are generally applied with off-farm resources such as a skilled contractor who has special equipment for installation. Structural BMPs usually require less of the farmer in terms of learning new skills.

The application of BMPs may require a significant change in the farmer's style of operation, and a period of readjustment may be needed to provide opportunity for the farmer to gain confidence in the revised crop production system. Various forms of technical assistance are essential to "sell" the farmer on the short- and long-term advantages of BMPs. Continuing technical assistance is essential to provide encouragement and troubleshooting when the farmer has problems and is tempted to return to more familiar methods. Economics and the return on investment are major selling points to be communicated to the land user. Acceptance and long-term management are often dependent on the BMP being able to "pay its way" with on-farm benefits. Farm income and market conditions play a major role in BMP implementation.

AGRICULTURAL BMPs AT WORK AROUND THE CHESAPEAKE BAY

Several BMPs, singly or in combination, have been successfully used in the Chesapeake Bay watershed. Some of the more important BMPs currently being used, along with their applicability and the primary pollutant(s) controlled, are shown in Table 3.3. These BMPs are discussed in the following sections. Each BMP is described, and its effectiveness is discussed.

Animal Waste Management

Management of animal waste usually involves both storage and proper use of waste as fertilizer on agricultural land in order to improve crop production and reduce transport of pollutants by runoff waters.

TABLE 3.3 BMPS APPLIED TO AGRICULTURAL LAND IN THE CHESAPEAKE BAY WATERSHED

BMP NAME	STRUCTURAL/ NON-STRUC.	POLLUTANT CONTROLLED				LAND USE APPLICABILITY						
		N	P	Sediment	Pesticide	Crop	Pasture	Orchard	Conversion to Pasture	Conversion to Woodland	Critical Areas	Non-agricultural
Animal Waste Mgmt.	Both	X	X	X	X	X	X	X				
Conservation Crop Sequence	Non-struc.	X	X	X	X	X						
Conservation Tillage	Non-struc.	X	X	X	X	X	X					
Contour Farming	Non-struc.	X	X	X	X	X		X				
Contour Strip Cropping	Non-struc.	X	X	X	X	X						
Cover Cropping	Non-struc.	X	X	X	X	X		X				
Critical Area Stabil.	Non-struc.			X			X			X	X	X
Diversions & Terraces	Structural	X	X	X	X	X		X				X
Grade Stabilization	Structural			X		X	X	X				X
Grass Filter Strips	Non-struc.			X		X	X	X				X
Grassed Waterways	Both			X		X						X
Integrated Pest Mgmt.	Non-struc.				X	X	X	X	X	X		X
Nutrient Management	Non-struc.	X	X	X		X	X	X	X			X
Pasture Management	Non-struc.	X	X	X			X					
Pasture Planting	Non-struc.	X	X	X			X		X			
Sediment Deten. Ponds	Structural	X	X	X	X	X		X				X
Tree Planting/Forest Buffer Strips	Non-struc.	X	X	X						X	X	X

Waste is usually stored in steel, concrete, or earthen structures large enough to hold at least 6 months of waste production. This allows for flexibility in timing of use of the waste. Waste is held for as much as several years in some cases. Also, diversion of outside runoff water is an important component if animal loafing areas receive outside runoff water from surrounding land or roof tops. Runoff water from animal loafing areas is diverted through a filter strip and allowed to infiltrate there or stored for application on the land.

Effectiveness is highly dependent upon the design of each system and its efficient operation. Diverting outside water to a safe path around contaminated areas prevents clean water from becoming polluted by flowing through contaminated areas. Containment of animal wastes and land spreading at the proper time can reduce phosphorus runoff by 50 to 70%. [2] Timing, method, and rate of application are controllable management factors that influence both the effectiveness of the material as a fertilizer and the degree to which pollution of runoff water is prevented.

Vegetative filter strips are effective for removal of sediment and other suspended solids from surface runoff from loafing areas or feedlots, provided that the flow is shallow and uniform and the vegetative filter strips have not been previously filled with sediment. See the "Grass Filter Strip" section for further discussion of this BMP's effectiveness.

Barnyard runoff controls in Wisconsin that met all Soil Conservation Service (SCS) standards reduced total phosphorus loadings by 80 to 99%. SCS standards included upslope diversions, gutters and downspouts, filter strips, and grassed waterways. [3]

Conservation Crop Sequence

Different crops are grown in recurring succession on the same land, instead of continuous culture of one crop. Rotations that include a sod crop can reduce erosion losses from 40 to 90%, increase organic matter and infiltration, and improve yields of the cash crop. [4] The economic loss in years when a cash crop is not grown reduces the acceptability of this practice. Effectiveness is dependent upon the crops rotated and the way crop residues are managed. Increased amounts of crop residue on the soil surface throughout the year will increase effectiveness.

Conservation Tillage

This practice includes any tillage and planting system that maintains at least 30% of the soil surface covered by residues of the previous crop after planting. Different types of conservation tillage are:

- No-Till--The soil is left undisturbed prior to planting. Planting is done in a narrow seedbed approximately 1-3 inches wide. Weed control is accomplished primarily with herbicides.

- Ridge-Till--The soil is left undisturbed prior to planting. Approximately one-third of the soil surface is tilled at planting with sweeps or a row cleaner. Planting is completed on ridges that are usually 4-6 inches higher than the row middles. Weed control is accomplished with a combination of herbicides and cultivation. Cultivation is used to rebuild the ridges.

- Strip-Till--The soil is left undisturbed before planting. Approximately one-third of the soil surface is tilled at planting time. Tillage in the row may consist of a rototiller, in-row chisel, etc. Weed control is accomplished with a combination of herbicides and cultivation.

- Mulch-Till--The total soil surface is disturbed by tilling prior to planting. Tillage tools such as chisels, field cultivators, discs, sweeps, or blades are used. Weed control is accomplished with a combination of herbicides and cultivation.

- Reduced-Till--Any tillage and planting system that meets the 30% residue requirement.

Conservation tillage has been found to reduce edge-of-field soil losses from 60 to 98%, depending on tillage method, soil cover, soil type, slope, and crop grown. No-till studies have generally found soil loss decreases of 80 to 98% compared to conventional tillage. [5] Conservation tillage systems reduce surface losses of phosphorus and nitrogen less than the loss of sediment, and may increase the amount of nitrogen in subsurface waters. The effect of conservation tillage on pesticide loss varies. Intensity of rainfall and time after application may affect pesticide loss. There are no conclusive results yet on the effect of tillage systems on ground-water quality. [6] However, research has shown that, while conservation tillage implies more reliance on pesticide usage than conventional tillage because reduced tillage may allow increased weed and insect populations, it does not necessarily require more pesticide usage. Of all conservation tillage practices, no-till appears to have more potential environmental problems associated with it than the others, e.g., it may require greater herbicide and insecticide use, it is difficult to incorporate N fertilizer and manure, and infiltration is greater. On the other hand, no-till clearly provides the most effective way of preventing erosion and movement of sediment-adsorbed chemicals. [7]

Conservation tillage systems will generally give higher crop yields relative to conventional tillage systems on well-drained soils or in dry years. This trend is reversed for poorly drained soils or during excessively wet years. Conservation tillage is considered by many scientists to be the single most effective and most cost-effective BMP; however, degree of effectiveness is related to the percent land cover at the time a runoff-producing storm event occurs.

Contour Farming

With contour farming, tillage operations follow the contour of the field perpendicular to the slope of the land. Crops are planted along these tilled contours.

Contouring can reduce soil loss by 50% on moderate slopes of 8% or less. Effectiveness decreases as the steepness of the slope increases. This BMP loses its effectiveness when the surface storage created by contour tillage reaches capacity or if the tillage marks begin to break down. Diversions or terraces are needed for contour farming to be effective on long slopes. [8]

Crop yields with contour farming may be higher under dry conditions, and lower when the soil is very wet or poorly drained.

Contour Strip Cropping System

Under this system, farming operations are performed on the contour with alternate strips of close-grown crops (such as grasses or legumes) and tilled row crops. This BMP reduces the velocity of water as it leaves the tilled area. Runoff water is absorbed in the close-grown crop strips to reduce the loss of nutrients and pesticides.

One study found that row crops and hay in alternate 50- to 100-foot strips reduced soil loss by about 50% compared with contour farming without strips. [9]

Cover Cropping

This BMP involves planting close-growing crops of small grain, grasses, or legumes, primarily for the purpose of soil protection outside the normal growing season. The usual alternative is to leave the land bare.

Erosion reduction depends upon when the cover crop is planted and the growth stage of the cover crop during the non-growing season. Erosion reduction rates are high (compared with continuous conventional till corn) when a dense rye cover is present until the time of planting. Effectiveness of cover crops may be lower when planted late, because fall growth is limited. Effectiveness is related to the amount of vegetation produced for soil cover. There is recent evidence that non-legume cover crops may reduce nitrogen leaching to ground water as a result of plant uptake. [10]

Critical Area Stabilization

This BMP is needed on areas where erosion has caused severe damage or where potential for erosion is high and the eroded soil can readily enter a body of water. Treatment sometimes consists of "land reclamation." Typical erosion control measures include: (1) sodding, (2) mulching, (3) seeding, and (4) excluding traffic.

Effectiveness varies with the site and its proximity to receiving waters.

Diversion and Terrace Systems

A diversion is an individually designed channel across a slope to divert surface runoff water for a specific conservation purpose. A diversion may be used to reduce the length of slope for erosion control or may be used to route runoff water around contaminated areas such as feedlots. An effective use of a diversion is to divert the path of runoff water around contaminated areas (such as loafing corrals for dairy cattle or potentially high erosion sites), thus preventing clean water from becoming polluted with animal wastes or causing erosion.

A terrace system is a series of earthen ridges designed to control rill and gully erosion by reducing the length of the slope. Terraces also trap soil that was eroded from areas above them. Systems of terraces are best suited to land with relatively uniform topography and slopes ranging from 3 to 7%. One study reported that a terrace with a vegetative outlet will trap 60 to 80% of the sediment moving into the terrace channel. [11] Terraces have been shown to reduce soil loss by 50 to 98% as compared to conventional tillage without terracing. Again, reduction of the loss of nutrients in surface runoff is not as great as for sediment, and subsurface nitrogen losses may increase.

Grade Stabilization Structures

These structures are intended to stabilize the grade of a gully or other watercourse, preventing further head-cutting or lowering of the channel grade.

Many complex factors influence effectiveness, including soil erodibility, climate, nature of the site involved, and flow characteristics. It is difficult to assign an effectiveness value that would be accurate across many sites. [12]

Grass Filter Strips

These practices are permanent strips of vegetation, which can be located near a stream or near a source of pollution, such as an animal feedlot, to filter pollutants from runoff water.

Filter strips are recognized as effective BMPs for control of silvicultural, urban, construction, and agricultural nonpoint sources of sediment, phosphorus, bacteria, and some pesticides. Parameters determining their effectiveness include: filter width, slope, type of vegetation, sediment size distribution, degree of filter submergence, flow rate, initial pollutant concentration, and uniformity of flow along the length of the filter. [13] Effectiveness diminishes as the filter strip accumulates sediment, however, and maintenance is difficult.

Grassed Waterways

This BMP consists of a natural or constructed waterway (usually broad and shallow) with an established cover of erosion-resistant grasses. It is used to conduct surface runoff down a slope. Grassed waterways are used primarily to prevent formation of a gully, to correct and stabilize an existing gully, or to guide flow of runoff in a prescribed path.

Integrated Pest Management

Integrated pest management (IPM) employs techniques designed to control diseases and insects while reducing the potential for chemical pollution of runoff. Techniques include: (1) selection of a pesticide with least persistence and low volatility, (2) timing of application to optimize performance, (3) choice of optimum method of application, and (4) use of resistant crop varieties, resulting in less need for chemical applications for pest control. Other changes in cultural practices may be employed under various circumstances. An effective IPM program should reduce pollutant loadings by at least 20 to 40%. Higher reductions have been reported.

Nutrient Management

Nutrient management involves controlling the rate, timing, and method of application of nutrients to minimize the potential of applied nutrients becoming pollutants in runoff and ground water.

Nutrient management systems that include soil and manure testing for available nutrients, splitting N applications, elimination of fall N applications, storage of animal waste, and nutrient application rates based on plant requirements, appear to be the most effective and cost-effective means of reducing N export to both surface and ground water. This BMP is recognized as the most important practice in controlling pollution of water by nutrients from agricultural lands. [14]

Pasture Management

This BMP involves manipulating the rate of of animal grazing, preventing overgrazing, and maintaining proper fertility so that forage crops provide adequate soil cover to prevent erosion and increase infiltration of water into the soil.

Effectiveness of pasture management in reducing nonpoint source pollution depends on the level of management practiced by the farmer to maintain good vegetative cover on the land. As such management and resulting cover increase, polluted runoff decreases.

Pasture Planting

This BMP entails establishing grasses and/or legumes for the purpose of forage for livestock grazing and hay production enterprise. It usually applies to land that is being converted from cropland; however, it can apply to re-establishment of permanent vegetation on pasture land that has been seriously degraded.

This BMP is most effective on poor cropland that is eroding at a high rate. Successful establishment of well adapted species will reduce erosion to a negligible rate. Establishment may be difficult on severely eroded land with little or no topsoil remaining. Effectiveness in reducing erosion is directly related to the density of the vegetation providing protective soil cover.

Sediment Detention Ponds

A sediment detention pond is a structure individually designed for the site to detain runoff water and trap sediment. Structures can be designed as wet basins (ponds), which are the most effective, or as dry basins for ease of maintenance.

Many complex factors influence effectiveness, including soil erodibility, detention time, physical characteristics of sediment, and flow characteristics. Sediment basins are discussed further in the urban BMP section of this chapter.

Tree Planting and Forest Buffer Strip

Tree planting provides excellent soil protection from erosion and improves soil condition, thereby increasing infiltration. An additional benefit is the wildlife habitat that a forest buffer strip can provide. A forest buffer strip is an established area of woody species adjacent to a stream.

Tree planting is most effective on marginal cropland with a high erosion rate. Successful establishment will reduce erosion to a negligible rate. Trees take a few years to reach full effectiveness. Establishment may be difficult on severely eroded land with little or no topsoil remaining.

A forest buffer strip is effective in removing nutrients from subsurface flow by uptake for plant growth. [15] Woody vegetation as a buffer strip along both sides of a stream provides an ideal environment for maximum reduction of nutrients in ground water moving toward the stream. Additional benefits are bank stabilization, reduced summer temperature of water, and some filtering of overland flow. [16] Effectiveness has varied considerably in studies of this practice.

OPTIMIZING BMP SYSTEMS

Any evaluation of BMPs for controlling nutrients (specifically N and P) from agricultural land must explore many questions. What is the impact of the BMPs on both surface and ground water? How do they affect the transport or loss of both sediment and nutrients? Are they technically feasible? Economically viable? Will the farmer accept them? Too often in the past, the larger picture has been overlooked in favor of the practice's absolute effectiveness in controlling a single pollutant (or even a single form of pollutant) being discharged to a single water source.

The following examples illustrate the complexity of systems evaluation:

- The use of no-till on permeable soils to reduce runoff and loss of P to surface water can result in greater infiltration and potential contamination of ground water by nitrate if nutrient management for nitrogen is not also considered.

- Expenditures of public cost-sharing funds for construction of manure storage facilities will have little environmental benefit and may even result in adverse effects if farmers have inadequate land for utilization or if the manure is improperly applied.

- Farmers using no-till on grain land to control sediment and P pollution of surface water may actually increase P levels in runoff water if manure or fertilizer is improperly applied to the land.

Clearly, a systems approach must be used for BMP selection and implementation for greatest benefits.

AGRICULTURAL BMPS AND SOCIOECONOMIC CONSIDERATIONS

Technical determinations regarding BMPs are certainly very important. Of equal importance, however, are socioeconomic factors related to the decision-maker who manages the land. Some of the significant factors are:

- <u>Size of Farm and Farm Income</u>--Research results have consistently demonstrated that conservation is more likely to be applied to larger farms. There also is a consistent, positive relationship between farm income and the use of conservation practices. [17] The need for investment in management, education, and machinery probably causes the lower rate of adoption of conservation tillage by small farmers, not lack of stewardship values. [18] Another study reported that 75% of the farmers (92% of the larger farmers) thought BMPs were cost effective. [19]

- <u>Farm Tenure</u>--The relationship between farm tenure (ownership) and use of conservation methods is less clear. Many studies have found a strong relationship between ownership and adoption of conservation measures, while others have found none. [20] Tenure, however, is a significant factor since absentee landowners may not take an interest in conservation; therefore, the renter is neither encouraged nor required to make use of conservation methods. In addition, many landlords are less inclined to give long-term leases, resulting in a shorter planning horizon for the decision-maker on the land.

- <u>Debt Service Requirements</u>--High debt service requirement is considered to be a negative factor in the adoption of conservation practices. Research indicated that high debt level would negatively affect conservation behavior in two ways: (1) more erosion-prone row crops must be planted to satisfy cash flow requirements, and (2) financing for conservation measures is more difficult since these do not provide immediate cash flow benefit. [21]

- Perception of the Problem--A farmer may have a serious conservation problem, but action is unlikely unless the farmer perceives it as a problem. [22]

- Perception of Economic Feasibility--A conservation system economically and objectively feasible may not be perceived as feasible by the farmer, who may therefore choose not to adopt it. Conversely, a conservation practice that appears to be economically infeasible on the basis of objective criteria may, nevertheless, be adopted. [23] Experience in Rural Clean Water Program projects where recommended BMPs were consistent with farmers' preferences showed that adoption rates of BMPs were high. Conversely, BMPs not preferred by farmers have relatively low rates of adoption. [24]

Thus, a NPS pollution control program or project with the goal of extensive participation cannot ignore the farmer. An understanding of the land characteristics shares equal importance with an understanding of the human resource. Many projects with conservation goals have failed to meet their objectives simply because the social characteristics of the landowners or managers were not adequately considered in developing the "marketing" strategy.

URBAN BMP EFFECTIVENESS: AN OVERVIEW

The Bay States and the District are using Chesapeake Bay implementation grant funds to help advance the understanding and use of various BMPs in urban settings. Control of erosion and sediment from construction is an important focus of the Bay program efforts in all Bay jurisdictions. Various BMPs are commonly used--in fact, are often required--for controlling erosion and sediment from areas under construction, e.g., filter fences, straw bales, etc. These practices are not discussed here, since for the most part they are not the subject of research or other funding under the Bay program. Furthermore, they are generally temporary, being removed once construction is complete. Maryland and Virginia have developed manuals that describe construction erosion control practices recommended for use in those states.

Practices are used to control stormwater from newly developing areas as well as for retrofitting to reduce runoff in established areas. Much of the available data on the effectiveness of the BMPs comes from previous research efforts such as the Nationwide Urban Runoff Program (NURP). State efforts to develop data on BMPs include comparison monitoring of porous and conventional pavement side-by-side in Prince William County, Virginia, monitoring of an extended detention dry pond in Fairfax County, Virginia, and studies of effectiveness of infiltration and other BMPs in various settings in Maryland. This section includes summaries of the available data on the following BMPs:

- Extended detention dry ponds;
- Wet ponds;
- Urban marshes;
- Porous pavement;
- Streambank stabilization; and
- Infiltration practices.

Each section that follows briefly describes one of these BMPs and then discusses its effectiveness and the cost of constructing it, when data are available. Where applicable, possible variations and any factors affecting its potential use are also mentioned. For example, maintenance is an important factor in BMP effectiveness. Maryland's Department of Natural Resources found that stormwater management structures are not very well maintained. Up to 70% of wet and dry ponds are not operating as designed. [25] Lack of maintenance can even result in BMP failure. Adequate planning and funding is essential to a successful maintenance program.

BMP costs vary widely, depending on the size of the area to be protected, but the relationship of costs to drainage area is not linear. The cost per acre generally is lower as the size of the protected area increases. Cost effectiveness varies, too. A recent study concluded that extended detention dry ponds offer a cost-effective method for control of nutrients and suggested that increasing detention time in existing dry ponds would be worthwhile. [26] More costly practices such as wet ponds are appropriate for larger sites, especially for "off-site" BMPs to control several developments.

Although infiltration practices in general were cost effective, infiltration trenches and porous pavement with runoff storage capability did not fare well in this analysis because of their higher cost. The authors suggested that small versions for water quality control along with dry ponds to reduce peak runoff might be an option for some situations. [27]

URBAN BMPs AT WORK AROUND THE CHESAPEAKE BAY

Extended Detention Dry Ponds

A detention basin is a pond designed to catch runoff from storms and thus control potential flooding and water quality problems. Conventional dry detention ponds are designed to briefly attenuate peak runoff rates, and thus, are normally dry except during brief periods after large storms.

Extended detention dry ponds are similar to the conventional dry ponds but have modified outlet structures which significantly extend detention time. The size of the outlet controls the release of water from the pond. One method to obtain extended detention is to install a perforated riser enclosed in a gravel jacket instead of an overflow pipe or bottom outlet. Many existing conventional dry detention ponds have been modified to extend the detention time.

Detention basins or dry ponds have been found to perform poorly at controlling pollution from stormwater runoff. [28] To correct some of the factors that limit the effectiveness of this practice, designers modified the basin outlet to slow the release of water from 1-2 hours to up to 24 hours. The additional time provided improved removal of some pollutants, similar to wet ponds for particulate pollutants. Table 3.4 shows that these basins can remove 64% of sediment, 30% of particulate organic nitrogen, 30% of chemical oxygen demand (COD), 57% of particulate zinc, and 84% of particulate lead. Soluble pollutant removal remained poor (less than 15% of total incoming

TABLE 3.4 COMPARISON OF DETENTION BASIN REMOVAL EFFICIENCIES (%)

PRACTICE	SEDIMENT	ORGANIC NITROGEN	COD	ZINC	LEAD	SOLUBLE NUTRIENTS	TOTAL PHOSPORUS
DRY POND	14	< 20	0	(-)		< 20	
EXTENDED DETENTION DRY POND	64	30	30	57	84	1-10*	15
WET POND	54	15	30	51	65		60

*Long-term removal of ortho-phosphorus was 1%, nitrate-nitrogen was 10%.

Source: Urban Runoff in the Washington Metropolitan Area, Final Report: Washington, D.C. Area Urban Runoff Project, Water Resources Planning Board, Metropolitan Washington Council of Governments, December 1983, p. 2.17-2.19.

dissolved nitrogen and dissolved phosphorus) because of the absence of a permanent pool within which biological reactions have an opportunity to occur in addition to sedimentation. [29]

Detention pond performance suffers when maintenance is neglected. Common problems include blocked outlets, bared soil, standing water in "dry" areas, pond area being too wet to mow, and excessive sedimentation (filling in). [30] Establishment of vegetation in the pond reduces the likelihood of scour or resuspension of pollutants. The amount of time water remains in the pond affects the removal of sediment. The cost of modifying a dry pond to achieve extended detention is about 10-12% of the cost for a dry basin. [31] This practice generally costs less than any other urban BMP designed to control water quality and quantity. Maintenance costs are about $300-500 per maintained acre per year. [32]

Extended detention dry ponds are a particularly promising practice because of their ability to combine flood control and water quality benefits, plus the potential for conversion of existing conventional stormwater management ponds. [33]

Wet Ponds

Wet ponds are similar to extended detention dry ponds, but are designed to maintain a permanent pool of water. The volume required to receive expected stormwater runoff must be calculated. A riser and overflow pipe control the rate of discharge of water. Rooted aquatic vegetation is generally present.

Wet ponds can be highly effective for pollutant removal, according to data from several NURP projects. Besides sedimentation, researchers believe that the permanent water pool's biological processes remove dissolved nutrients. Removal efficiency varies based on the size of the basin relative to the size of the area draining into it, along with local storm characteristics. [34] This basin size relationship controls the overflow rate. Where the overflow rate is low in relation to the settling velocity of the particles entering the basin, the removal efficiency is high. A design ensuring that only a small amount of water is forced out with each storm also boosts removal efficiency, since the bulk of the water resides in the pond for a long time. [35] For several wet ponds studied in the Washington, D.C. area NURP project, 54% of the sediment, 30% of the COD, 15% of the organic nitrogen, and 60% of the total phosphorus, along with 51% of zinc and 65% of lead were removed. [36]

Maryland is testing the use of a device upstream of a wet pond to intercept the first flush of sediment and other pollutants during a storm. State staff expect this device to increase the efficiency of removal.

The cost of constructing wet ponds may be as much as 40% higher than the cost for dry ponds due to the greater volume required to accommodate the permanent pool and the more complex outfall. NURP data suggest an annualized construction cost per acre of urban area of $60-$175 for on-site control or $10-$25 for off-site control. [37] The low figure in each case represents 50% removal of total suspended solids, while the higher figure represents 90% removal. The off-site application benefits from economy of scale, since it serves a much larger area (640-1,000 acres, as compared to 20-40 acres for the on-site application). Maintenance costs are similar to those for extended detention dry ponds ($300-500/year for routine maintenance, plus 1-2% of cost of construction for nonroutine maintenance). [38]

Urban Marshes

An urban marsh can be a natural or a constructed area that remains wet throughout the year and where marsh plants are available to increase sediment trapping and prevent sediment resuspension. Water channeled into it will be trapped for a period of time to allow for pollutant removal by natural processes. Marshes can be installed separately or as part of an extended detention pond. Wetland plants may also be established around the fringes of wet ponds.

Wetland and marsh areas have been used in treatment of municipal wastewater. They appear to work best with dilute nutrient loads. [39] Data related to their ability to remove sediment, nutrients, and metals from runoff are not available yet. At issue is whether or not the flow can be slowed enough to retain runoff in the marsh area for the period of time necessary to affect removal. Studies in Maryland and Virginia have begun, supported by the Chesapeake Bay Program. The construction cost of adding a marsh when building an extended detention pond is minimal, and a lessened need for mowing will reduce maintenance costs. Grading and vegetation generally cost less than $5,000. [40]

Porous Pavement

Normal pavement on roads, parking lots, and other paved areas can be replaced with a porous asphalt paving material underlain by a high-void aggregate base. Such pavement allows for infiltration of rain and runoff and temporarily stores the water. The four layers that typically make up a porous pavement installation include a sub-base of undisturbed existing soil; a layer of 1- to 2-inch diameter stone, underlain by filter fabric; 2 inches of 1/2-inch aggregate as a stabilizer; and a surface of porous asphalt 2-1/2 to 4 inches thick. [41] Typically, porous pavement is made from asphalt from which the fine particles are missing. Drainage systems can be used to solve problems with permeability of the underlying soil or where the pavement must be installed over an impervious base. [42]

Data from a NURP study in the Washington, D.C. area show high removal rates for sediment, COD, trace metals, and total nitrogen (greater than 80%), plus 60% removal for dissolved phosphorus and nitrogen. This study's results are based on calculated removal rates, however. [43] Other studies are underway, including a side-by-side monitoring project to compare conventional and porous pavement in Prince William County, Virginia. Porous pavement must be maintained to ensure long-term effectiveness. Periodic vacuum sweeping followed by high-pressure hosing seems to be the best cleaning technique. Once the pavement is significantly clogged, it may not be possible to fully restore it. Protection of the pavement from oil, grease, and dirt from contractor vehicles during the early life of the paved area is important, and installation of curbing to prevent surrounding soils from washing onto the paved surface is also recommended. [44] The lifetime performance of porous installations has not been tested. Pollutant removal occurs through rapid and complete infiltration into the soil profile, with adsorption, trapping, and chemical decay of pollutants in the soil. [45] Construction costs for porous pavement are higher than conventional pavement due to the higher cost of porous over conventional asphalt, the need for extra stones, filter cloth and test wells, and probably higher contingency costs. The annual maintenance cost has been estimated to be $0.032/square meter ($0.003/square foot). [46]

Streambank Stabilization

Vegetation is a common method of non-structural streambank stabilization. Virginia is carrying the use of vegetation a step further by studying a technique used in the southeastern U.S. and other areas called "biotechnical" streambank stabilization. This technique involves dormant woody plant cuttings, which are built into the streambank in bundles or layers. The cuttings sprout and provide both surface vegetative stabilization and deep root growth that stabilizes the soil and removes moisture from the soil to reduce sliding of the bank.

The effectiveness of biotechnical streambank stabilization has not been thoroughly studied. However, vegetation is generally an effective method of controlling soil erosion; grass plantings along shorelines have been found to be 90-95% effective in reducing soil loss due to erosion compared to bare surfaces. [47] Some biotechnical installations in the southeastern U.S. seem to be working well. Maintenance of such practices is critical to their long-term effectiveness.

The first examples of biotechnical stabilization installed in this area may cost as much as structural practices (bulkheads). However, with experience, later installations of biotechnical stabilization should be less costly.

Infiltration Practices

Increased infiltration is the goal of many BMPs, such as infiltration basins and trenches, dry wells, porous pavement (discussed above), and vegetative swales and filters. The design of these practices is discussed in detail in publications by the Maryland Department of Natural Resources and the Metropolitan Washington Council of Governments. Generally, they involve catching water in an area designed to hold the water long enough for it to move through the soil and be retained as ground water rather than to run off the site. A vegetative or grassed swale is a depression used in place of normal curb and guttering to convey water. It allows a portion of the flow to infiltrate. Infiltration trenches provide a coarse gravel filter or other area for temporary storage of stormwater while physical, chemical, and biological processes remove pollutants. [48] Sediment must be prevented from entering and clogging the stone void spaces. This calls for a vegetative strip surrounding the trench, plus filter fabric at the inlet. [49]

To be effective, infiltration systems should be designed to retain stormwater within the structure longer than is generally expected for ponds. Infiltration trenches can remove 50% of sediment and trace metals and 37% of COD, but provide little nutrient removal according to one study. [50] However, the Metropolitan Washington Council of Governments reports that higher removal efficiencies are possible--75-90% for sediment, 50-70% for total phosphorus, 45-60% for total nitrogen, and 75-90% for trace metals--if the capture of the "first flush" is high. This water contains the most pollutants. Grassed swales did not perform well in the NURP study, providing little pollutant removal. In the Washington D.C. area NURP effort, the lack of underlying soil porosity, limited retention time compared to soil infiltration rate, the high degree of slope of the swales, and frequent mowing of grass all served to limit the ability of the sites to filter pollutants, suggesting that effectiveness could be increased. The final nationwide NURP report also concluded that additional study of design considerations could improve performance of swales. [51] Maryland and Virginia currently have several studies of infiltration systems underway.

CONCLUSIONS AND RECOMMENDATIONS

Existing NPS control programs often have been based on use of a "system" of BMPs to reduce erosion. In recent efforts, the emphasis on solving specific problems in a cost-effective manner within the systems framework has increased. However, the effects of even large-scale adoption of BMPs will not be seen in the receiving waters in periods of less than 5 to 10 years. Data from some of the Rural Clean Water Program projects, Model Implementation Program, and other similar NPS activities will allow a more refined evaluation of the feasibility and cost effectiveness of the BMPs, though much work remains.

Findings on the effectiveness of BMPs give rise to several conclusions:

- Erosion reduction on cropland is generally proportional to the reduction in the amount of tillage performed.

- Since 48 to 98% of nitrogen and 87 to 99.6% of P in surface runoff is bound to sediment, sediment control practices can reduce the input of N and P from nonpoint sources. [52]

- A linear relationship between pesticide application rates and surface runoff losses is suggested by numerous studies. The implication is that improved spraying and integrated pest management techniques will reduce pesticide inputs to aquatic systems to the extent that they reduce the quantities applied.

- <u>Systems</u> of BMPs should be emphasized rather than individual BMPs.

- For maximum effectiveness, BMPs should be focused on lands that are producing the highest volume of pollution delivered to the Chesapeake Bay and its tributaries.

- The socioeconomic characteristics of the decision-makers (i.e., landowners and land managers) on targeted lands should be understood and a marketing strategy planned to gain a high participation rate.

- Technical assistance is essential to effective implementation and maintenance.

While the technology obviously exists for reducing sediment and nutrients in runoff, development of implementation programs will require consideration of socioeconomic realities, production concerns, and technical and institutional limitations--most of which are site-specific. Failure to analyze situations in a comprehensive way, ranking these factors appropriate- ly, can lead to real or perceived situations of substituting one environmental problem for another.